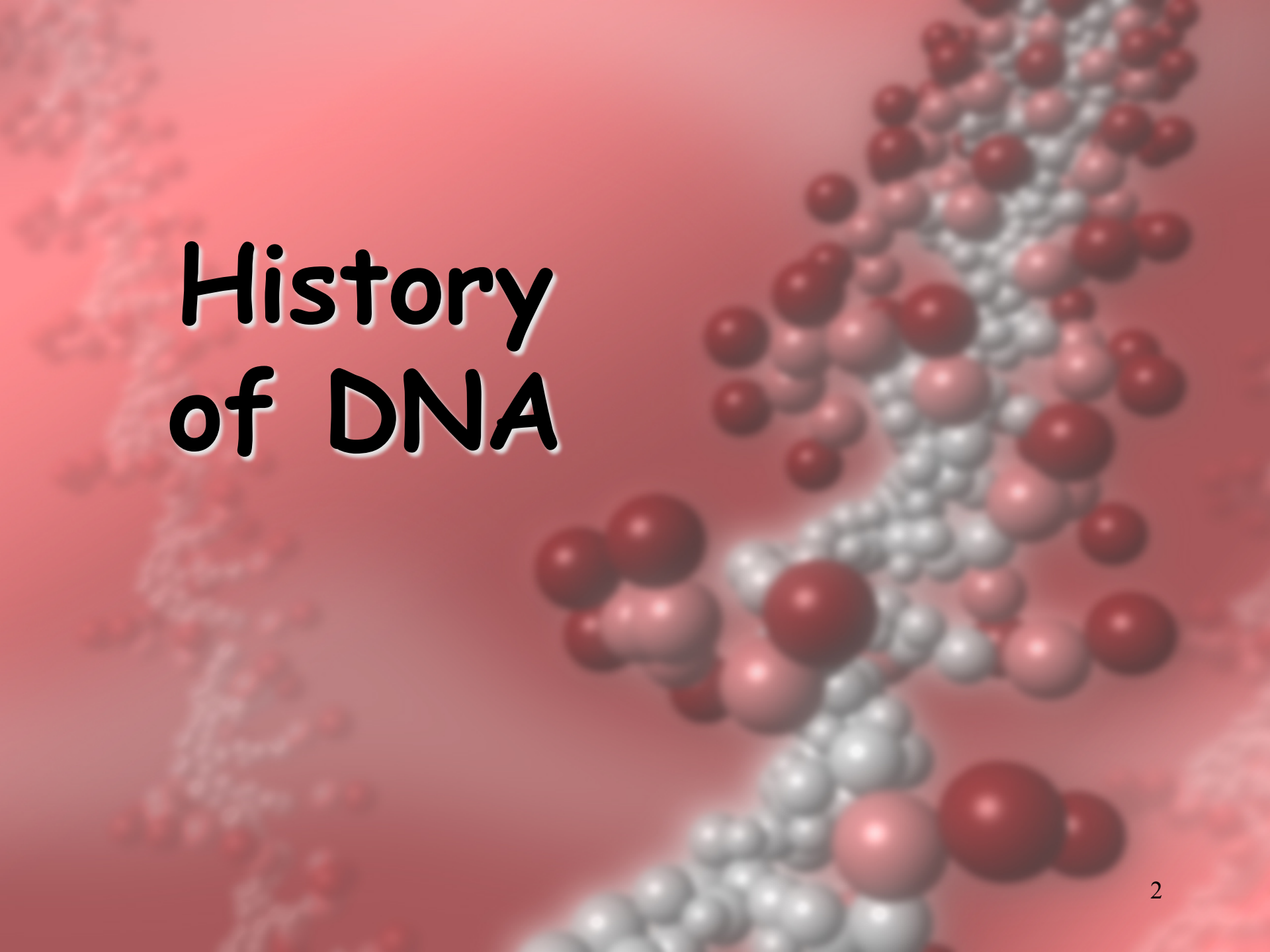
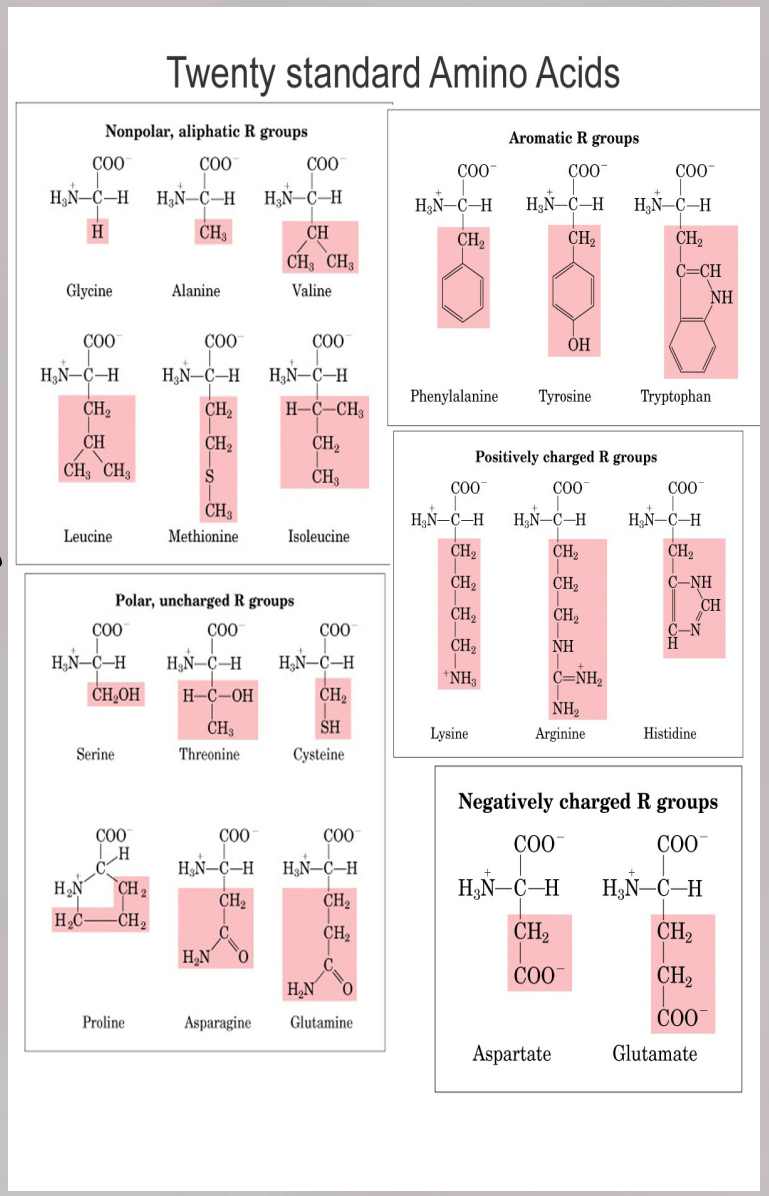
DNA and Replication

History of DNA



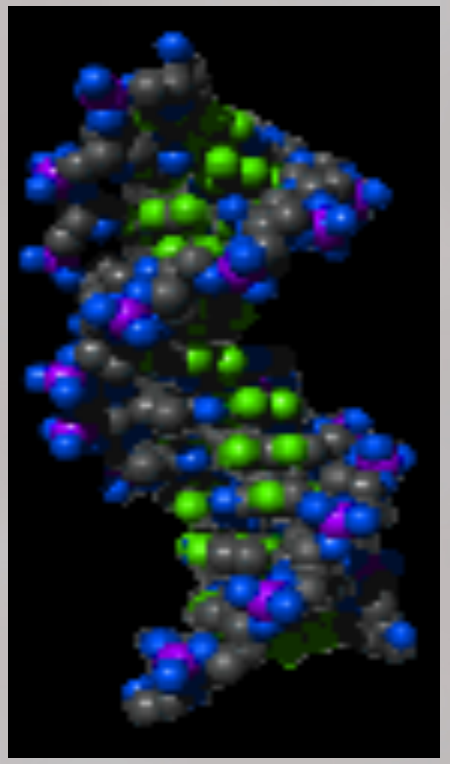
History of DNA

- Early scientists thought **protein** was cell's hereditary material because it was **more complex** than DNA
- Proteins had ***20 different amino acids*** in long polypeptide chains



Arguments for DNA

1. Found in nucleus
2. No other uses known.



The Discovery of the Structure of DNA

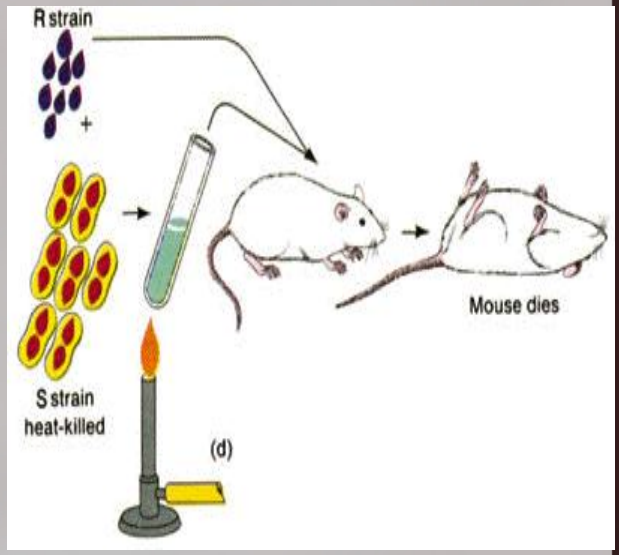
What is a Virus?

- A virus is nonliving
- Composed of DNA (Sometimes RNA)
- Have a protective protein coat
- n ho

Transformation

- 1928--Fred Griffith worked with 2 strains of Pneumonia causing bacteria
- Smooth strain (Virulent S) slime capsule (not seen by immune system and kills mice) *and*
- Rough strain (NonvirulentR) no capsule (easily killed)

- He found that R strain could become VIRULENT when it took in DNA from heat-killed S strain

