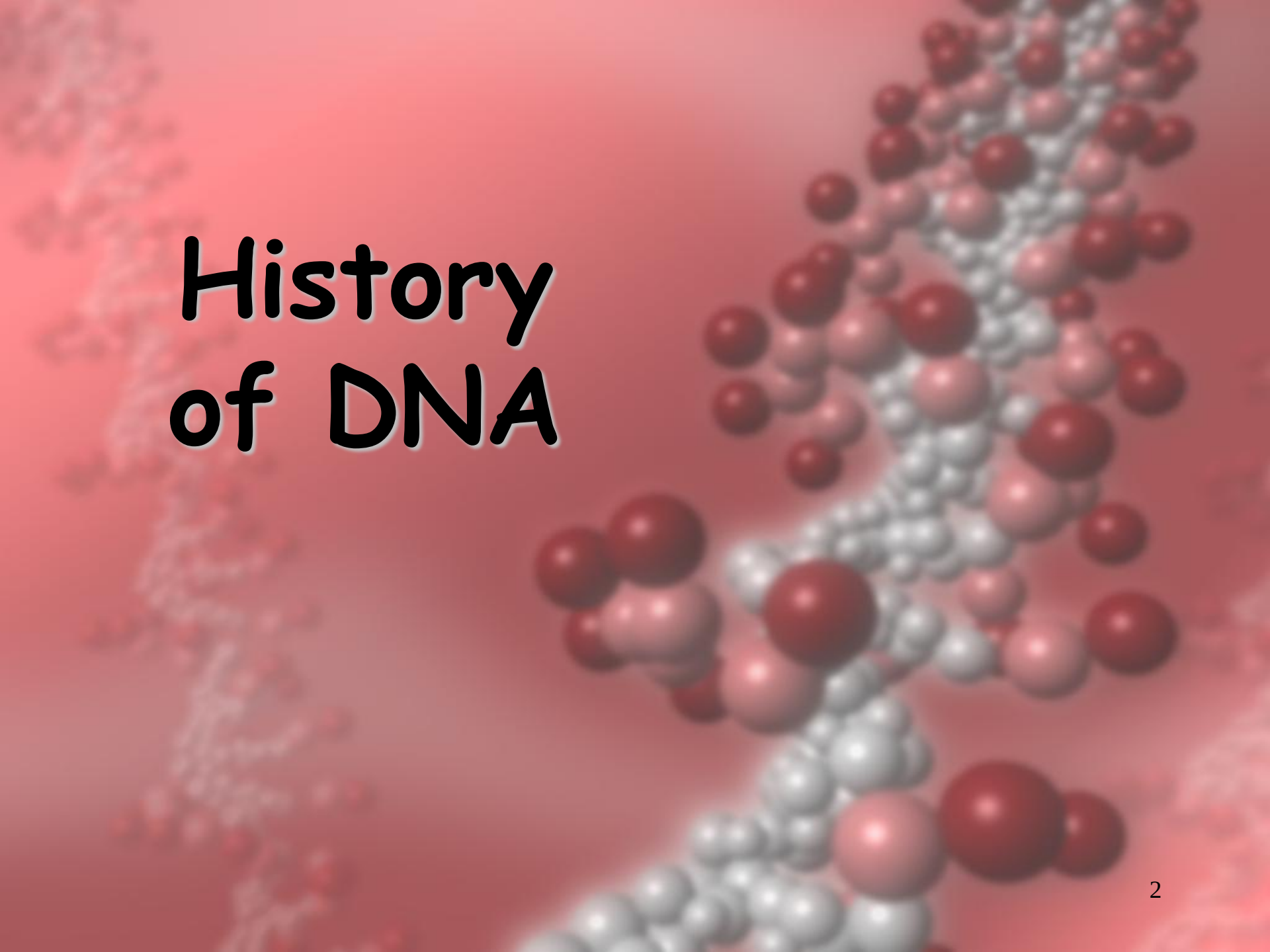
DNA and Replication

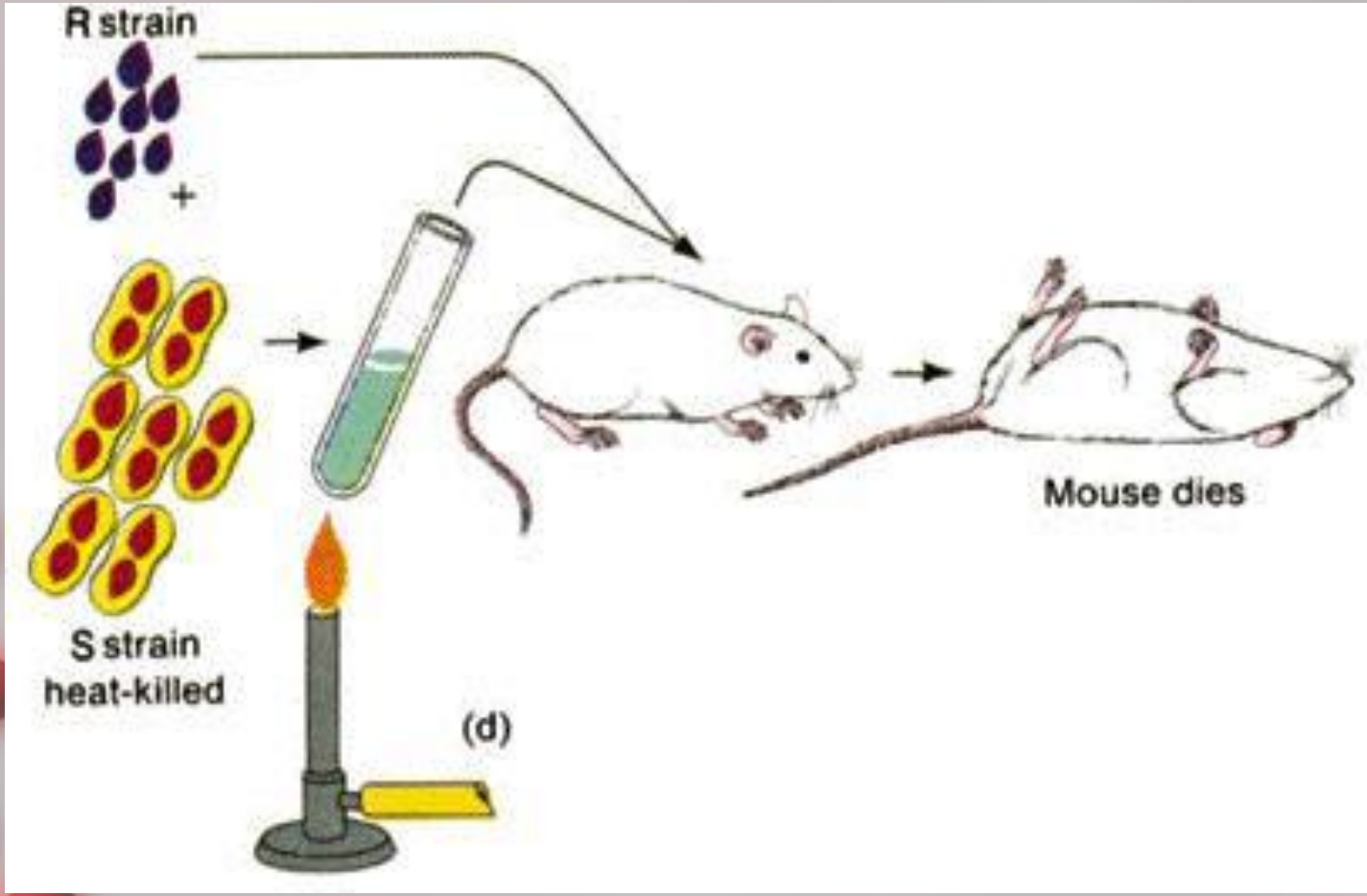
History of DNA



Transformation

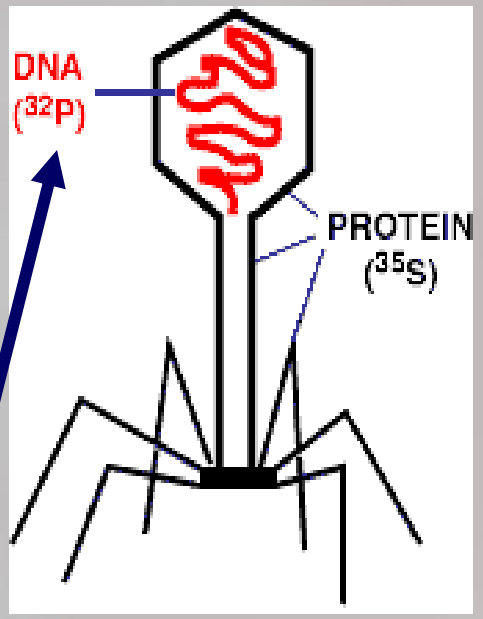
- Fred Griffith worked with virulent S and nonvirulent R strain *Pneumoccocus* bacteria
- He found that R strain could become virulent when it took in DNA from heat-killed S strain
- Study suggested that DNA was probably the genetic material

Griffith Experiment



