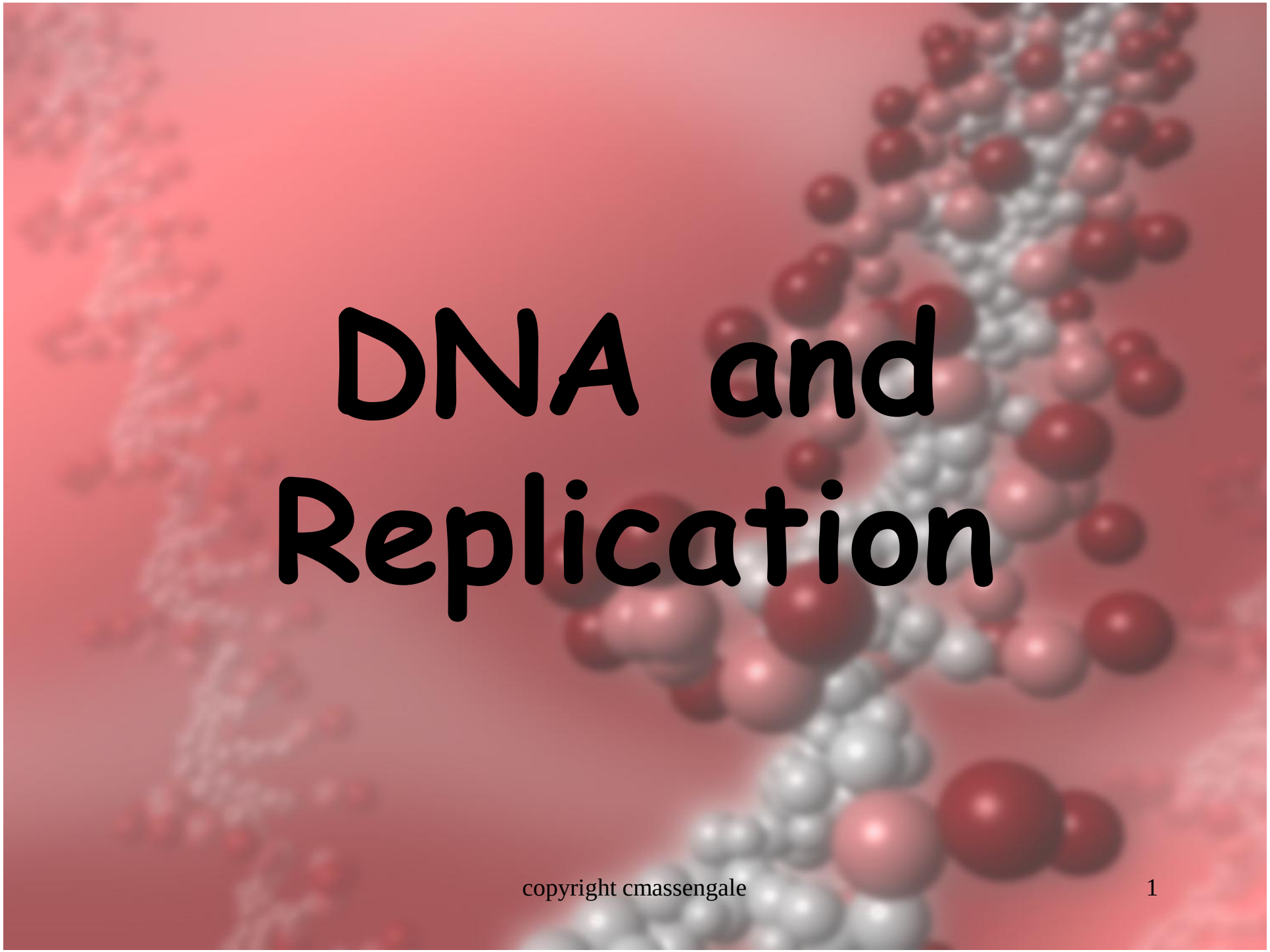
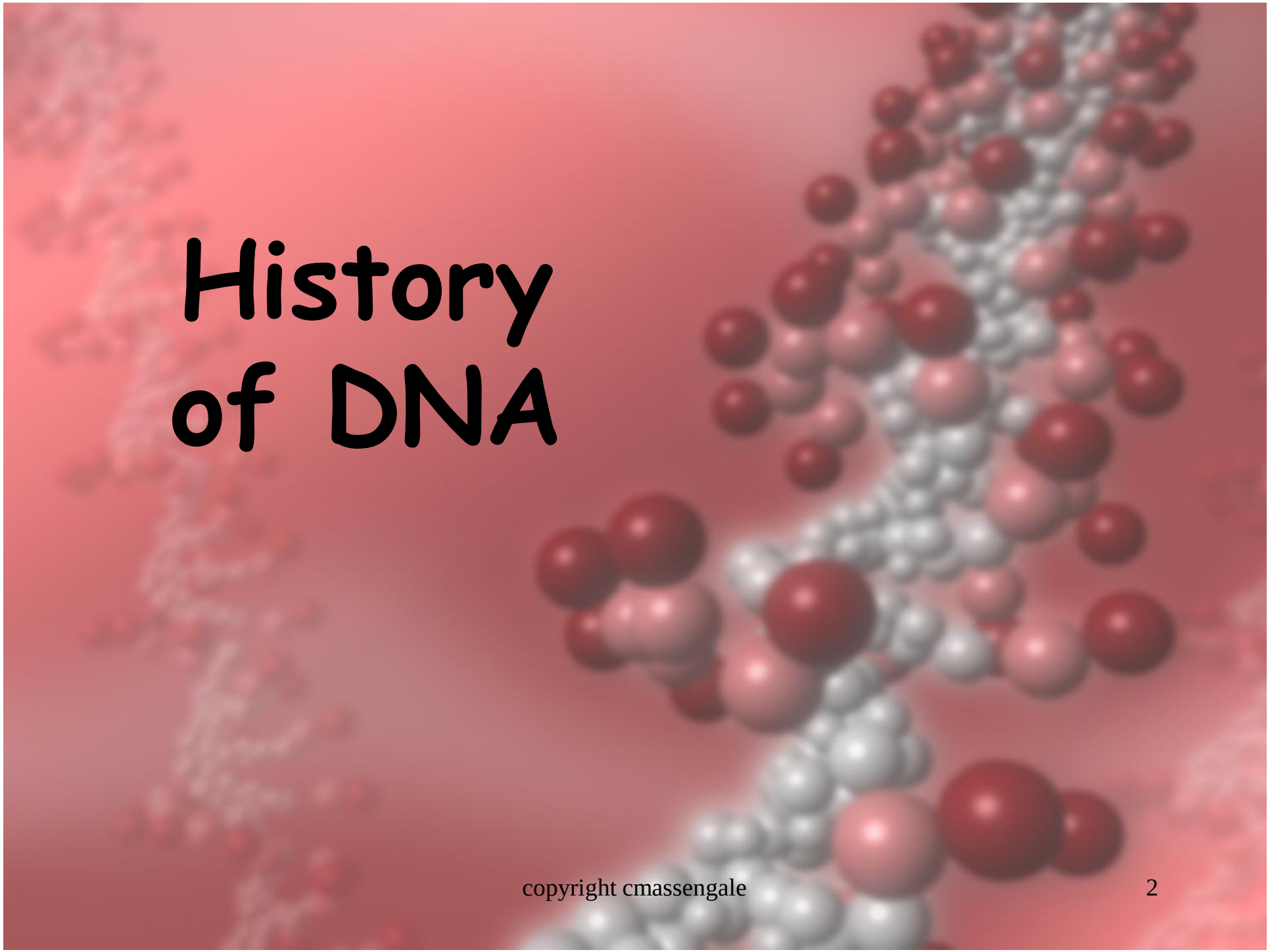