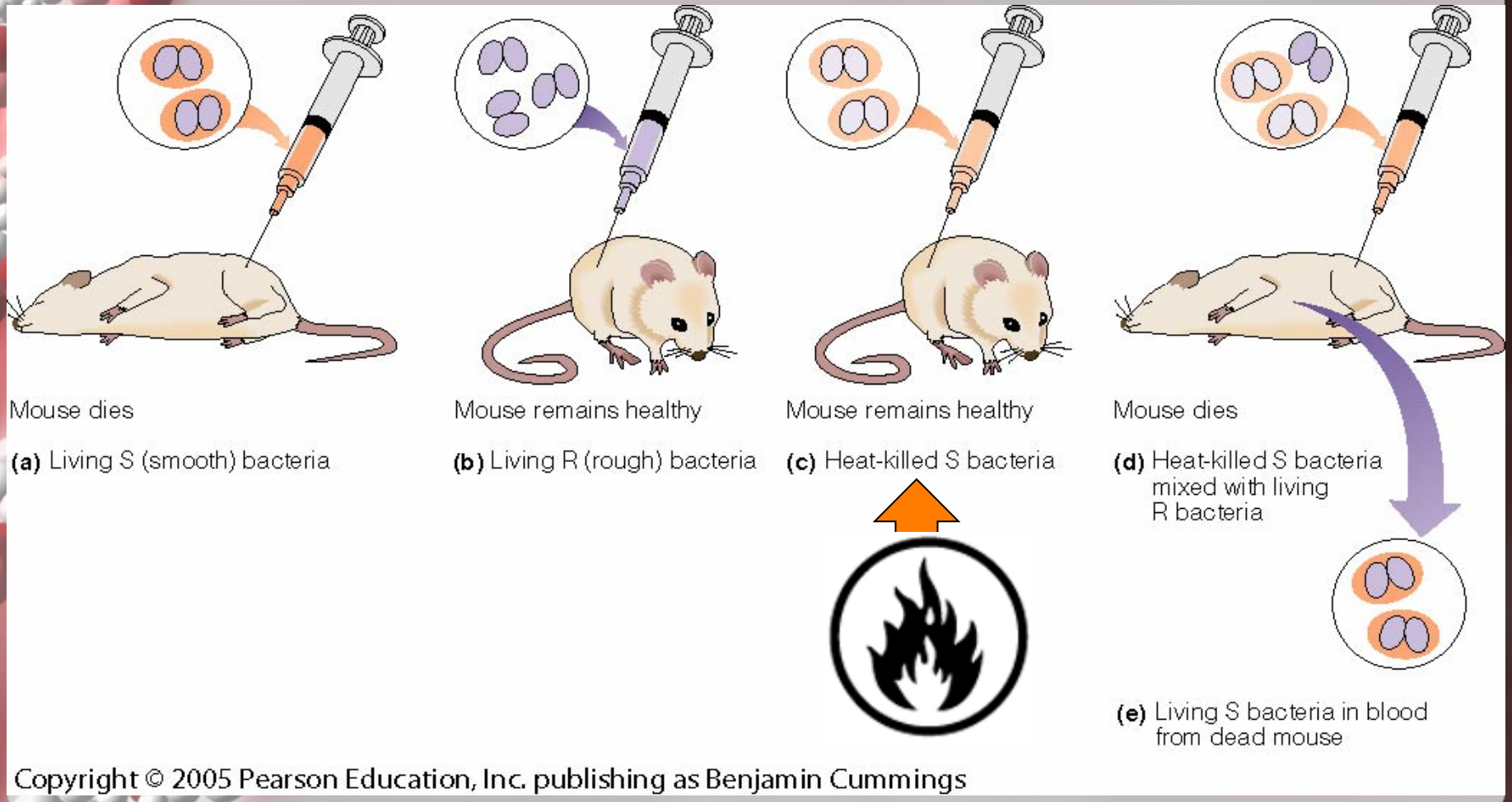


Pneumoccocus bacteria

Study suggested that DNA was probably the genetic material

Fred Griffith
Bacterial Transformation

This animation (Audio) describes Griffith experiment.



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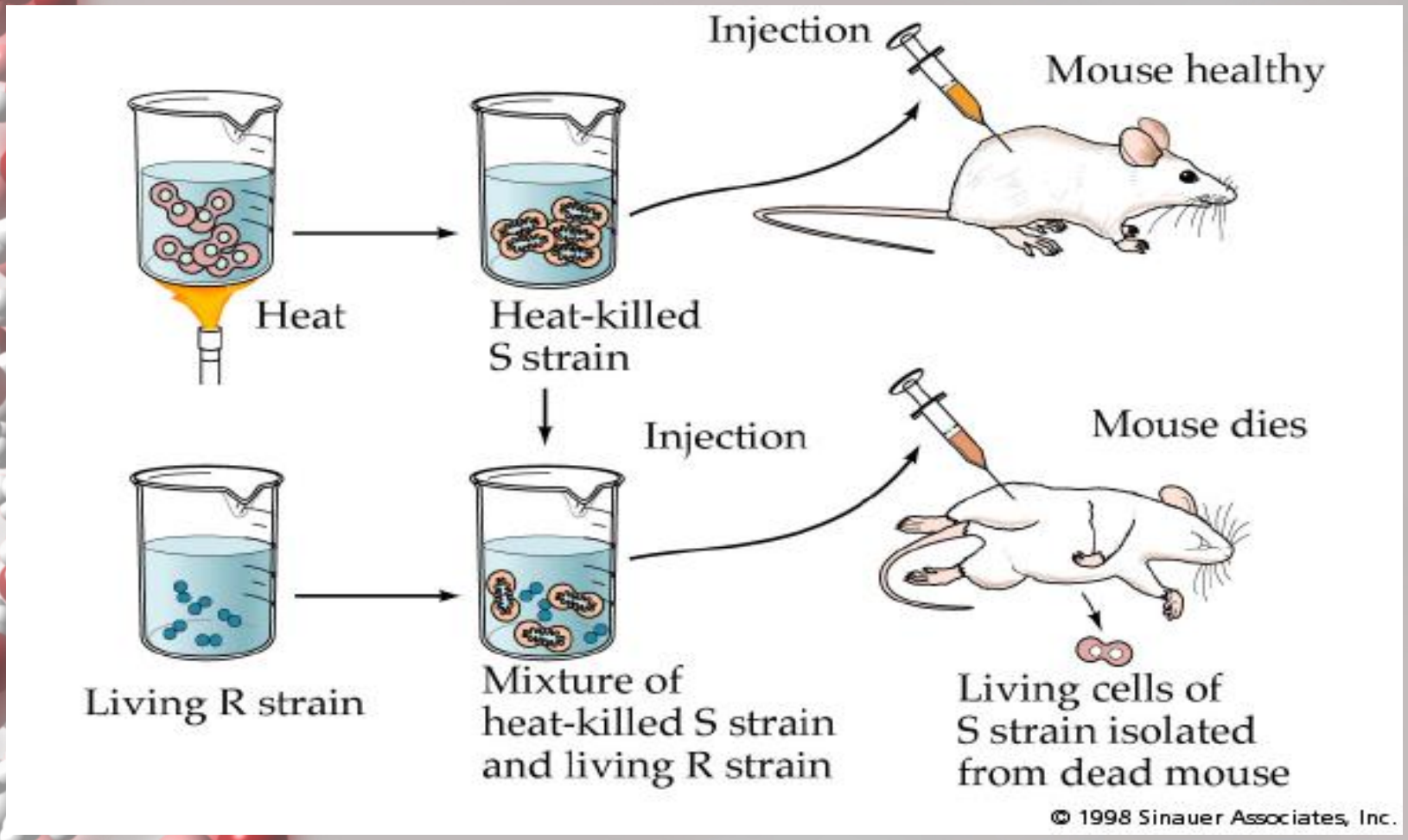
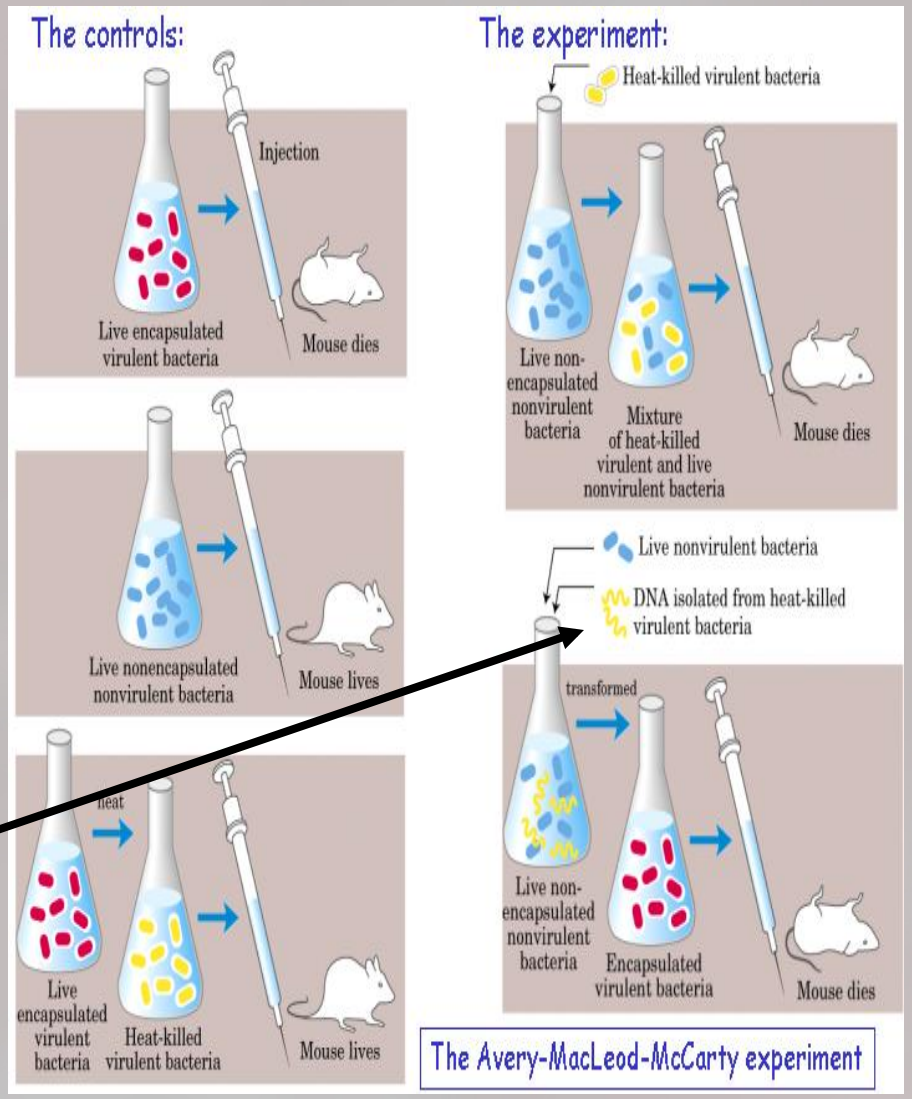
Griffith Experiment



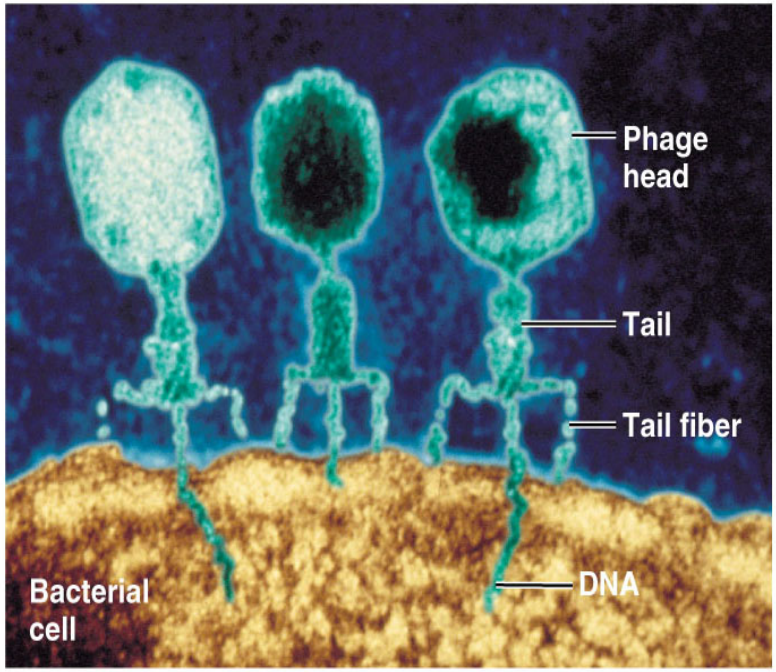
Avery-MacLeod-McCarty Experiment

- Repeated Griffith's experiment adding enzymes to destroy
  1. lipids,
  2. carbohydrates
  3. proteins
  4. RNA
- ***Transformation*** still occurred only **DNA** was left



Hershey & Chase

Used ***viruses*** to demonstrate that the virus injects **DNA** and that's what takes over the cell



(a) T2 and related phages use their tail pieces to attach to the host cell and inject their genetic material (TEM).