History of DNA

- Chromosomes are made of both 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!

Discovery of DNA Structure

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

  A = 30.3%

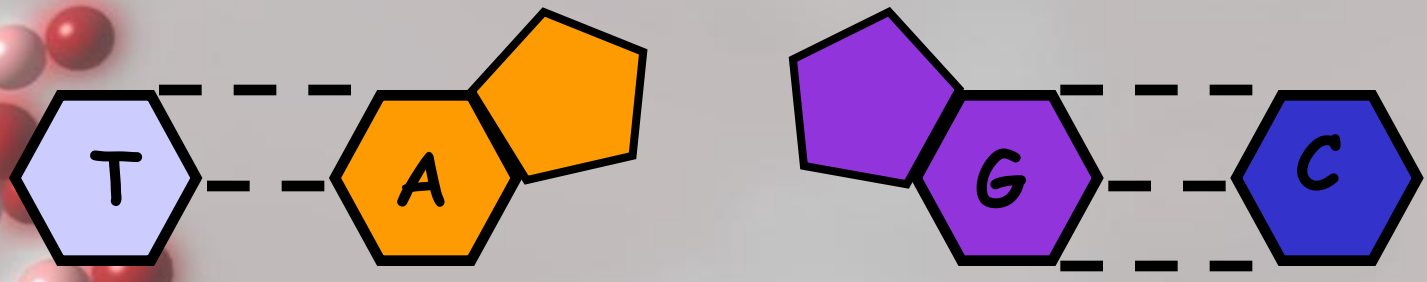
  T = 30.3%

  G = 19.5%

  C = 19.9%

Chargaff's Rule

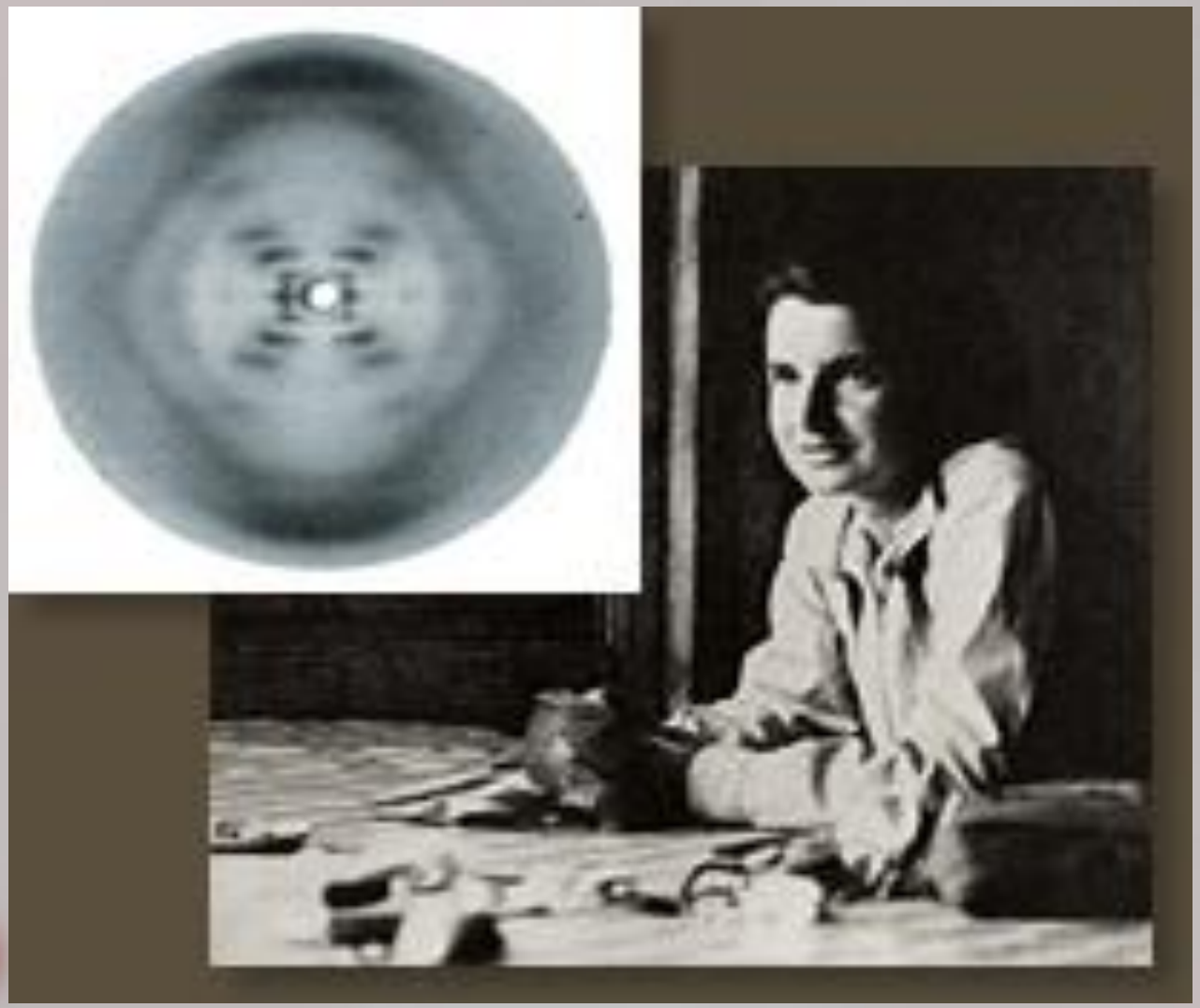
- Adenine must pair with Thymine
- Guanine must pair with Cytosine
- The bases form weak hydrogen bonds