History of DNA



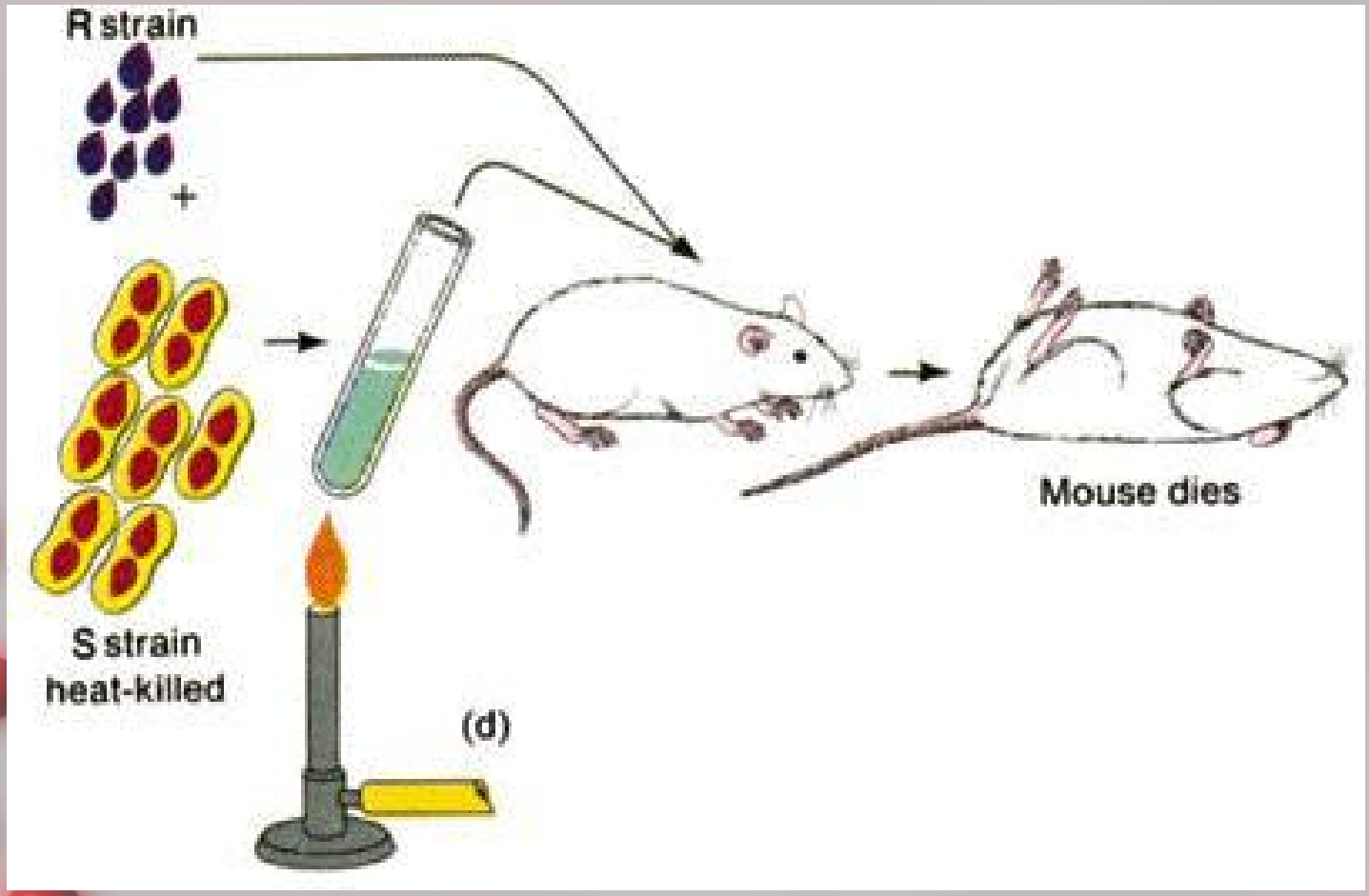
History of DNA

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

Transformation

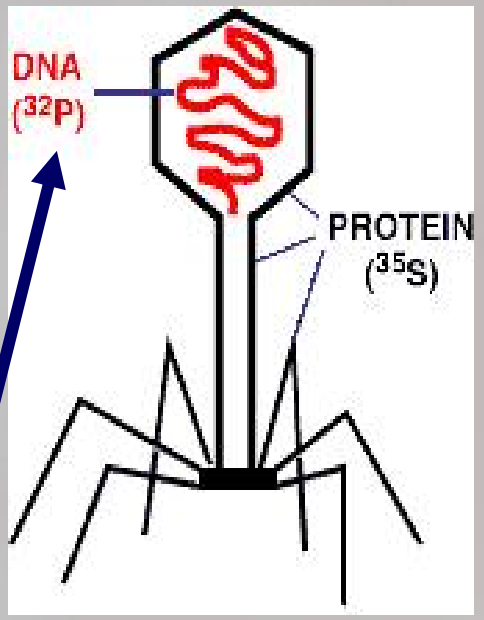
- Fred Griffith worked with virulent S and nonvirulent R strain *Pneumoccocus* bacteria
- He found that R strain could become virulent when it took in DNA from heat-killed S strain
- Study suggested that DNA was probably the genetic material

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



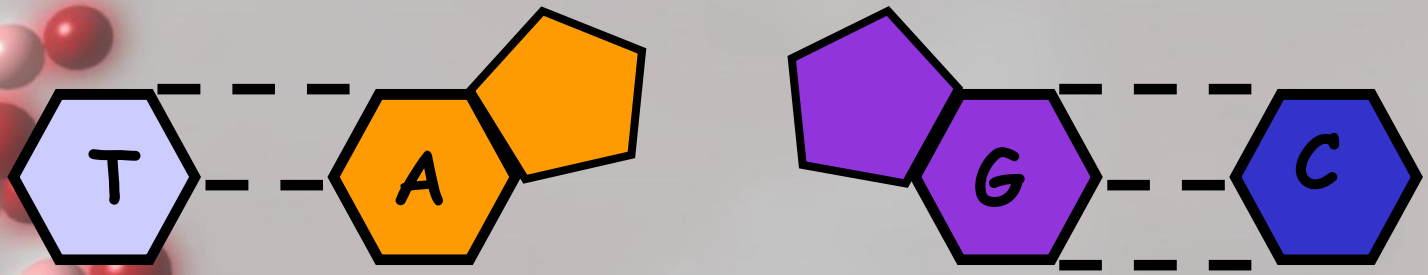
Radioactive ^{32}P was injected into bacteria!