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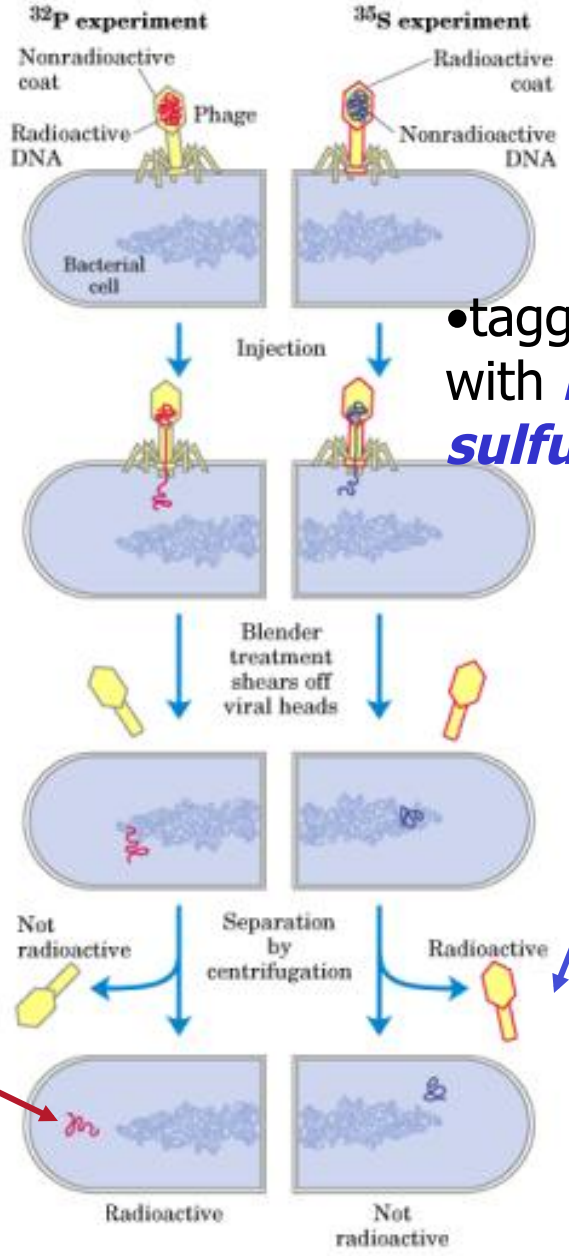
This animation (Audio) describes the Hershey-Chase experiments.

Bacteriophage— ***virus*** that specializes in attacking ***bacteria.***

The Hershey-Chase blender experiment

- tagged DNA of the virus with ***radioactive phosphorus*** **P^{32}**

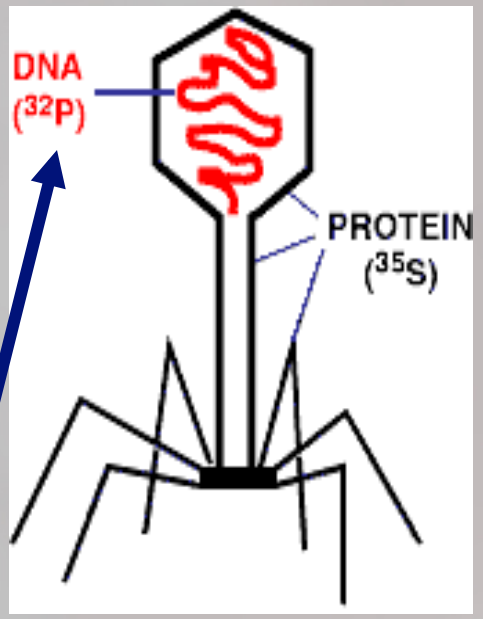
- What ever was injected into the bacteria to take over the cell was the carrier of genetic information.



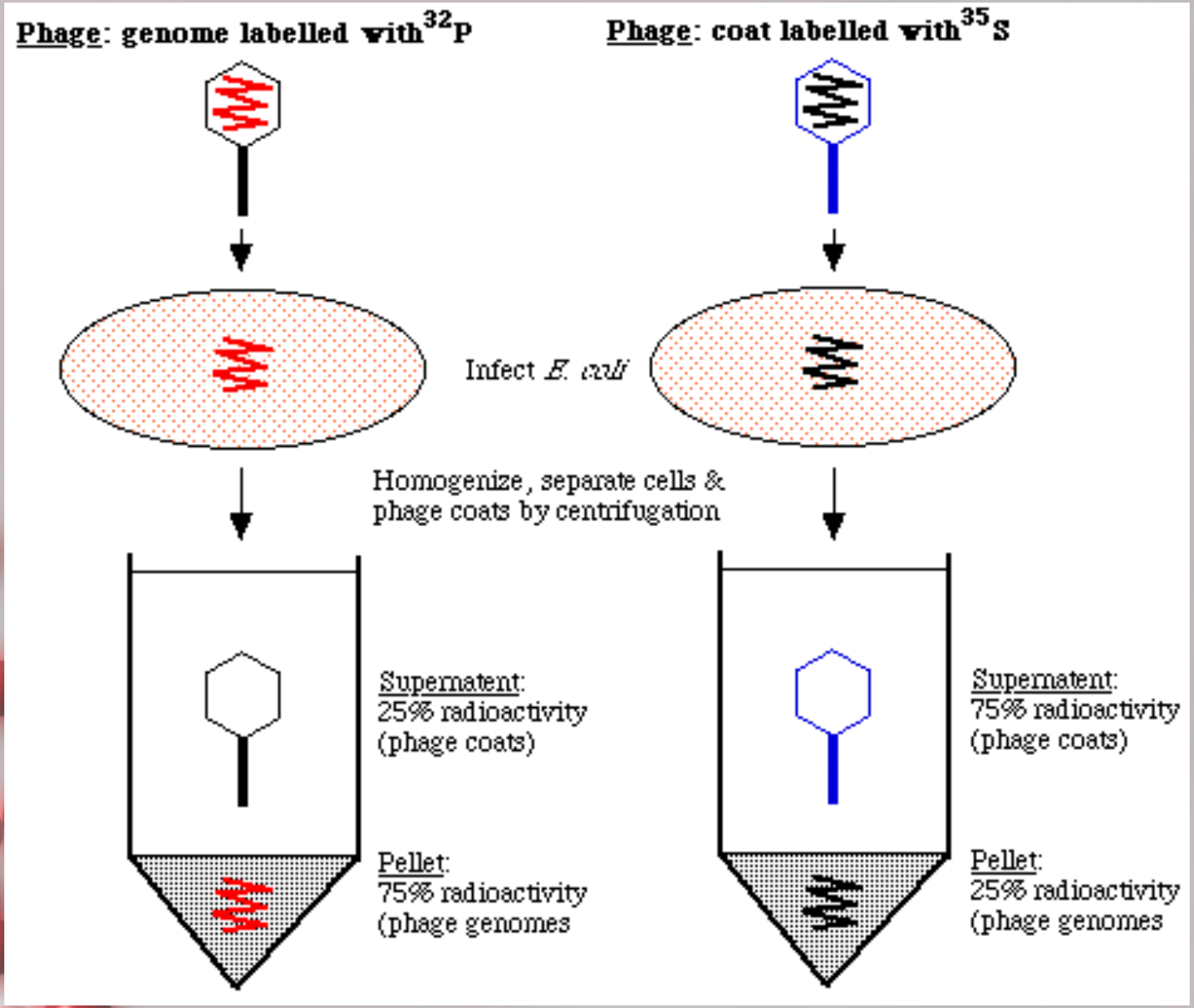
- tagged protein of virus with ***radioactive sulfur. S^{35}***

History of DNA

- **Chromosomes**:made of DNA and protein
- Experiments on **bacteriophage** viruses by **Hershey & Chase** proved that DNA was the cell's genetic material



Radioactive ^{32}P was injected into bacteria!


Phage: genome labelled with ^{32}P
Phage: coat labelled with ^{35}S
Infect *E. coli*
Homogenize, separate cells & phage coats by centrifugation
Supernatent: 25% radioactivity (phage coats)
Pellet: 75% radioactivity (phage genomes
Supernatent: 75% radioactivity (phage coats)
Pellet: 25% radioactivity (phage genomes

Discovery of DNA Structure

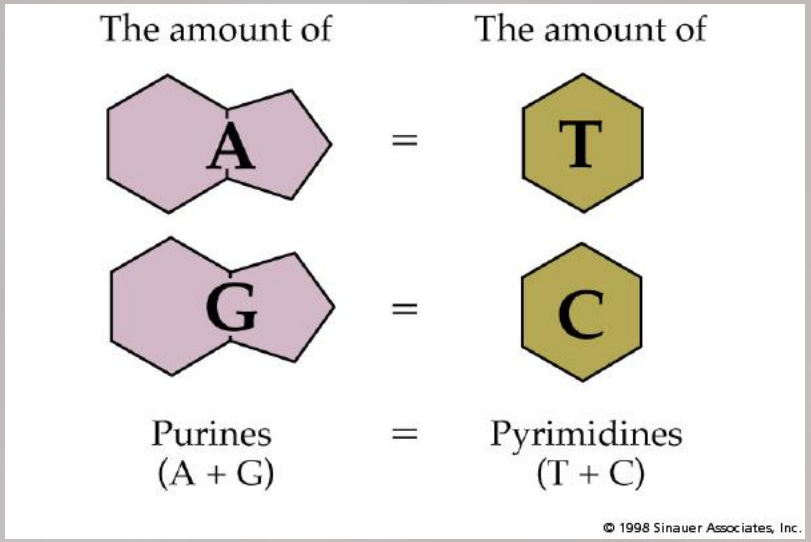
- **Erwin Chargraff** showed the amounts of the four bases on DNA (A,T,C,G)
- In a body or somatic cell:

A = 30.3%

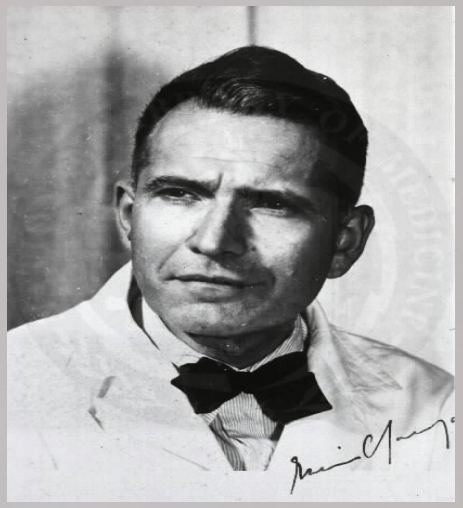
T = 30.3%

G = 19.5%

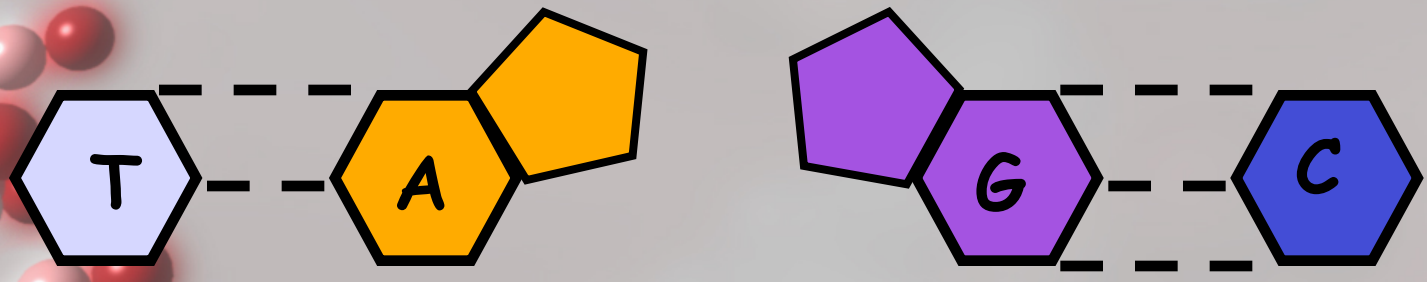
C = 19.9%



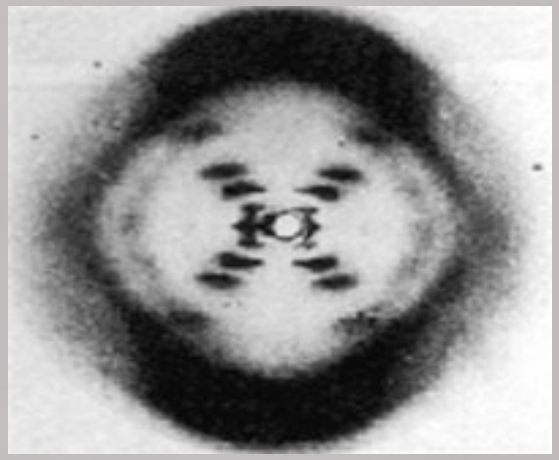
Chargaff's Rule



- Adenine must pair with Thymine
- Guanine must pair with Cytosine
- Bases form weak *hydrogen bonds*