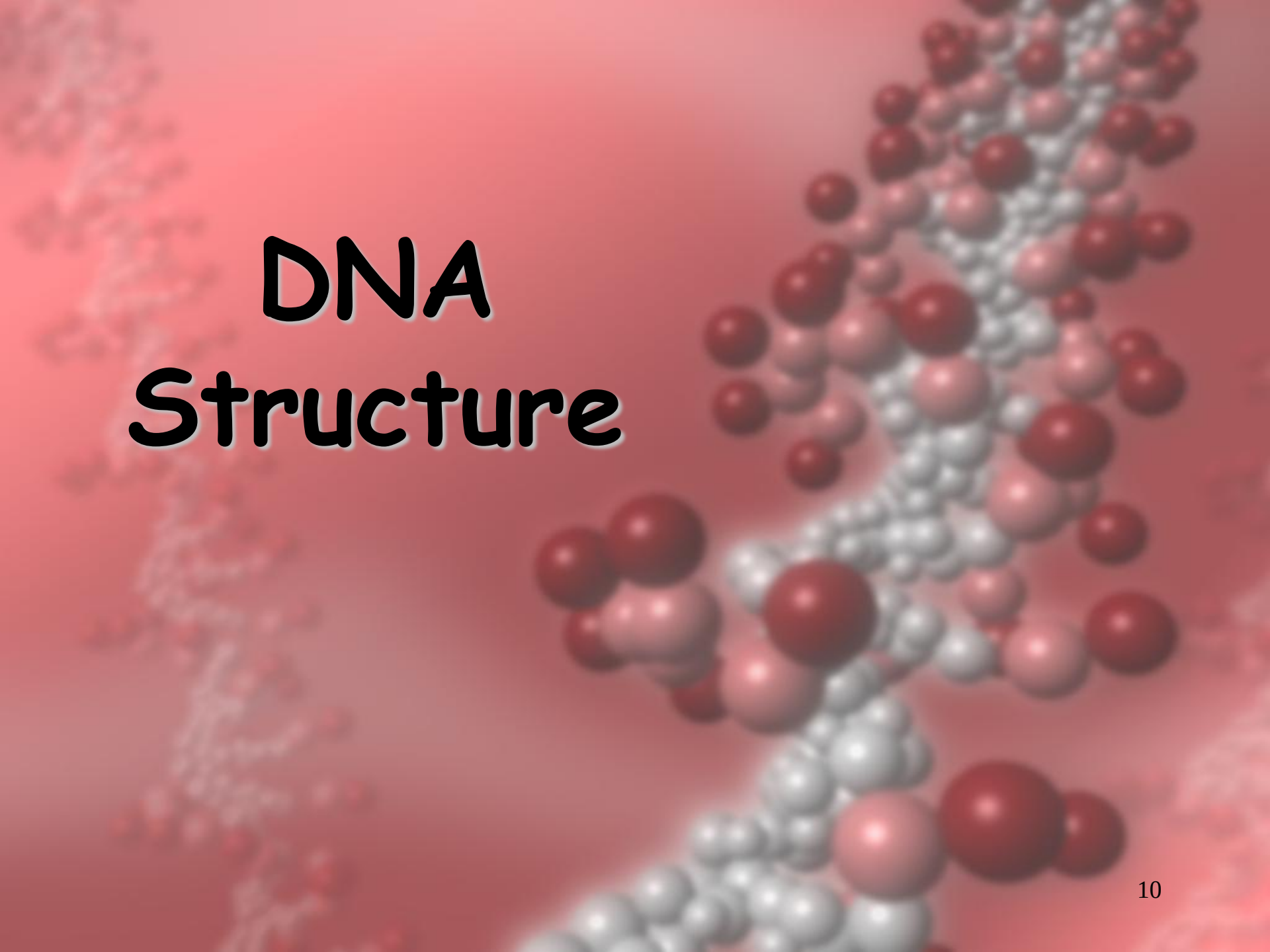
DNA Structure

- 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

Rosalind Franklin



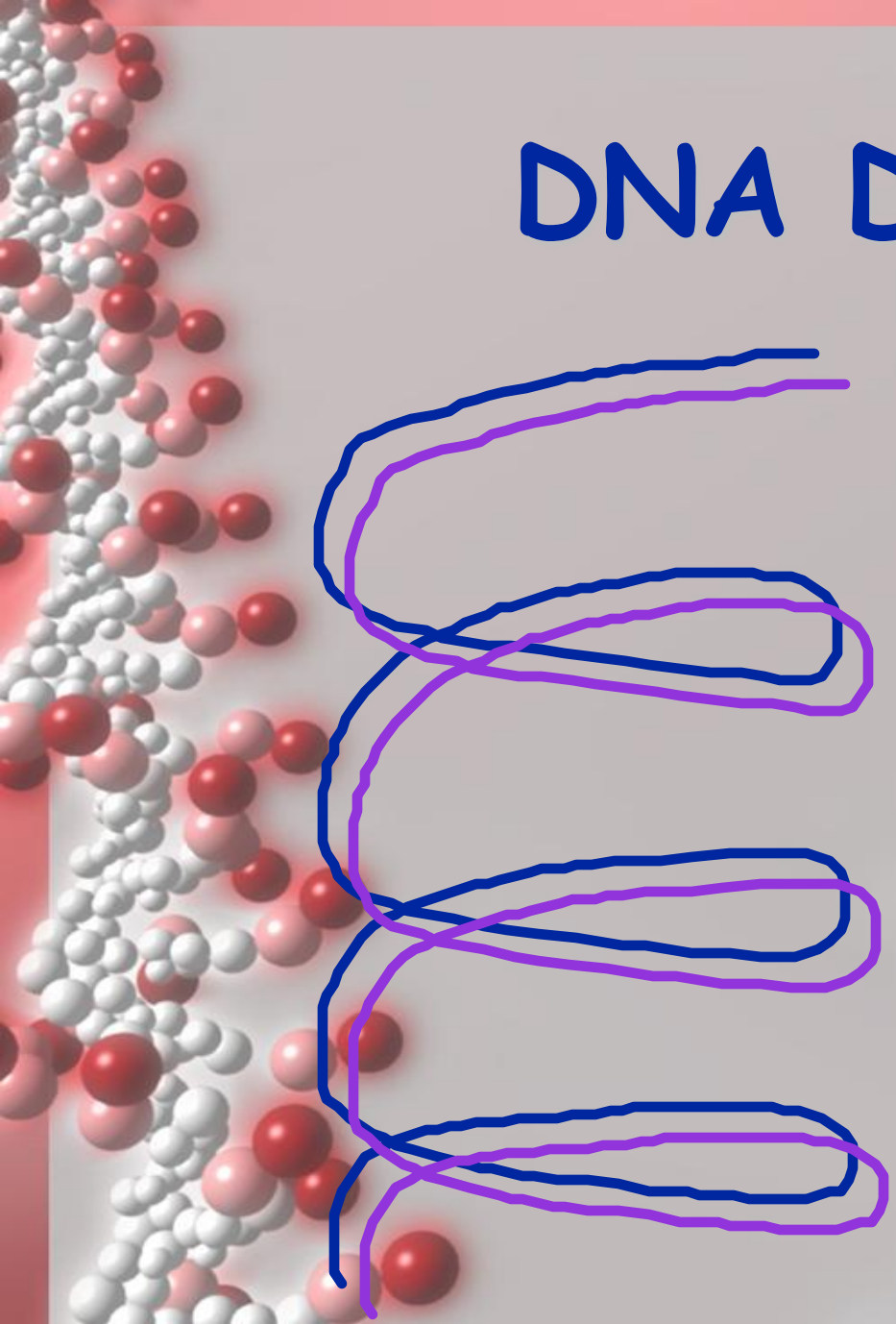
DNA Structure

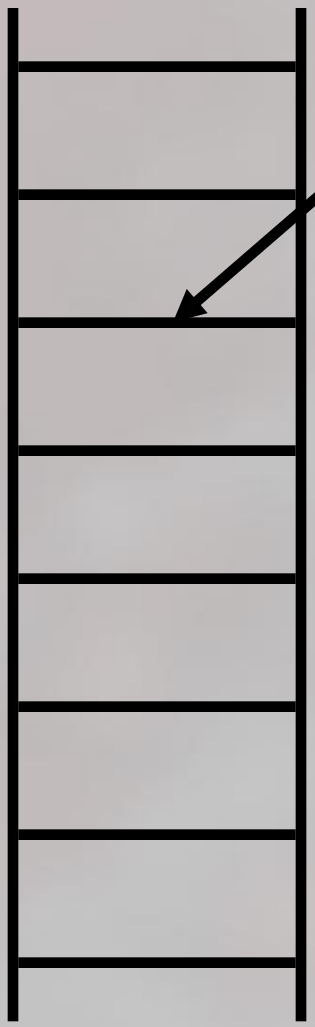


DNA

- Two strands coiled called a double helix