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

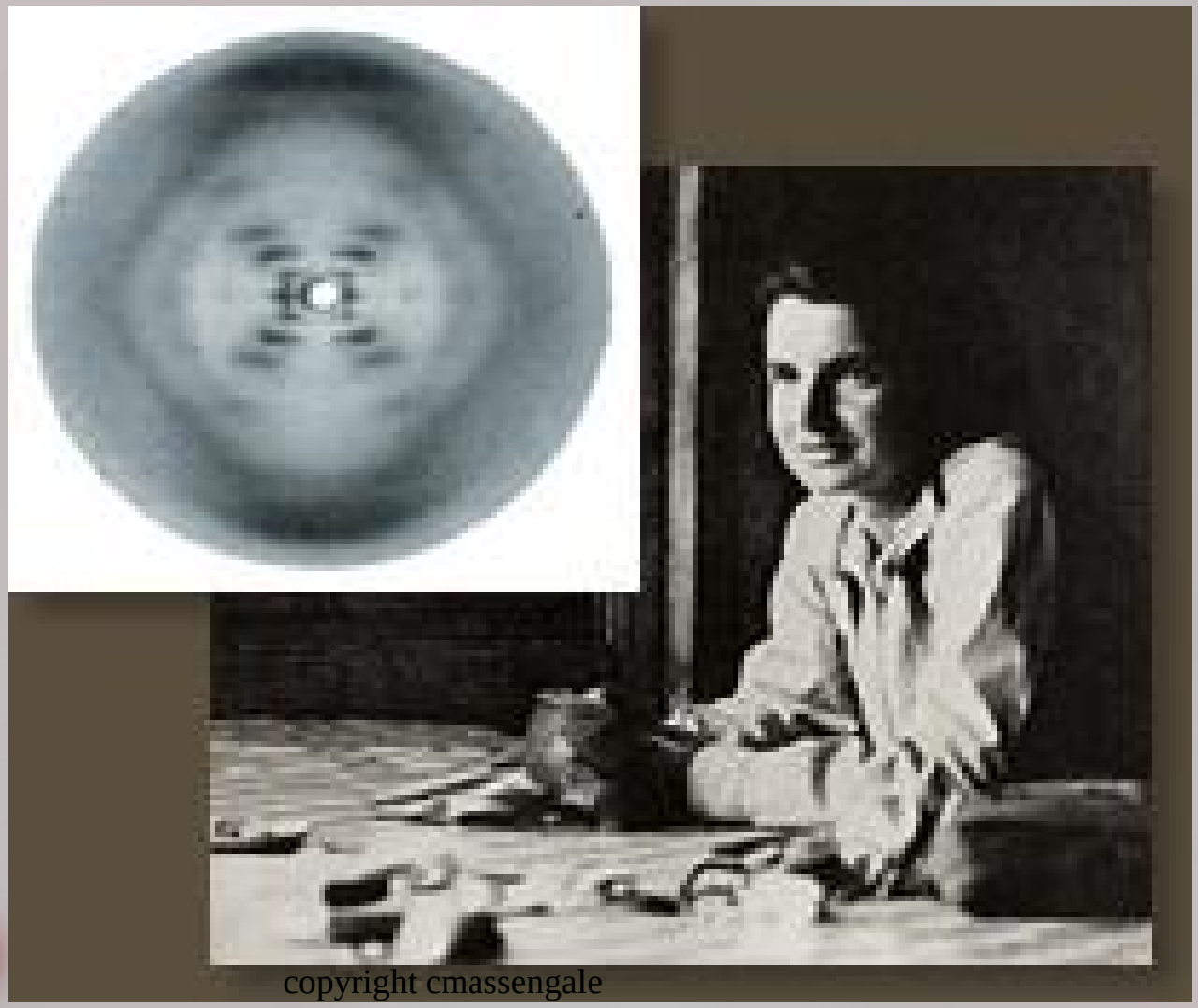
- **Adenine** must pair with **Thymine**
- **Guanine** must pair with **Cytosine**
- The bases form weak hydrogen bonds