DNA Structure

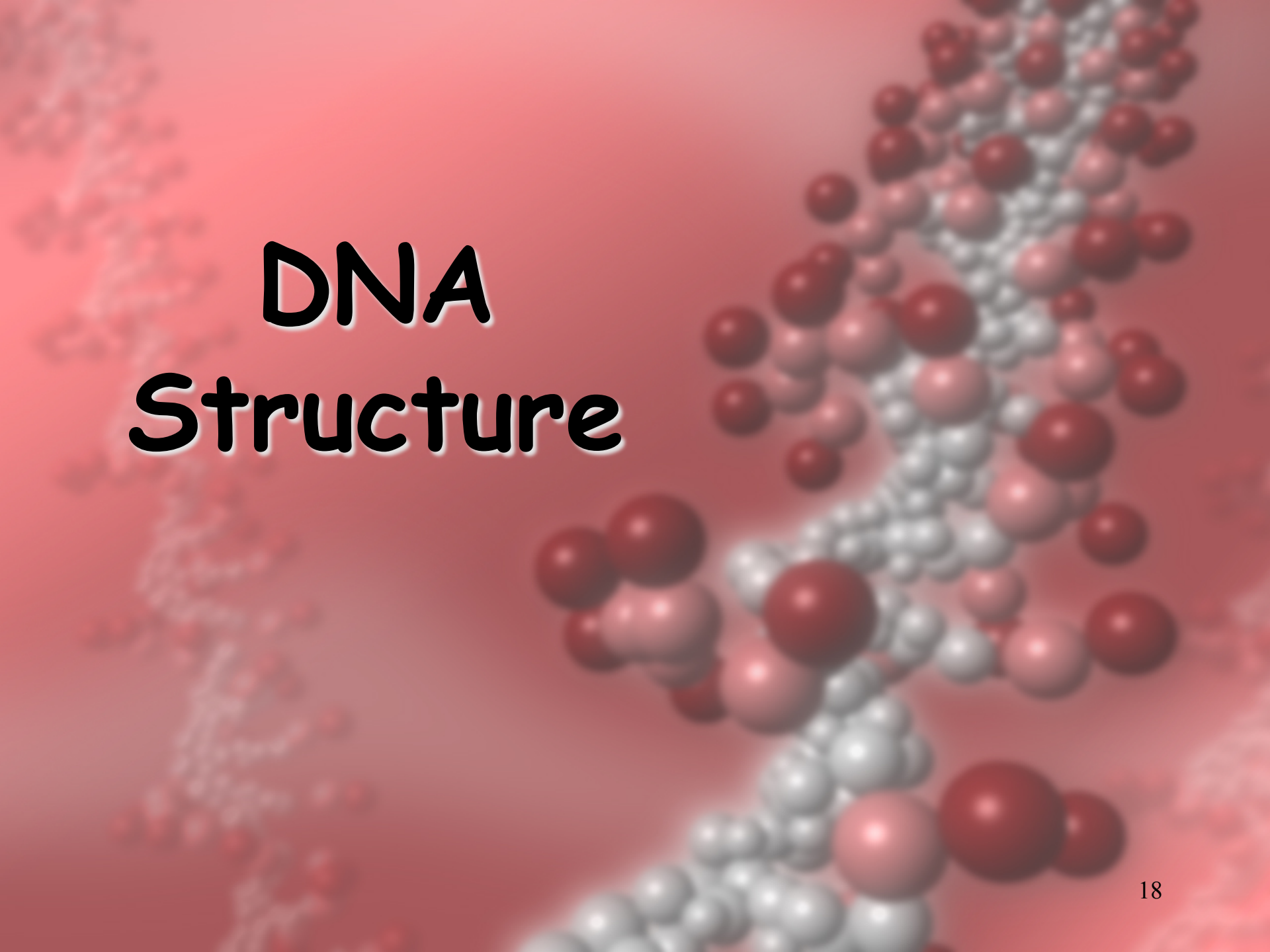


- Rosalind Franklin took *diffraction x-ray* photographs of DNA crystals
- In the 1950's, Watson & Crick built the first model of DNA using Franklin's x-rays

These animations describe the structure of DNA:
DNA structure 1.
DNA structure 2.

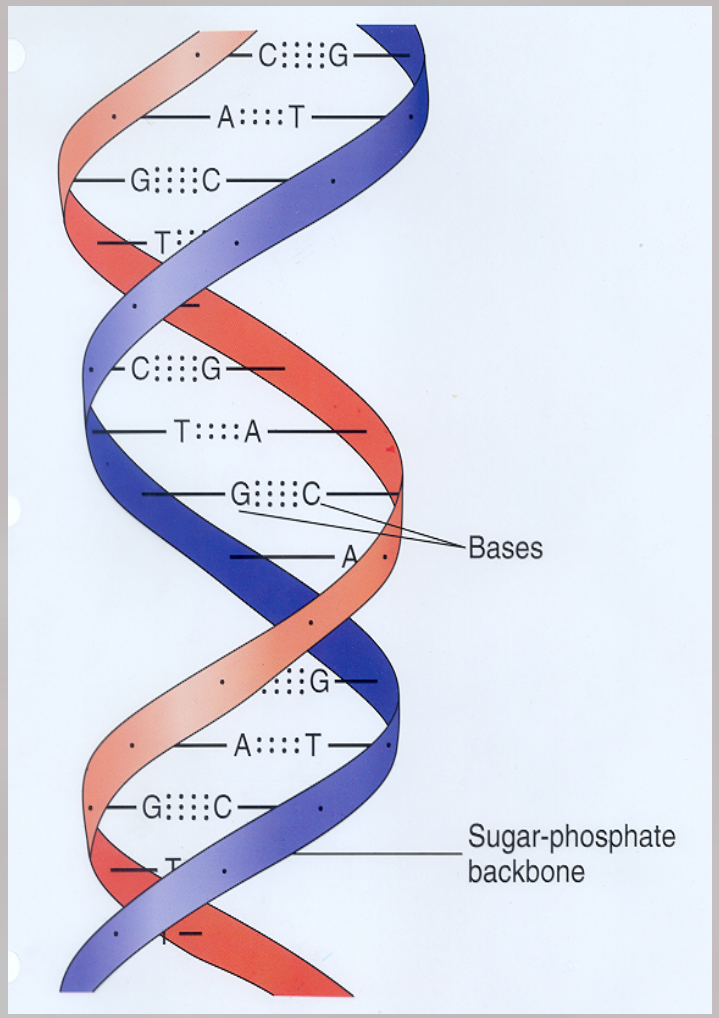
Rosalind Franklin and Watson & Crick

DNA Structure



DNA
Deoxyribonucleic Acid

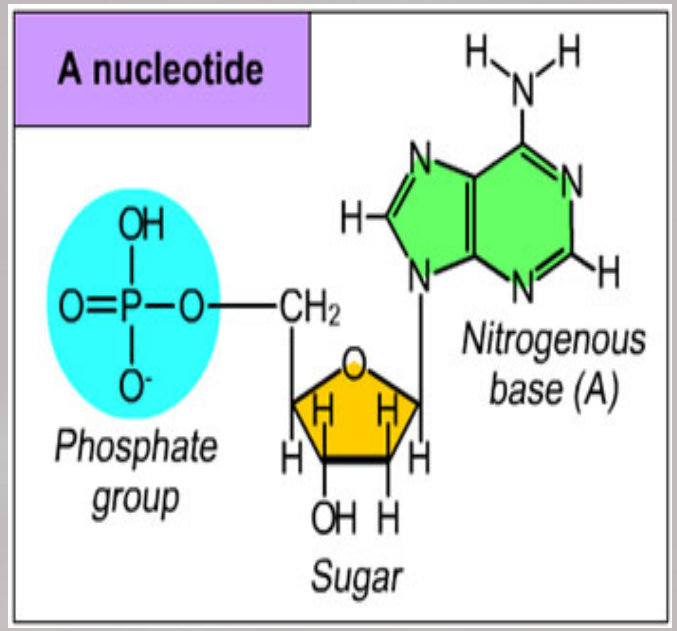
- Two strands coiled = *double helix*
- *Sides* = pentose sugar *Deoxyribose* bonded to *phosphate* (PO_4)
- *Rungs (center)* = *nitrogen* bases bonded together by weak *hydrogen bonds*



DNA: Deoxyribonucleic acid

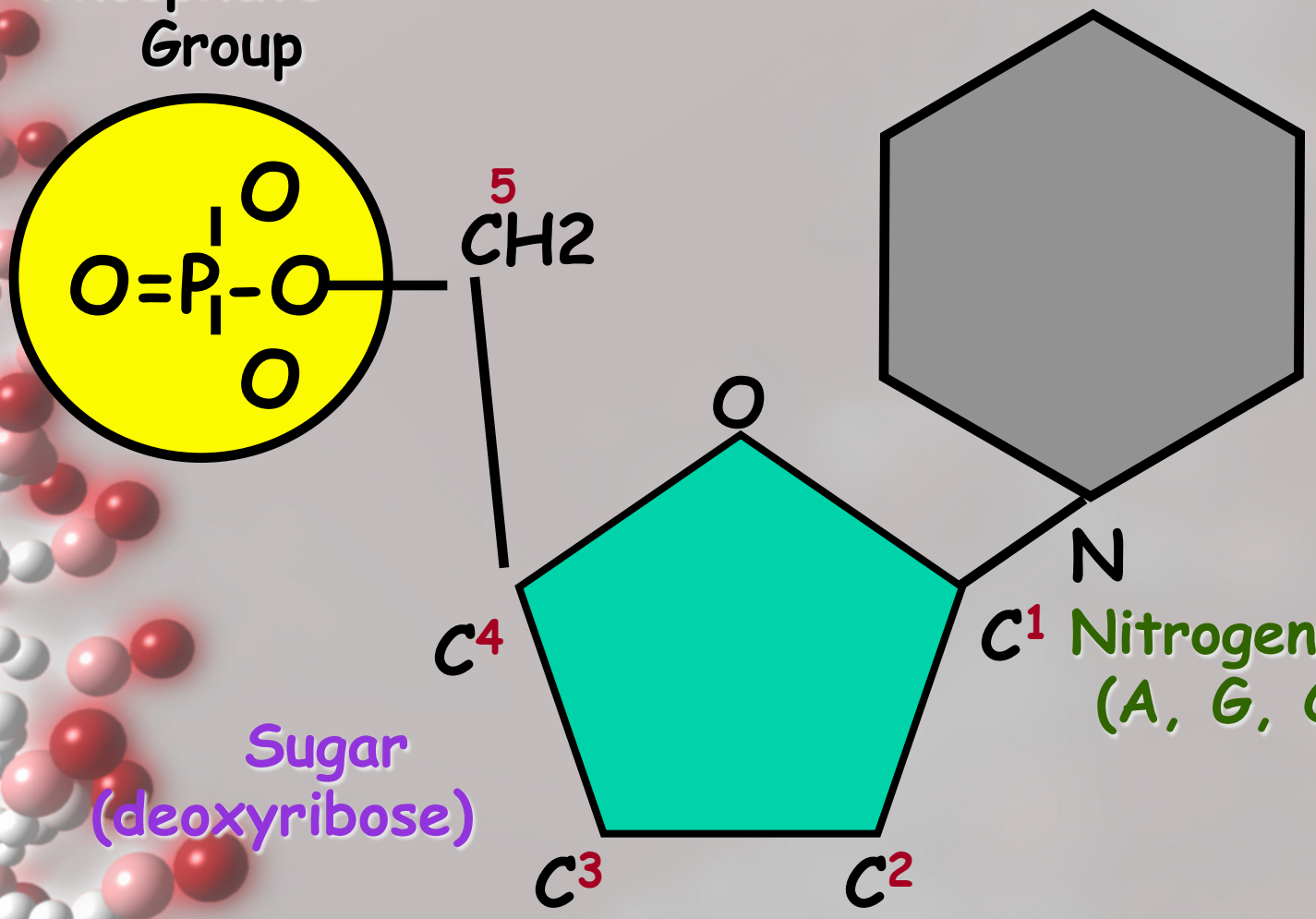
- Made up of subunits called *nucleotides*

- Nucleotide made of:
  1. Phosphate group
  2. 5-carbon sugar
  3. Nitrogenous base