- Sides made of a 5-carbon sugar, deoxyribose, bonded to phosphate groups
- Center made of nitrogen bases bonded together by weak hydrogen bonds

DNA Double Helix





"Rungs of ladder"

Nitrogenous Base (A,T,G or C)

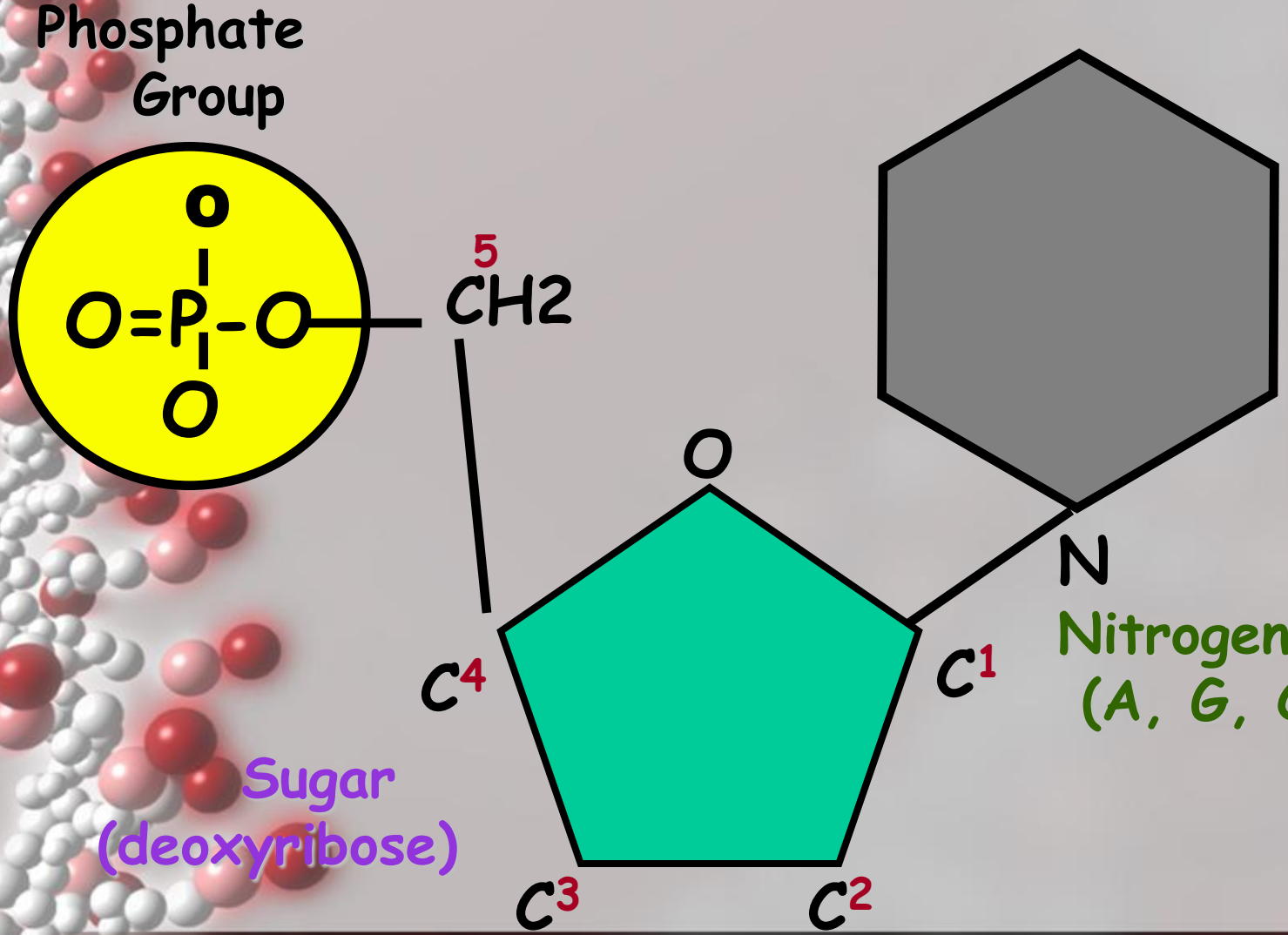
"Legs of ladder"