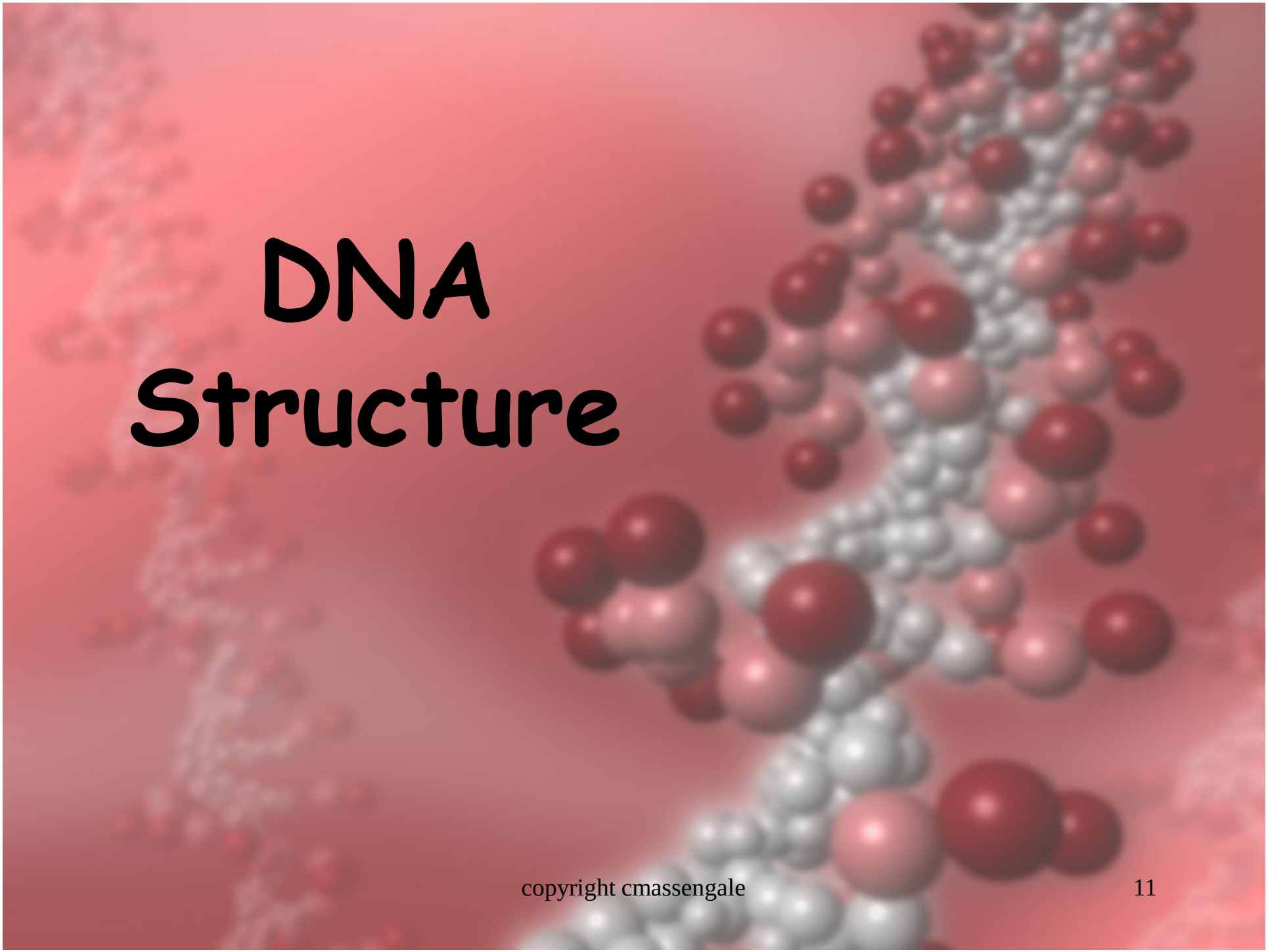
DNA Structure

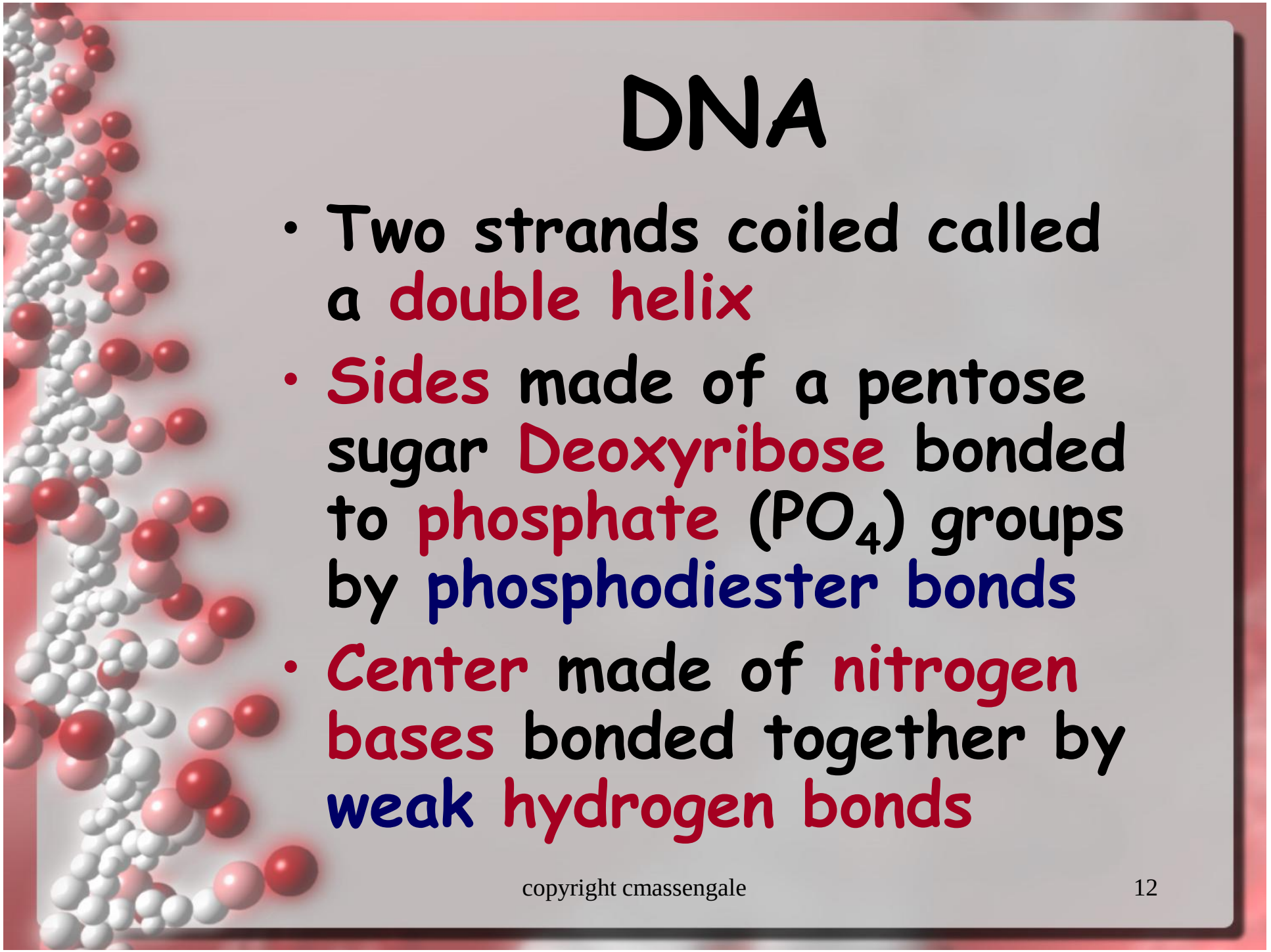
- Rosalind Franklin took diffraction x-ray photographs of DNA crystals
- In the 1950's, Watson & Crick built the first model of DNA using Franklin's x-rays