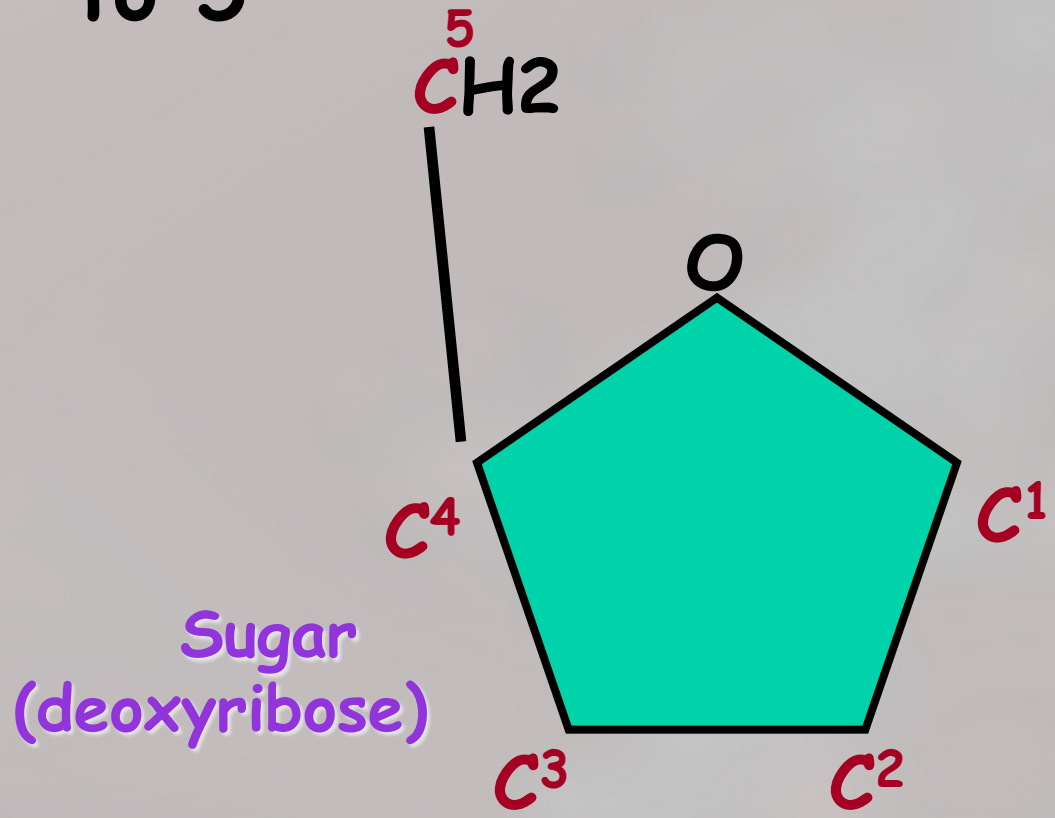
This animation (Audio - Important) describes DNA subunits.

DNA Nucleotide

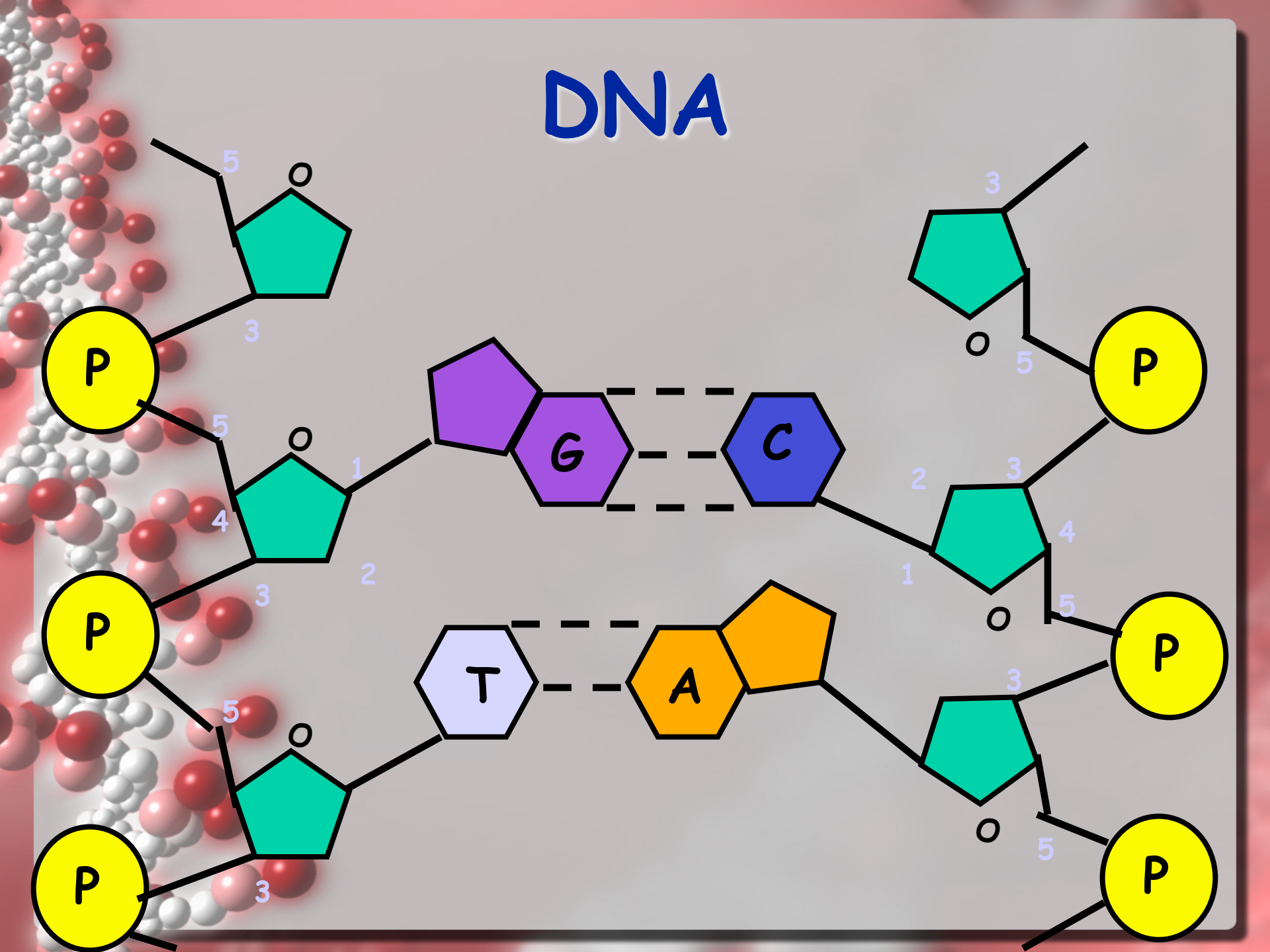


Pentose Sugar

- Carbons are numbered clockwise 1' to 5'

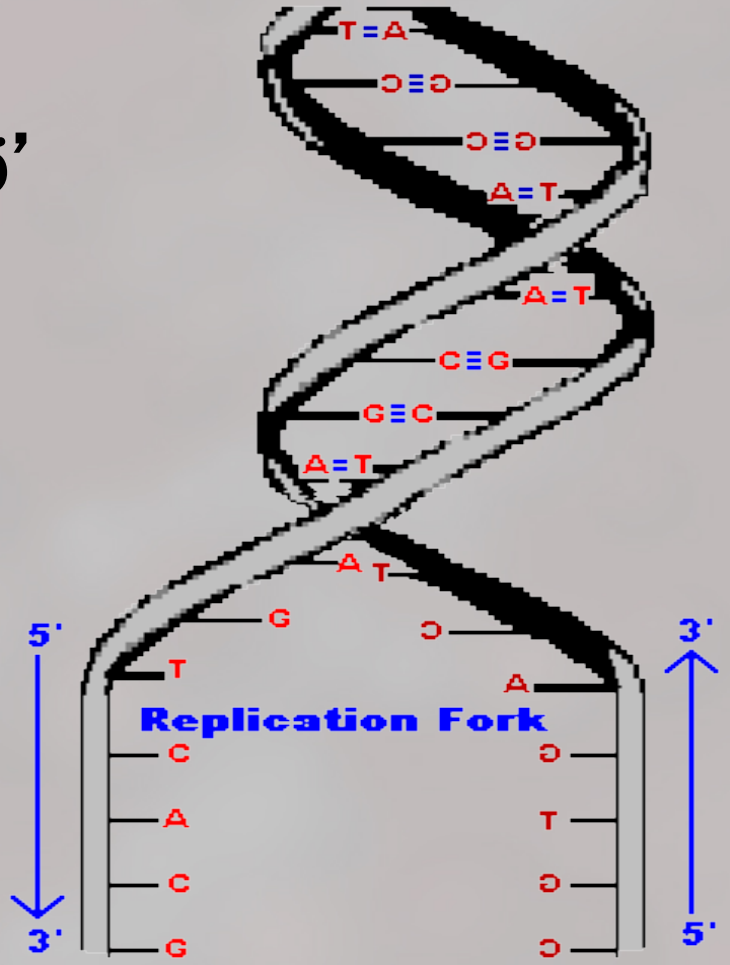


DNA



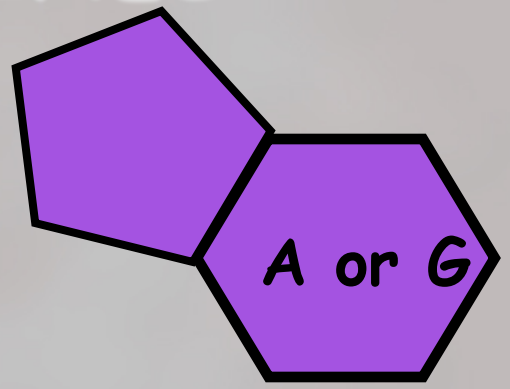
Antiparallel Strands

- One strand of DNA goes from 5' to 3' (sugars)
- The other strand is opposite in direction going 3' to 5' (sugars)