Phosphate & Sugar Backbone

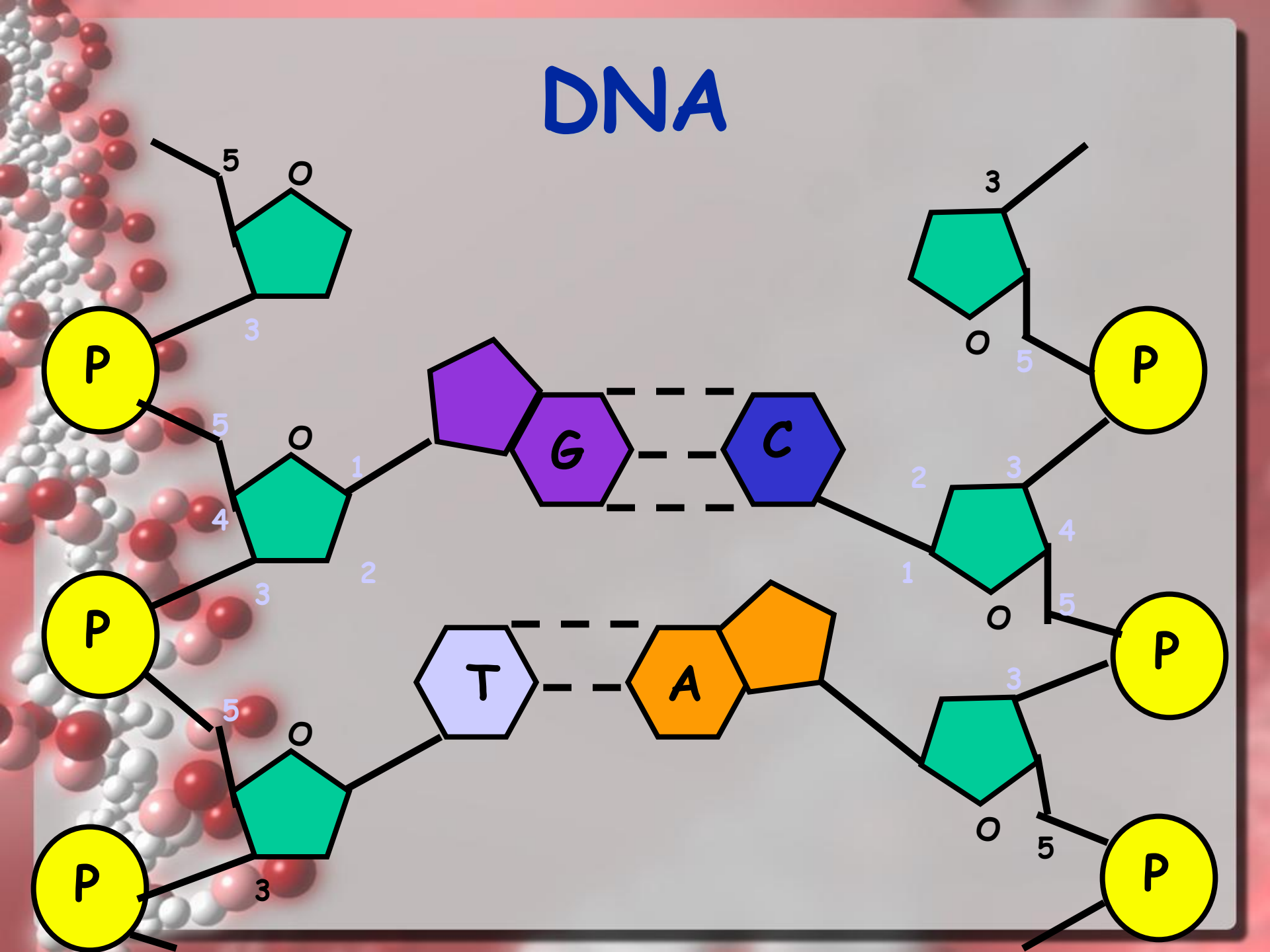
DNA

- Stands for deoxyribonucleic acid
- Made up of subunits called nucleotides
- Nucleotides are made of:
    1. Phosphate group
    2. 5-carbon sugar
    3. Nitrogenous base