Rosalind Franklin



DNA Structure

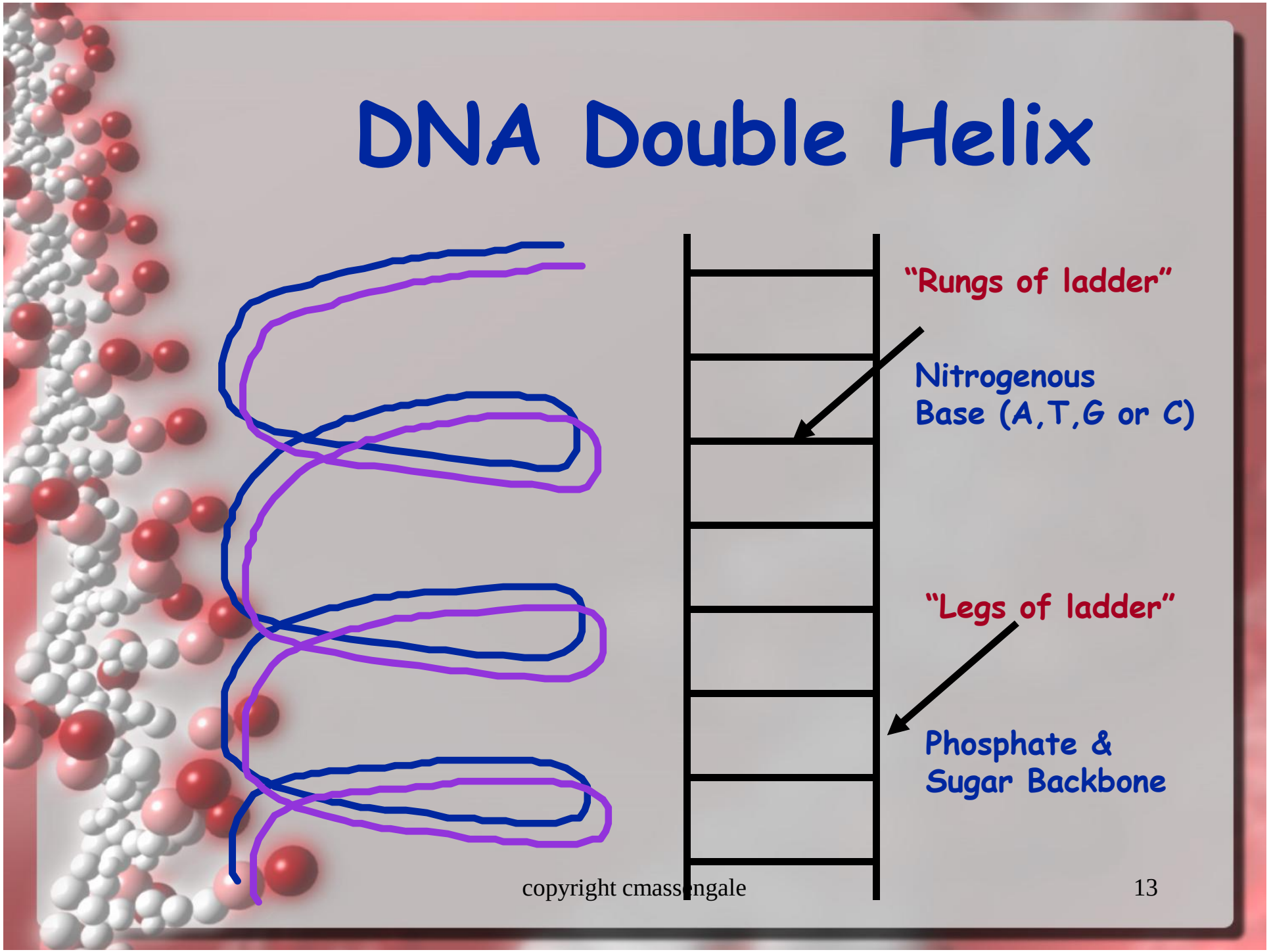




DNA

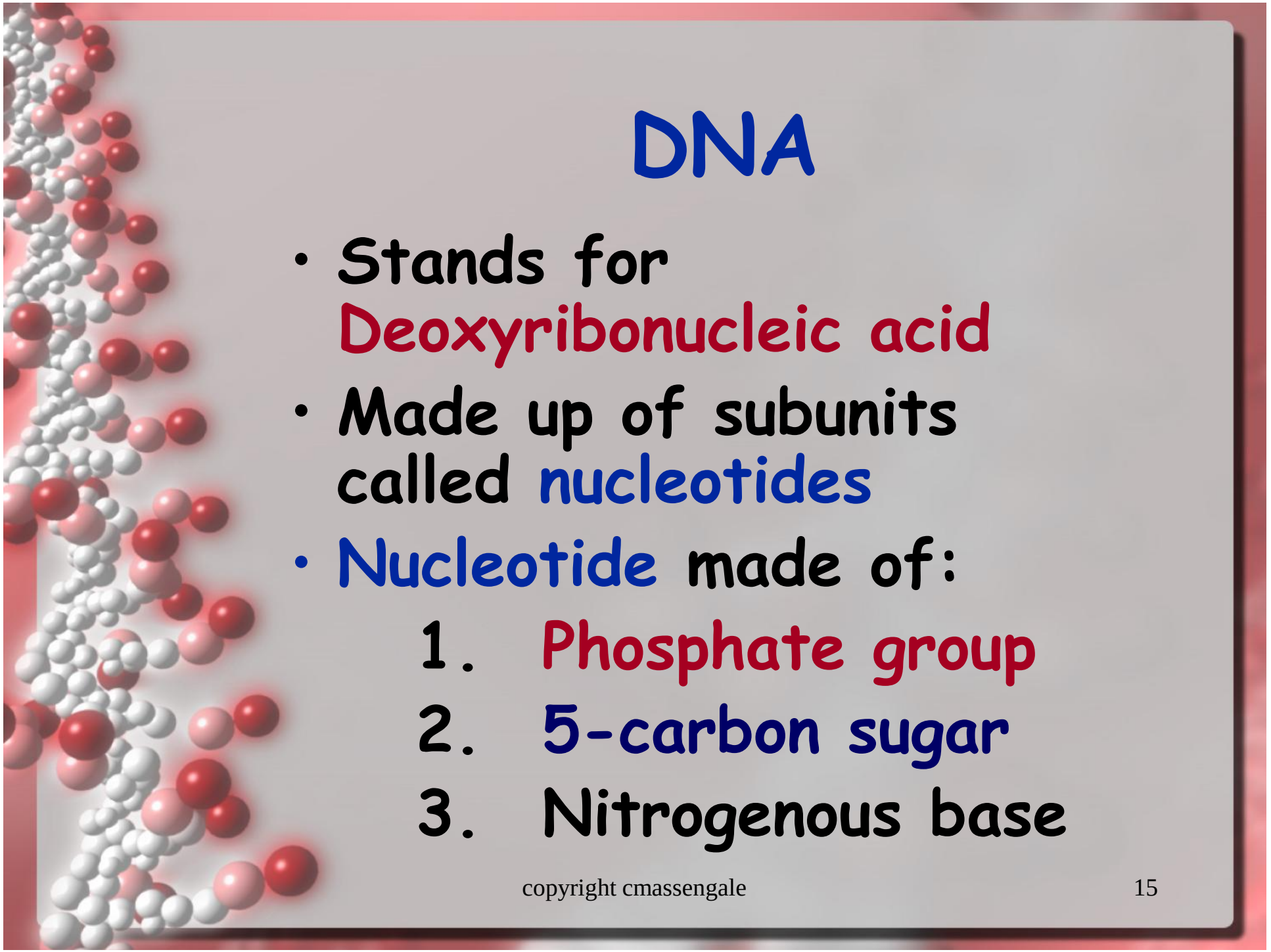
- Two strands coiled called a double helix
- Sides made of a pentose sugar Deoxyribose bonded to phosphate (PO_4) groups by phosphodiester bonds
- Center made of nitrogen bases bonded together by weak hydrogen bonds