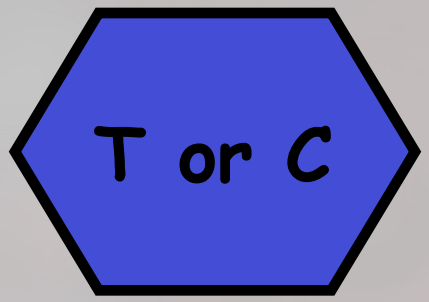


Nitrogenous Bases

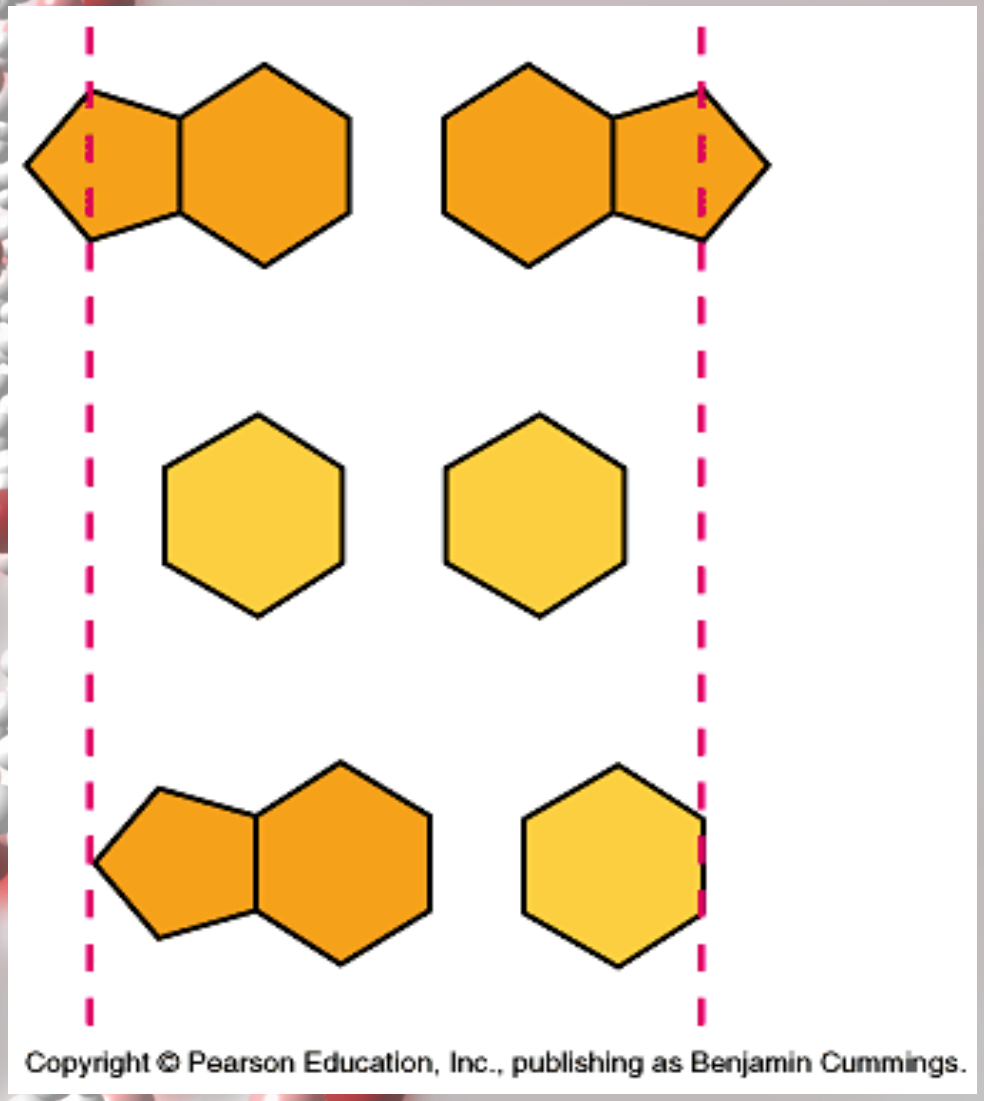
- Double ring **PURINES**
  - Adenine (A)
  - Guanine (G)



- Single ring **PYRIMIDINES**
  - Thymine (T)
  - Cytosine (C)

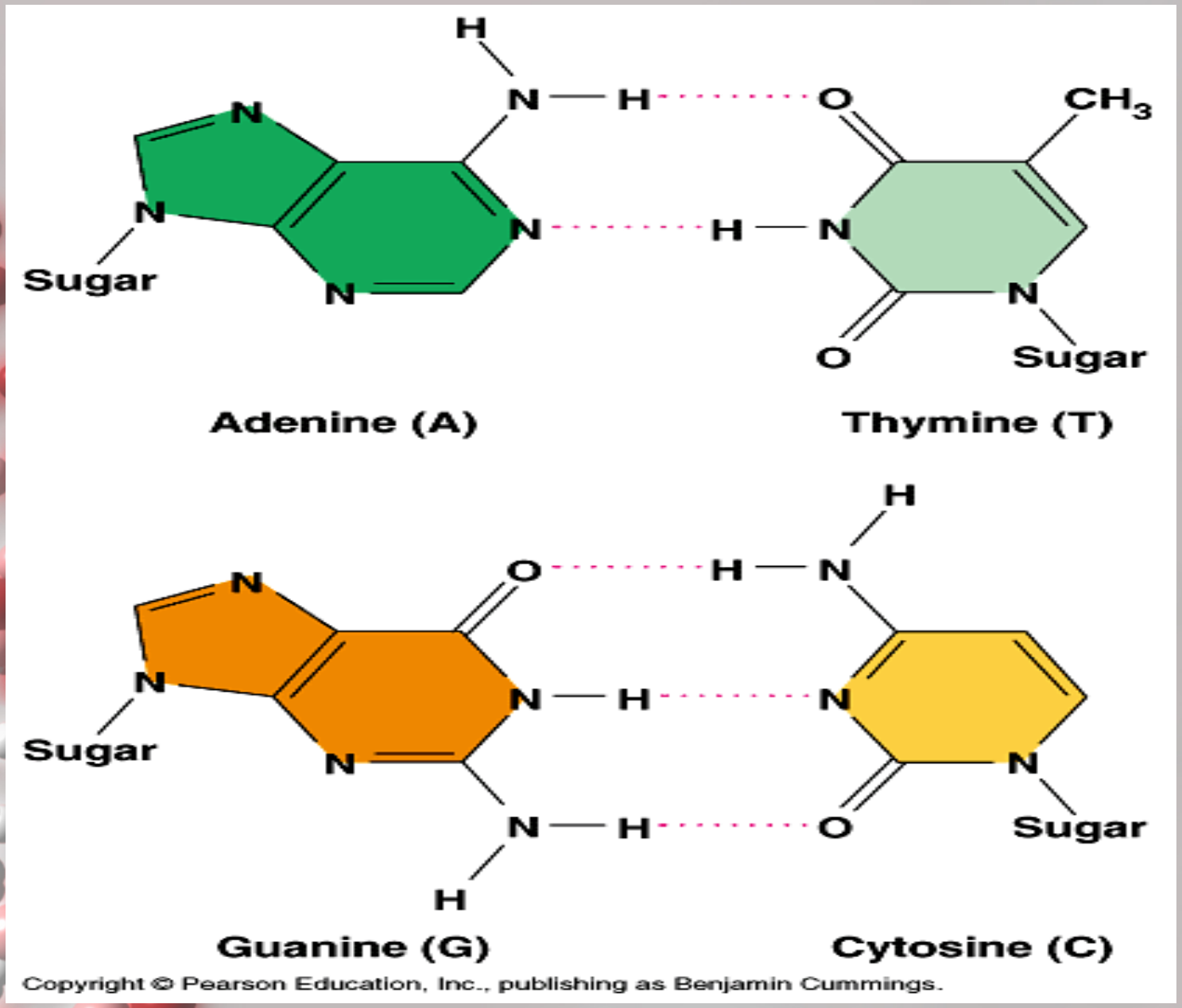


Base-Pairings



- **Purines only pair with Pyrimidines**

It's easy to see why a ***single ring*** like cytosine **Pairs** with a ***double ring*** molecule like guanine and not another single ring like thymine.



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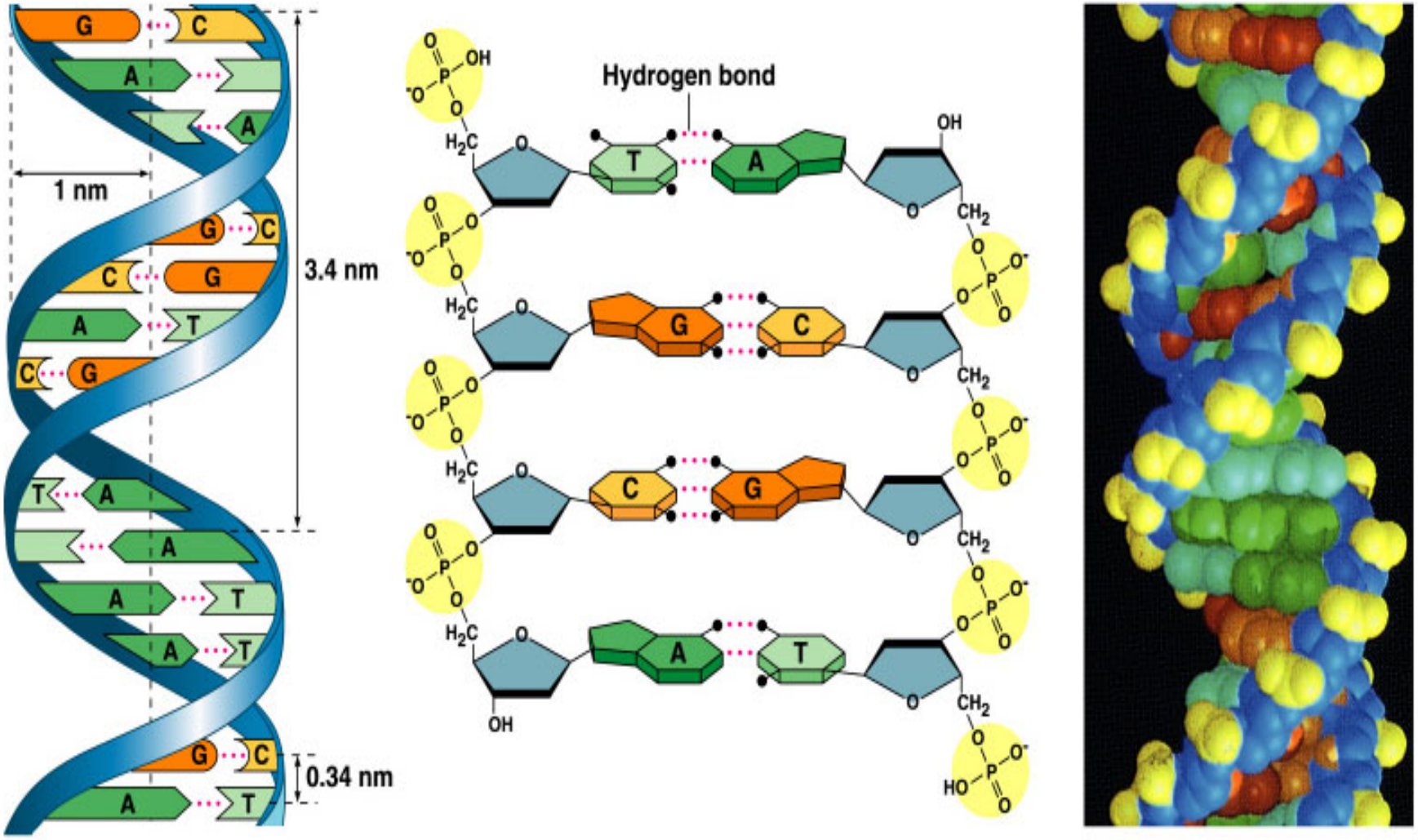

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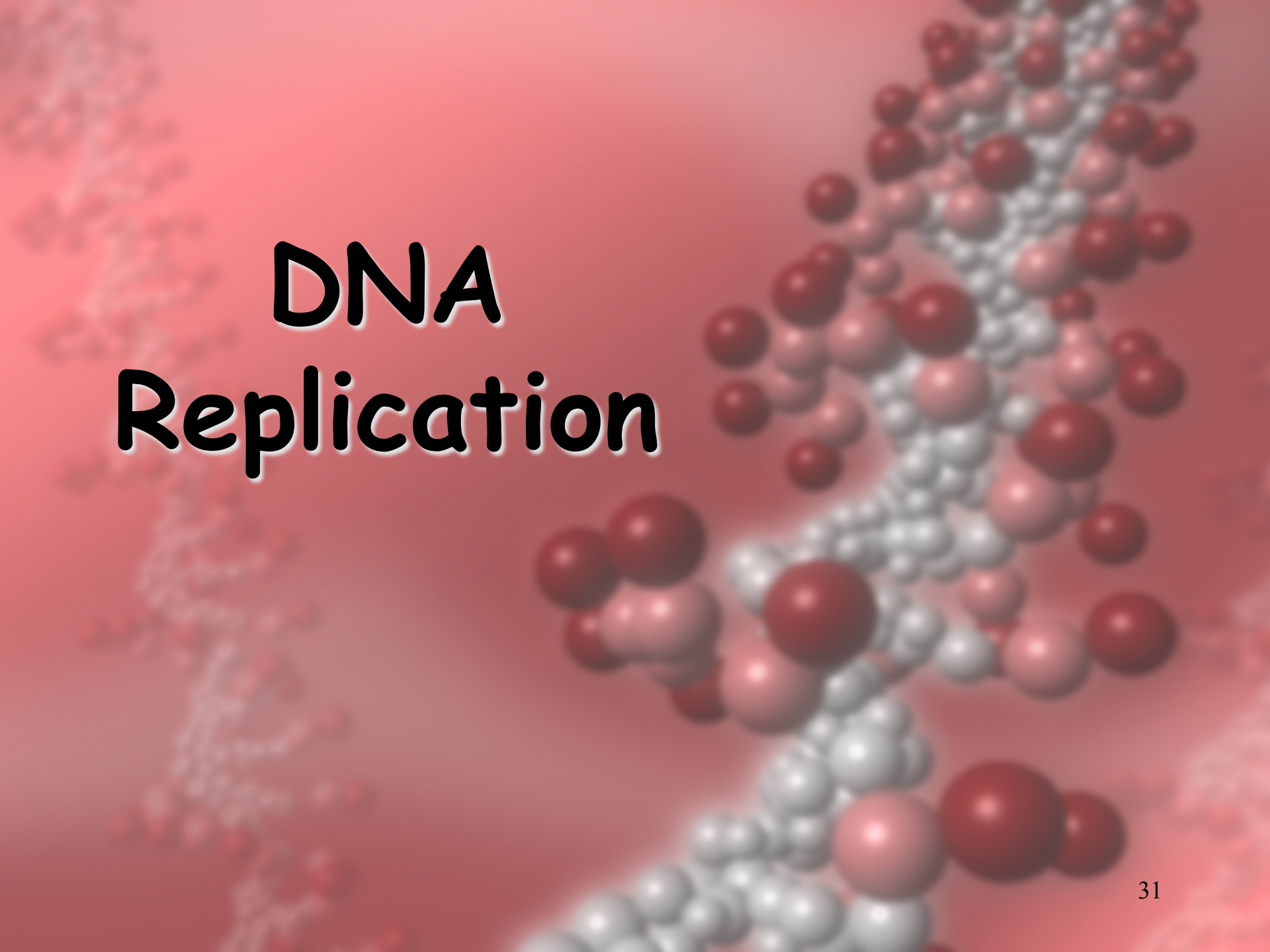
Question:

- If there is 30% Adenine, how much Cytosine is present?