DNA Nucleotide

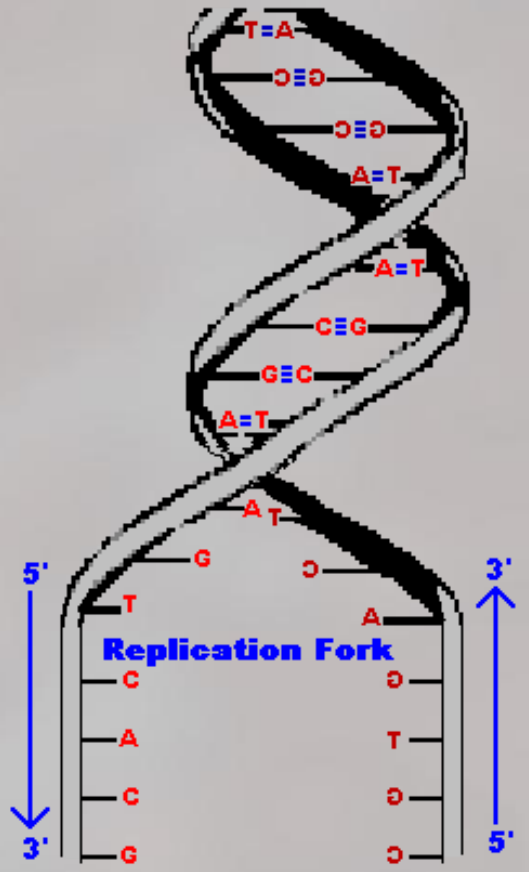


DNA



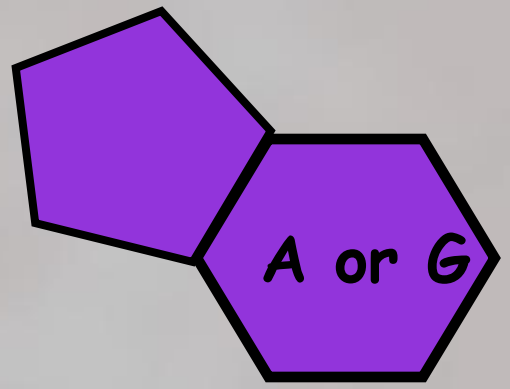
Antiparallel Strands

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

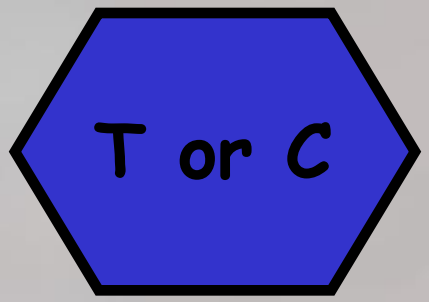


Nitrogenous Bases

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

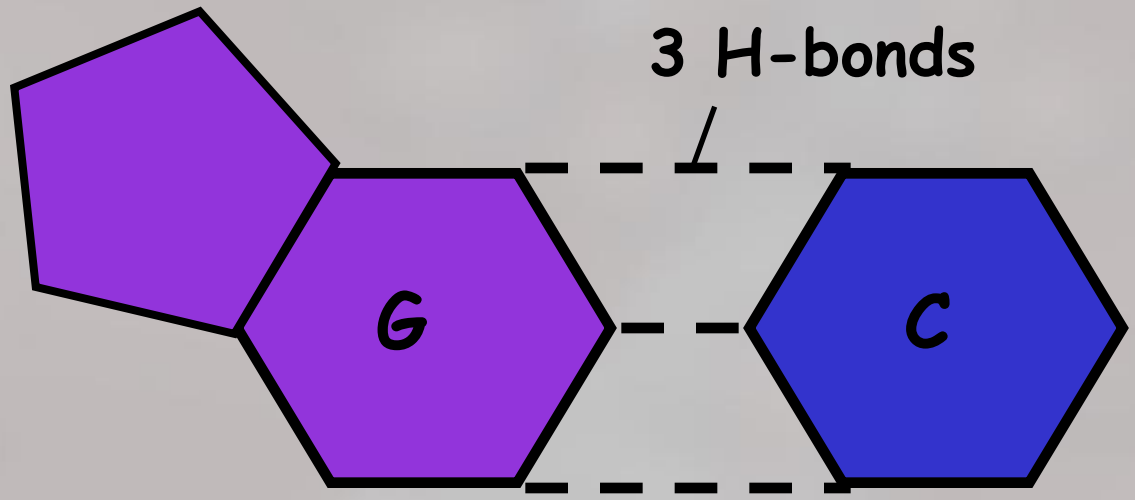


- Single ring **PYRIMIDINES**
  - Thymine (T)
  - Cytosine (C)

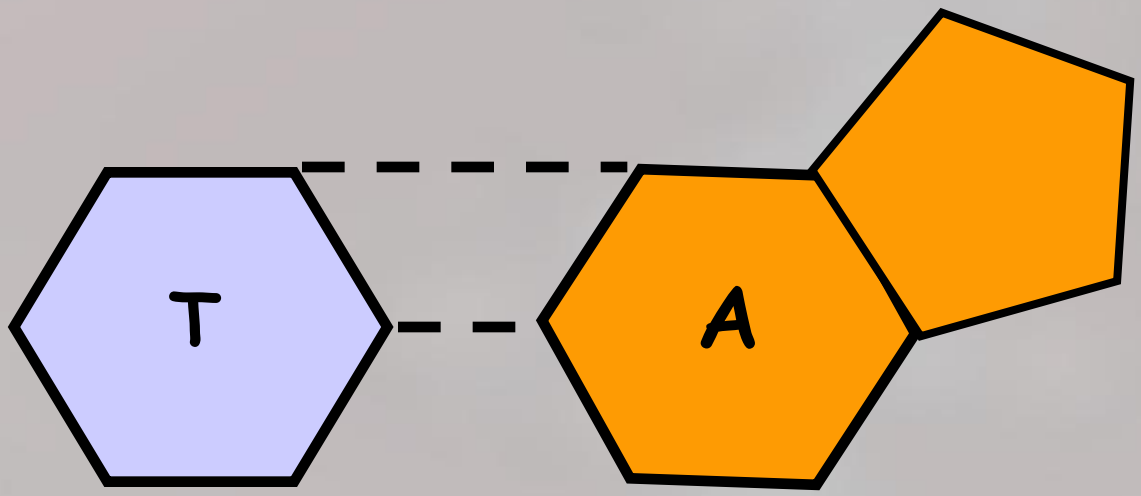


Base-Pairings

- Purines only pair with Pyrimidines
- Three hydrogen bonds required to bond Guanine & Cytosine