DNA Double Helix



Helix

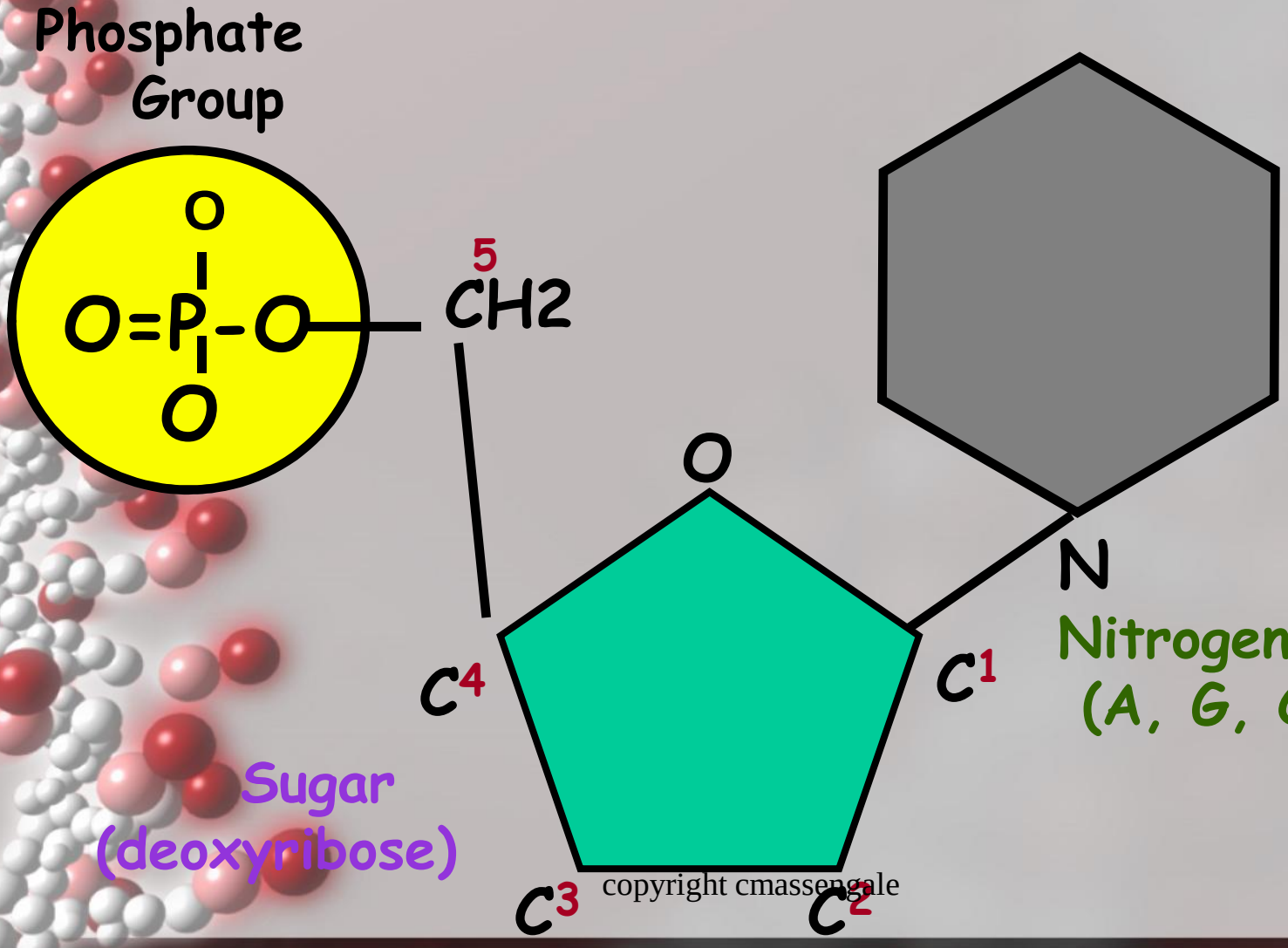
- Most DNA has a right-hand twist with 10 base pairs in a complete turn
- Left twisted DNA is called Z-DNA or southpaw DNA
- Hot spots occur where right and left twisted DNA meet producing mutations



DNA

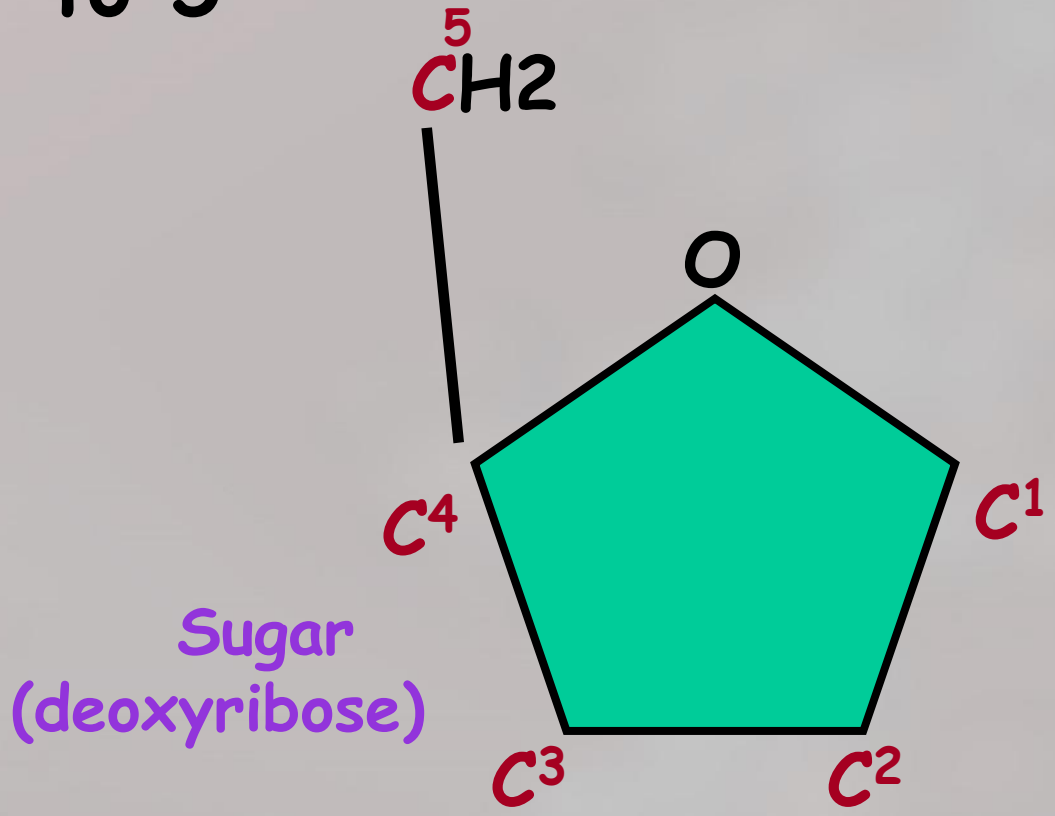
- Stands for Deoxyribonucleic acid
- Made up of subunits called nucleotides
- Nucleotide made of:
    1. Phosphate group
    2. 5-carbon sugar
    3. Nitrogenous base