Answer:

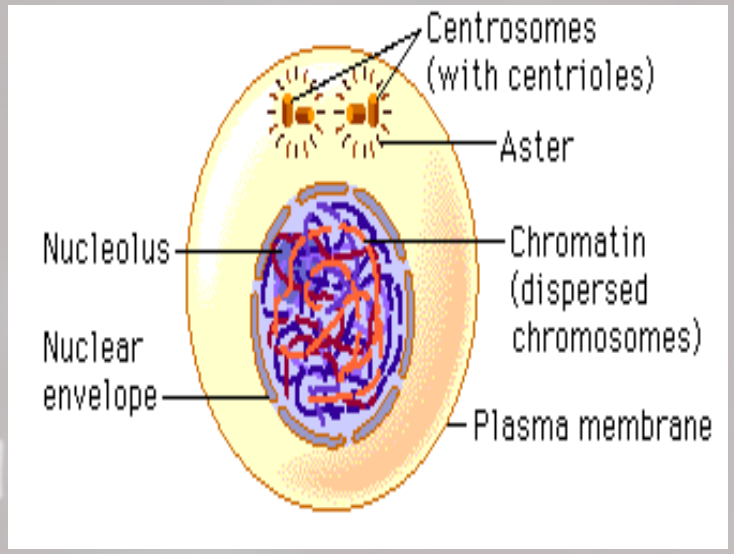
- There would be 20% Cytosine
- Adenine (30%) = Thymine (30%)
- Guanine (20%) = Cytosine (20%)
- Therefore, 60% A-T + 40% C-G

DNA Replication



Replication Facts

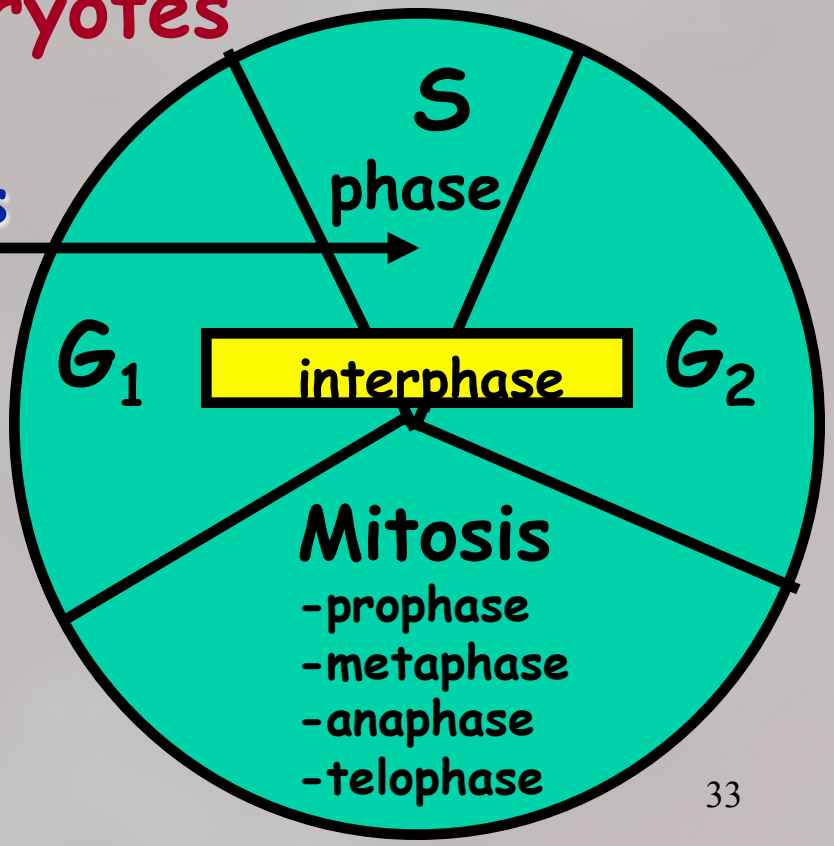
- DNA has to be copied **before a cell divides**
- DNA is copied during the **S** or *synthesis phase* of **interphase**
- New cells will need **identical** DNA strands



Synthesis Phase (S phase)

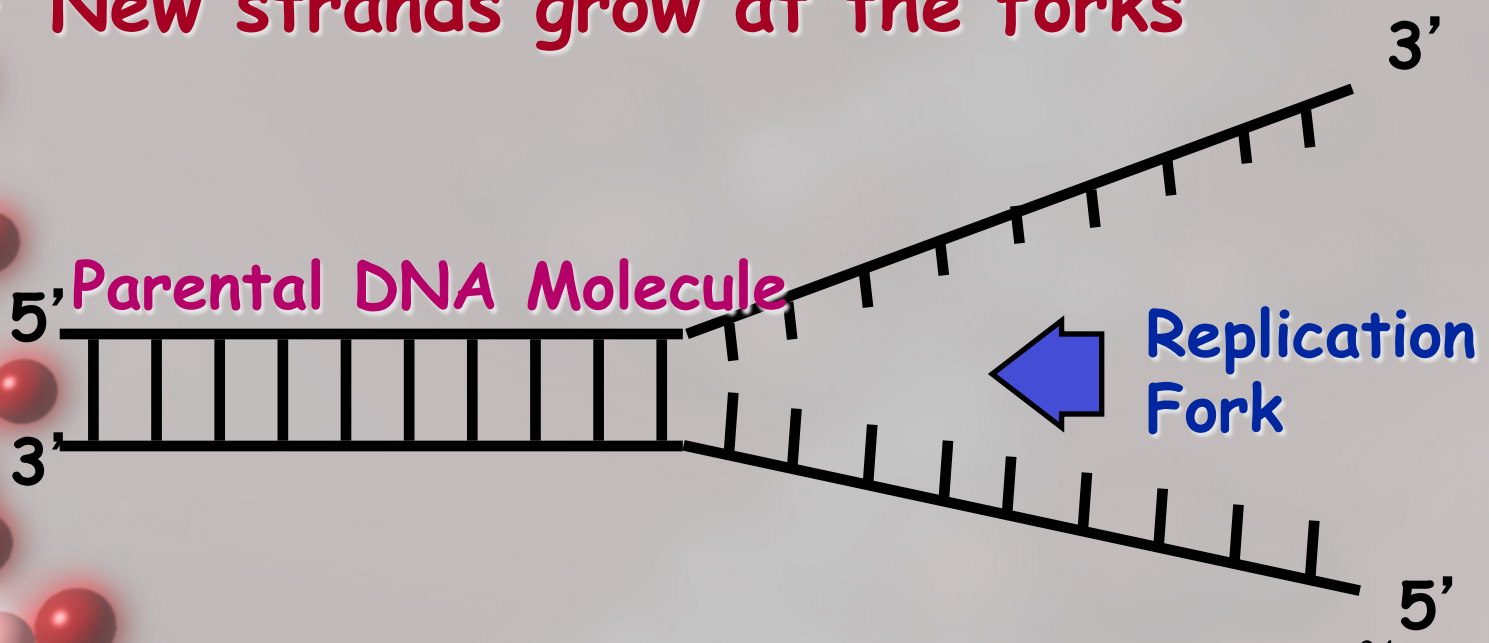
- S phase during interphase of the cell cycle
- Nucleus of eukaryotes

DNA replication takes place in the S phase.