- **Two** hydrogen bonds are required to bond Adenine & Thymine



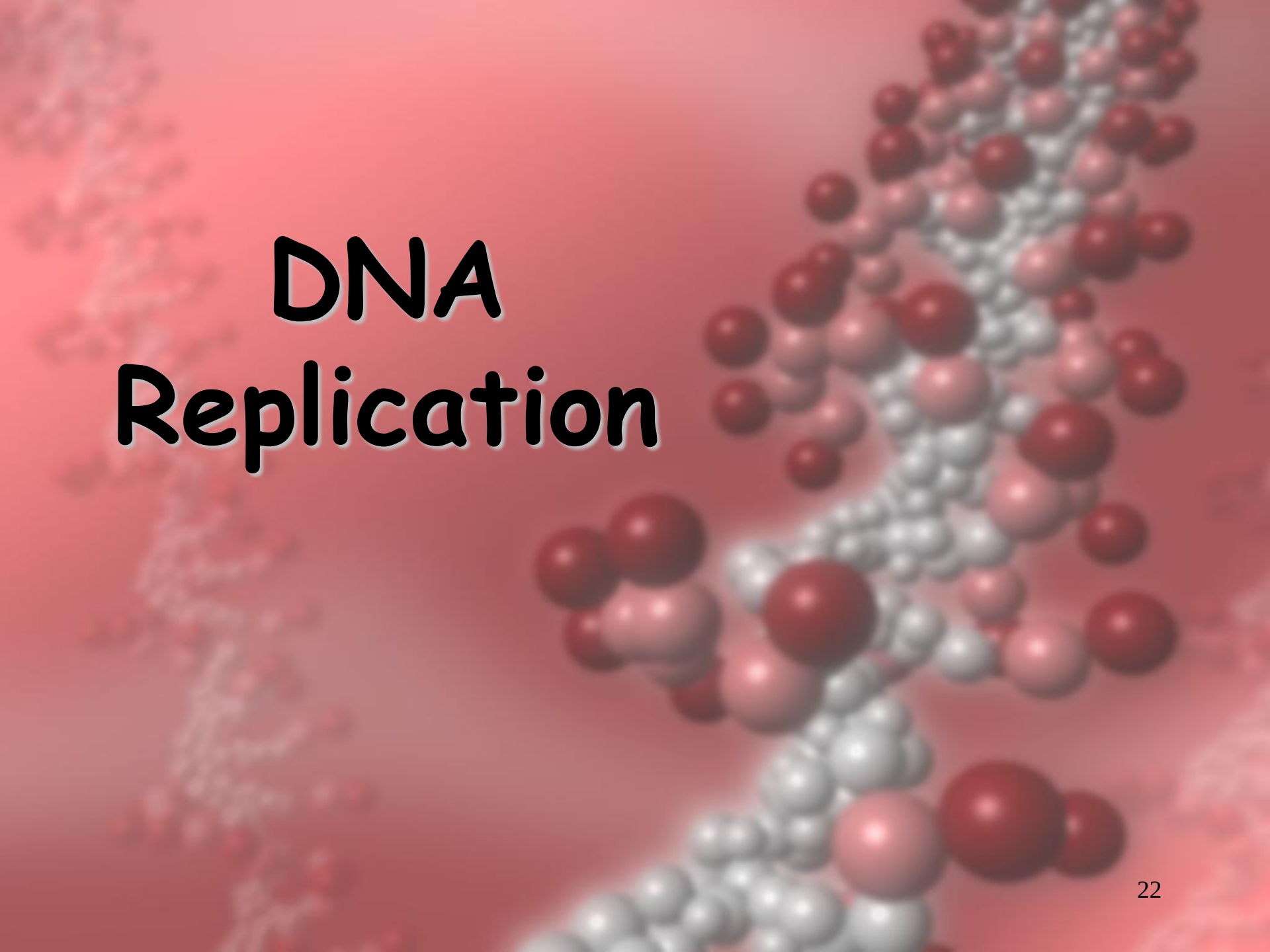
Question:

- 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 and 40% C-G

DNA Replication



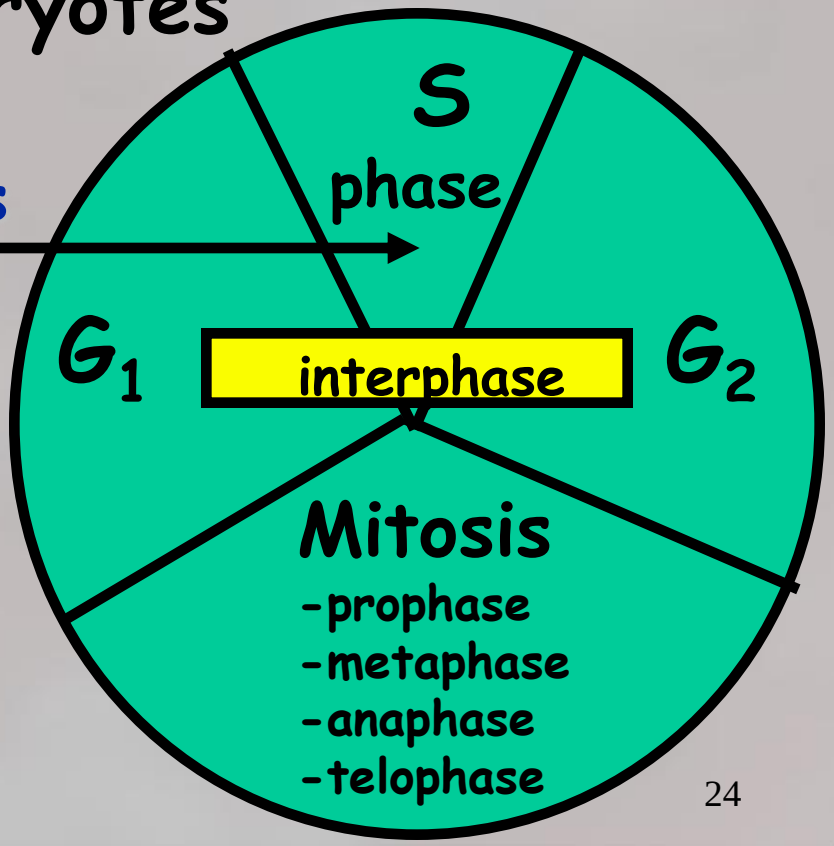
Replication Facts

- 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)

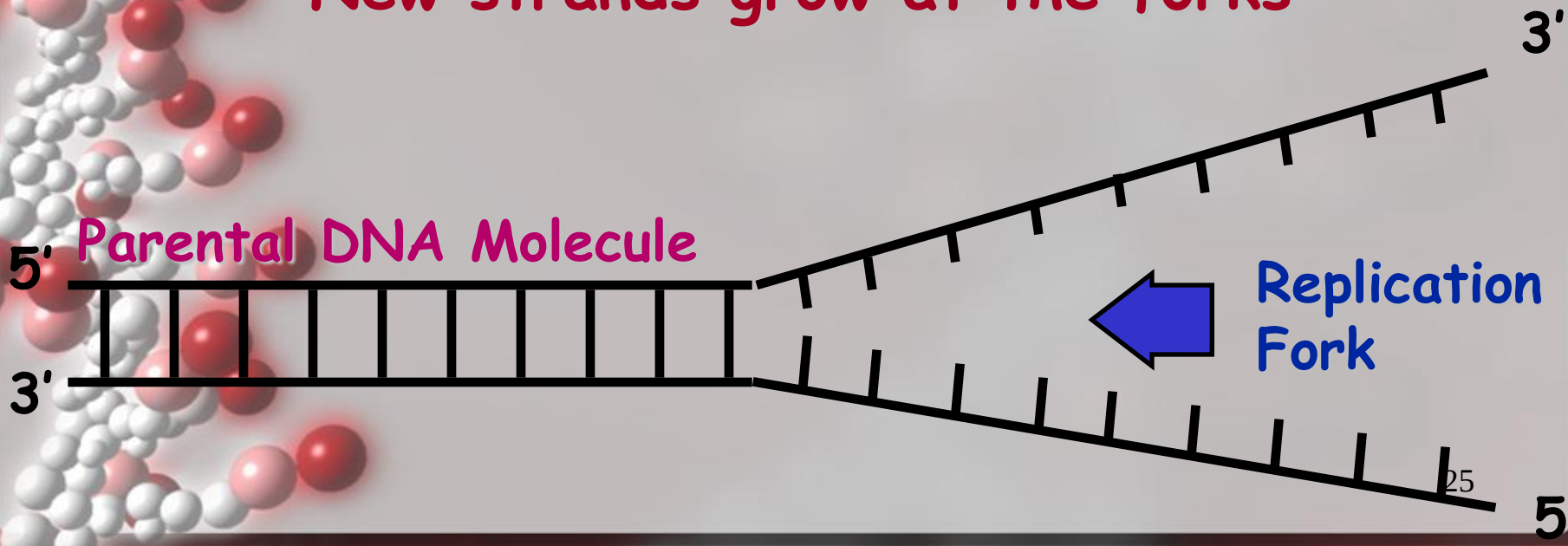
- S phase during interphase of the cell cycle
- Nucleus of eukaryotes

DNA replication takes place in the S phase.