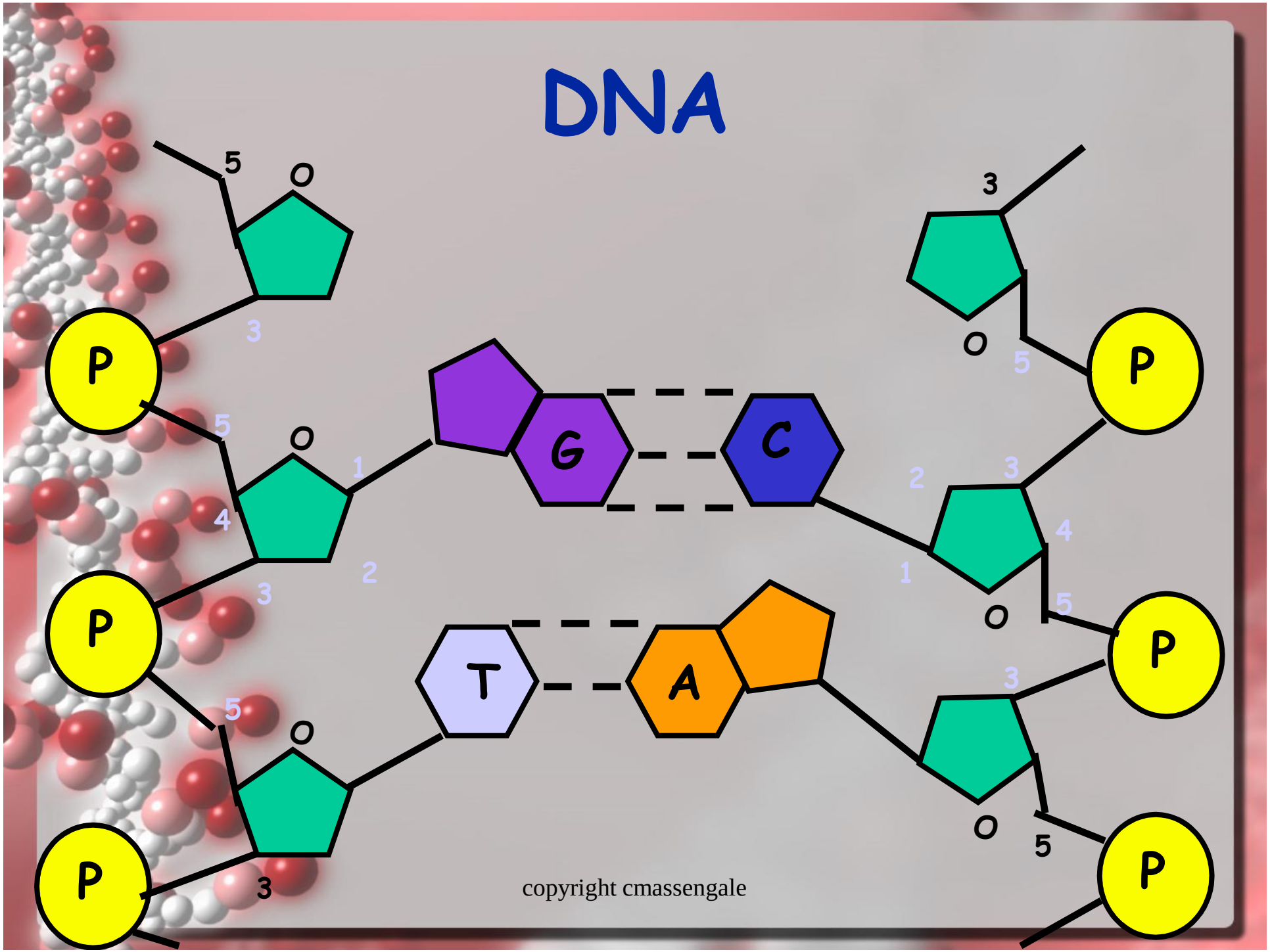
DNA Nucleotide



Pentose Sugar

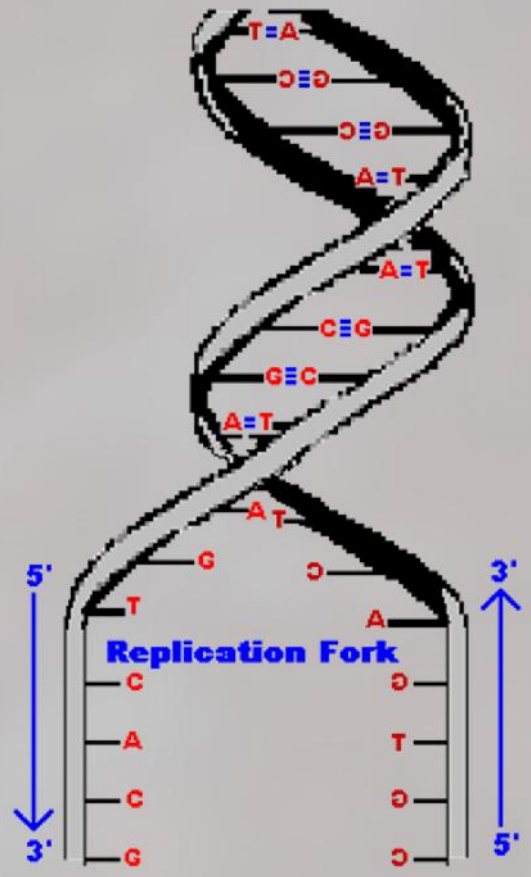
- Carbons are numbered clockwise 1′ to 5′




DNA
5
O
3
P
5
O
1
G
C
4
2
3
2
3
4
1
O
5
P
P
5
T
A
3
5
O
O
P
3
5
P
copyright cmassengale