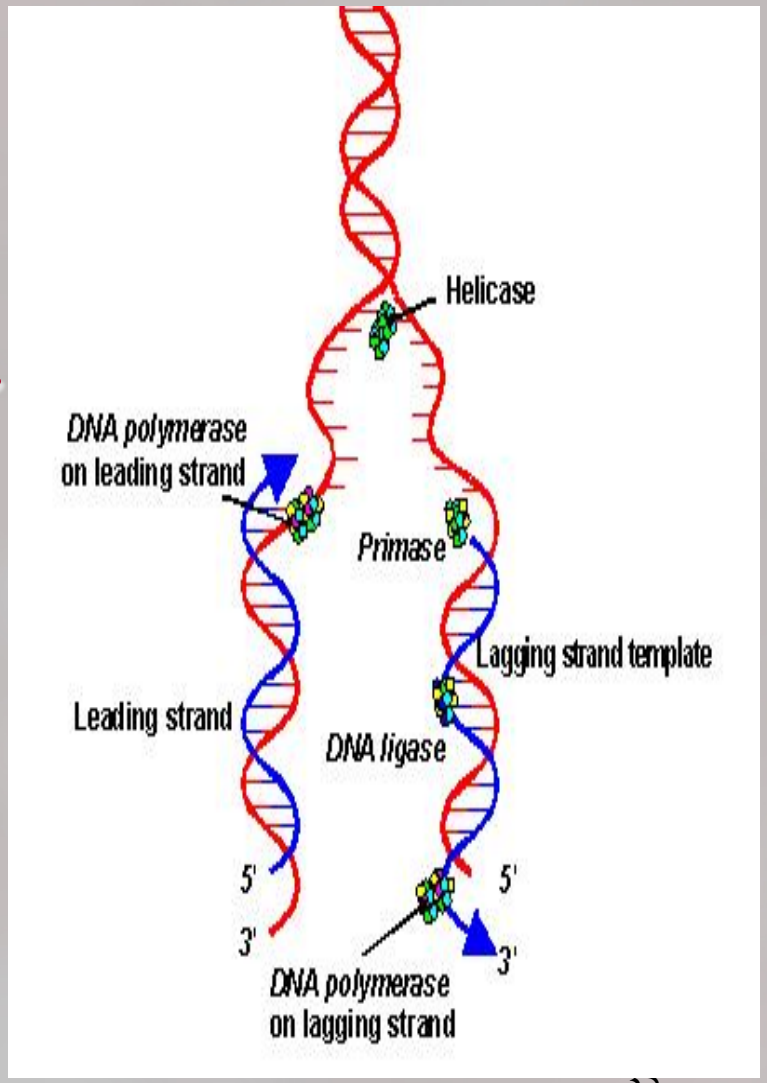
DNA Replication

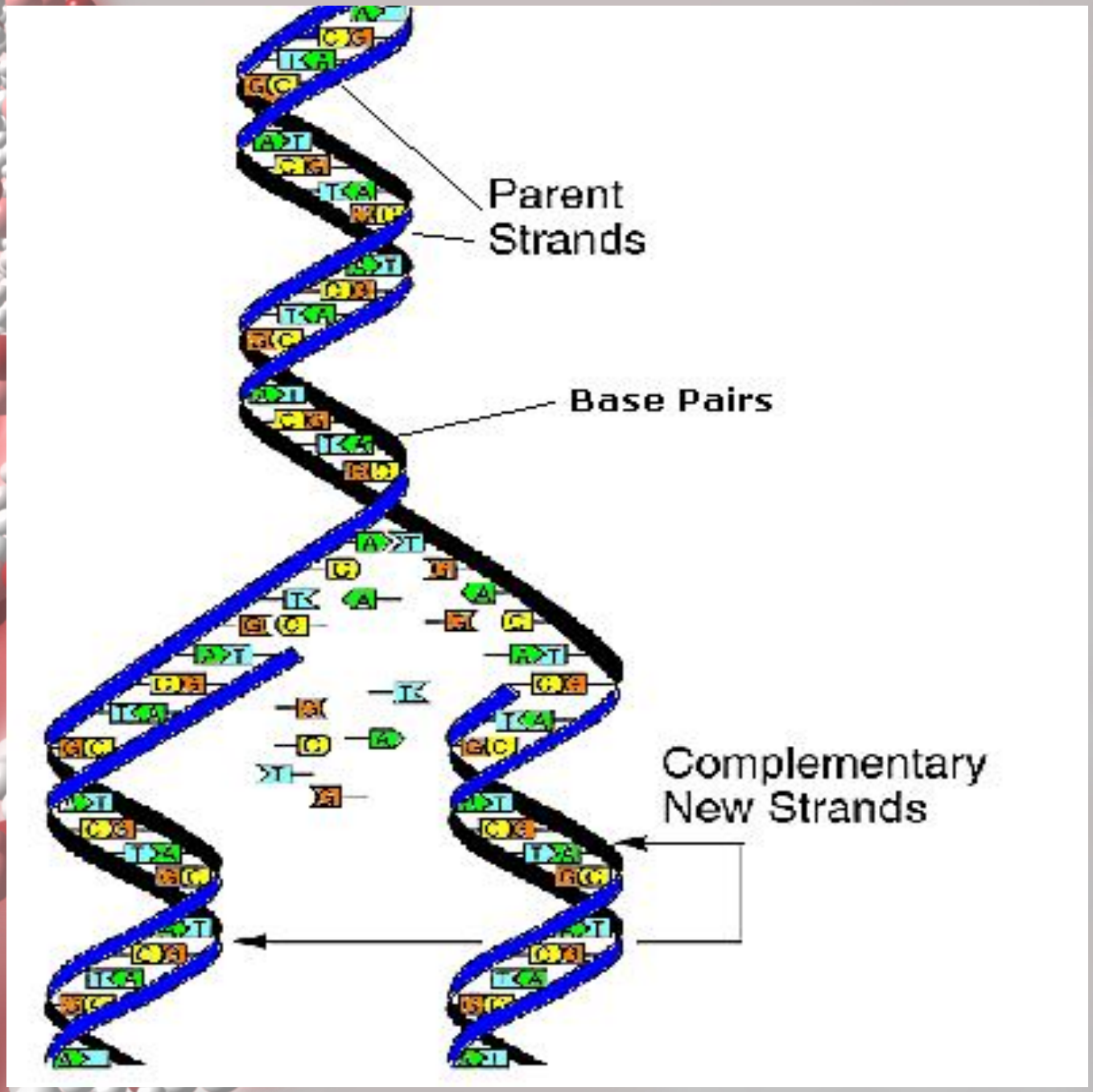
- Begins at Origins of Replication
- Two strands open forming Replication Forks (Y-shaped region)
- New strands grow at the forks



DNA Replication

- Enzyme Helicase unwinds and separates the 2 DNA strands by breaking the *weak* hydrogen bonds
- DNA polymerase can then add the new nucleotides





These animations (Audio - Important) describe DNA replication:

DNA replication1,

DNA replication 2.

DNA Replication

(a) The parent molecule has two complementary strands of DNA. Each base is paired by hydrogen bonding with its specific partner, A with T and G with C.

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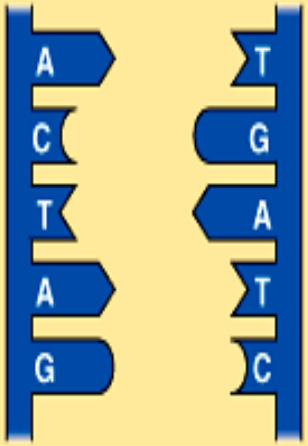

(b) The first step in replication is separation of the two DNA strands.

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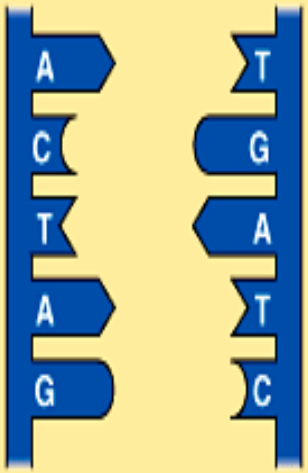
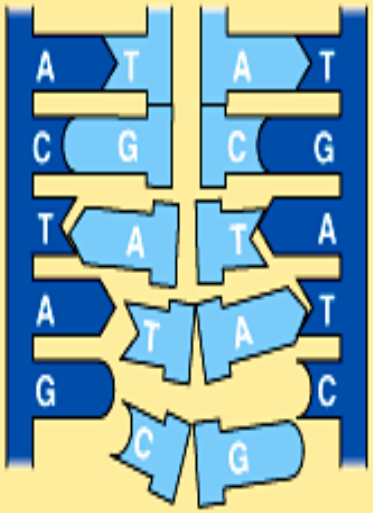


(b) The first step in replication is separation of the two DNA strands.



(c) Each parental strand now serves as a template that determines the order of nucleotides along a new complementary strand.

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DNA Replication

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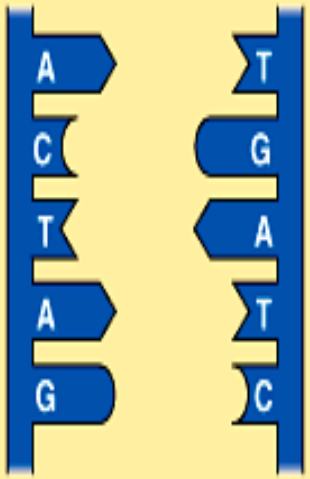

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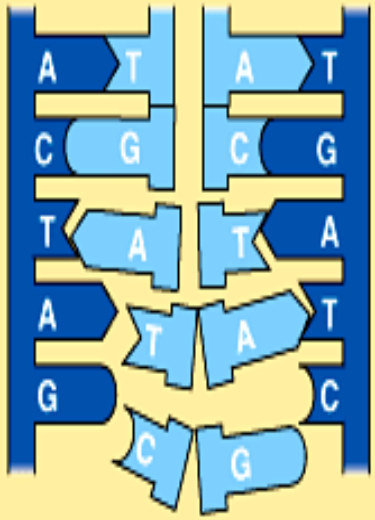

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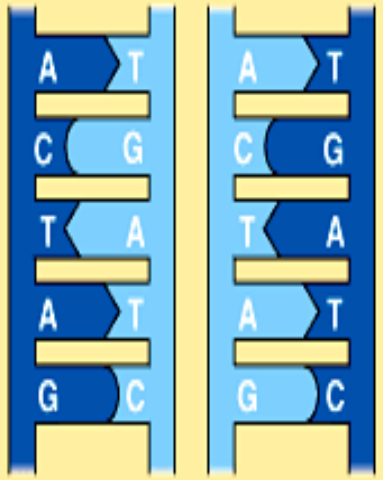

(d) The nucleotides are connected to form the sugar-phosphate backbones of the new strands. Each "daughter" DNA molecule consists of one parental strand and one new strand.

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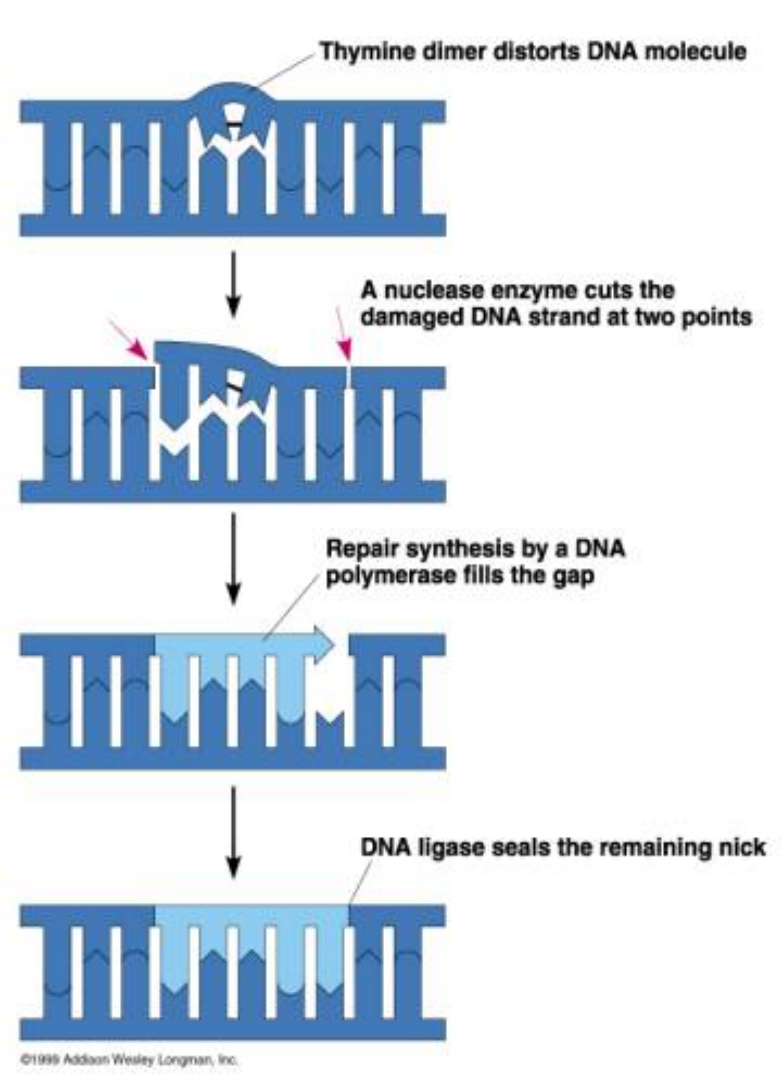
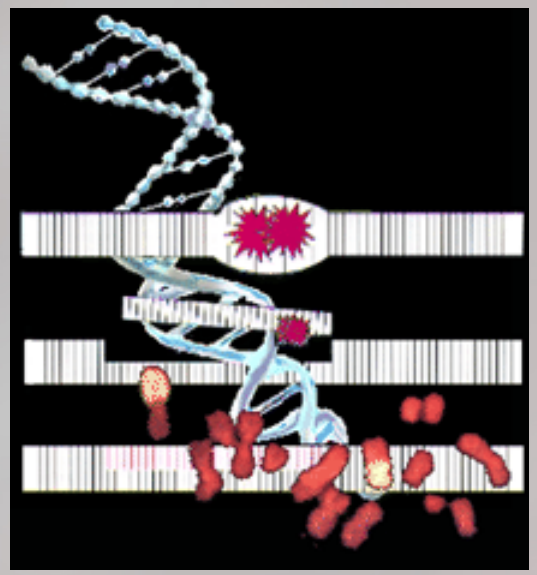
Proofreading New DNA

- DNA polymerase initially makes about 1 in 10,000 base pairing errors
- Enzymes proofread and correct these mistakes
- The new error rate for DNA that has been proofread is 1 in 1 billion base pairing errors



DNA Damage & Repair

- Chemicals & ultraviolet radiation damage the DNA in our body cells
- Cells must continuously repair DAMAGED DNA
- Excision repair occurs when any of over 50 repair enzymes remove damaged parts of DNA
- DNA polymerase and DNA ligase replace and bond the new nucleotides together



Question:

- What would be the complementary DNA strand for the following DNA sequence?

DNA 5'-CGTATG-3'

Answer:

DNA 5’-GCGTATG-3’

DNA 3’-CGCATAC-5’

In Closing

- DNA is responsible for all the different forms of life on the planet today
- DNA is responsible for carrying genetic information since the beginning of life on the planet