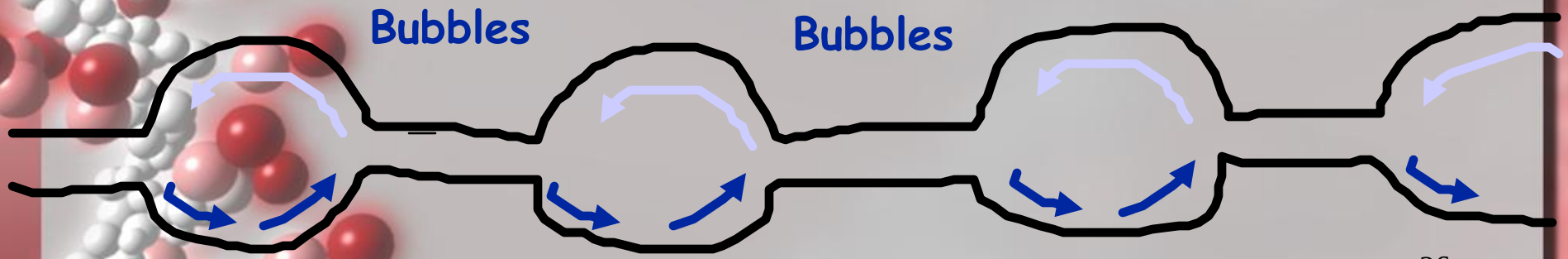
DNA Replication

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



DNA Replication

- As the 2 DNA strands open at the origin, Replication Bubbles form
- Eukaryotic chromosomes have MANY bubbles
- Prokaryotes (bacteria) have a single bubble

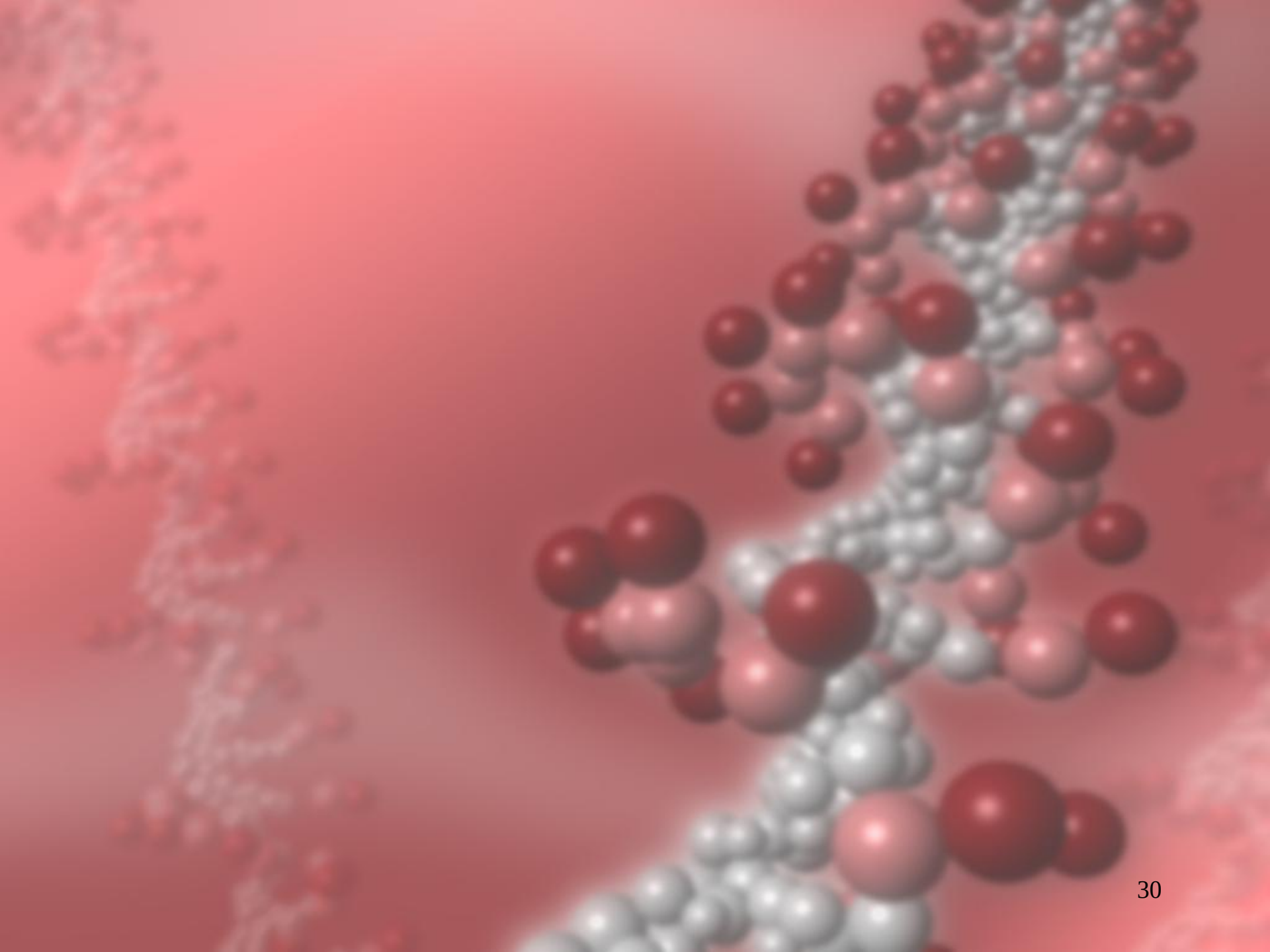


DNA Replication

- Enzyme helicase unwinds and separates the 2 DNA strands by breaking the weak hydrogen bonds
- Single-strand binding proteins attach and keep the 2 DNA strands separated and untwisted

Proofreading New DNA

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

DNA Damage & Repair

- Chemicals & ultraviolet radiation damage the DNA in our body cells
- Cells must continuously repair DAMAGED DNA