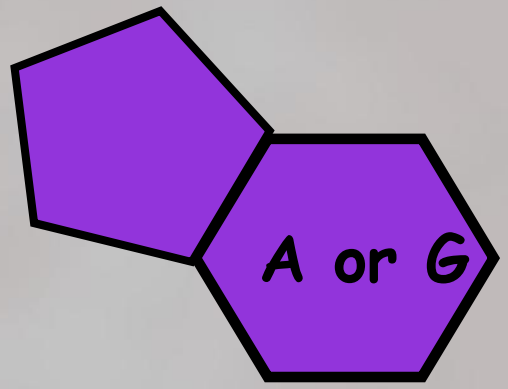
Antiparallel Strands

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

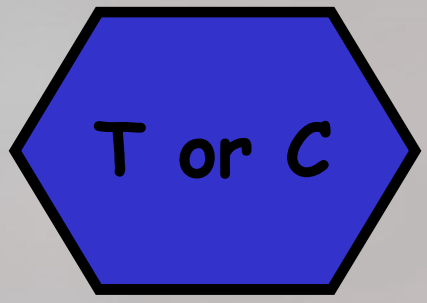


Nitrogenous Bases

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

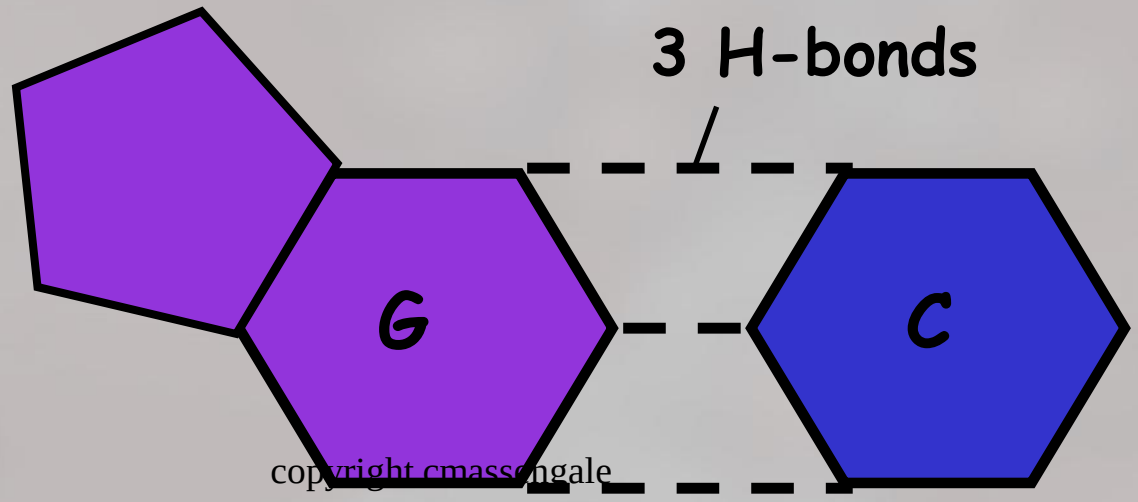


- Single ring **PYRIMIDINES**
  - Thymine (T)
  - Cytosine (C)

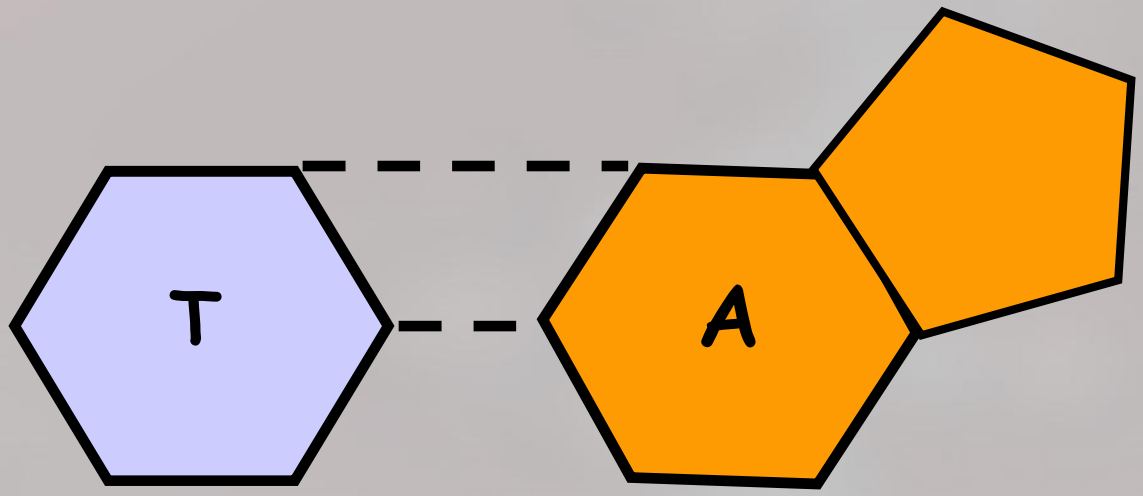


Base-Pairings

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



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

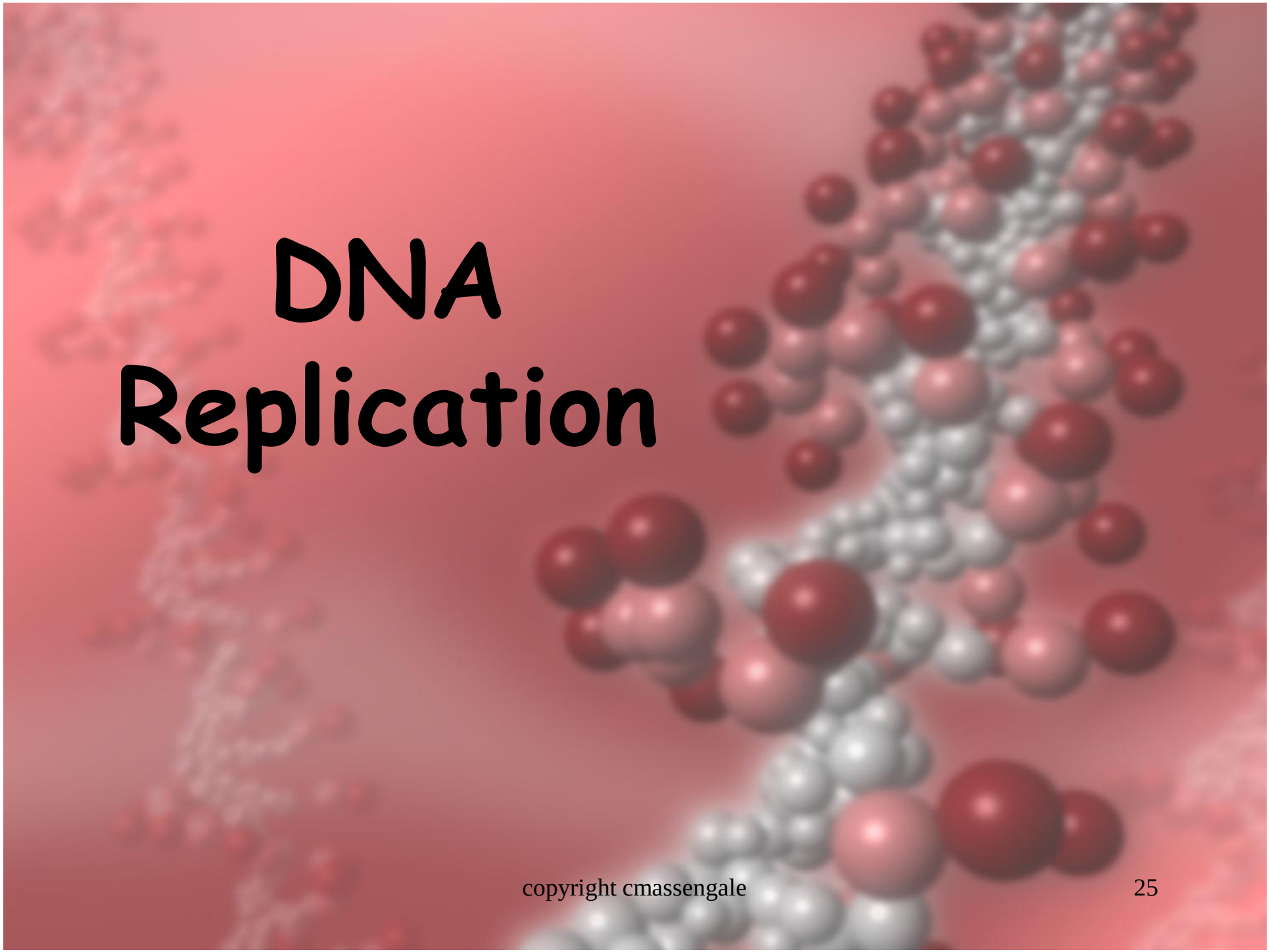


Question:

- 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



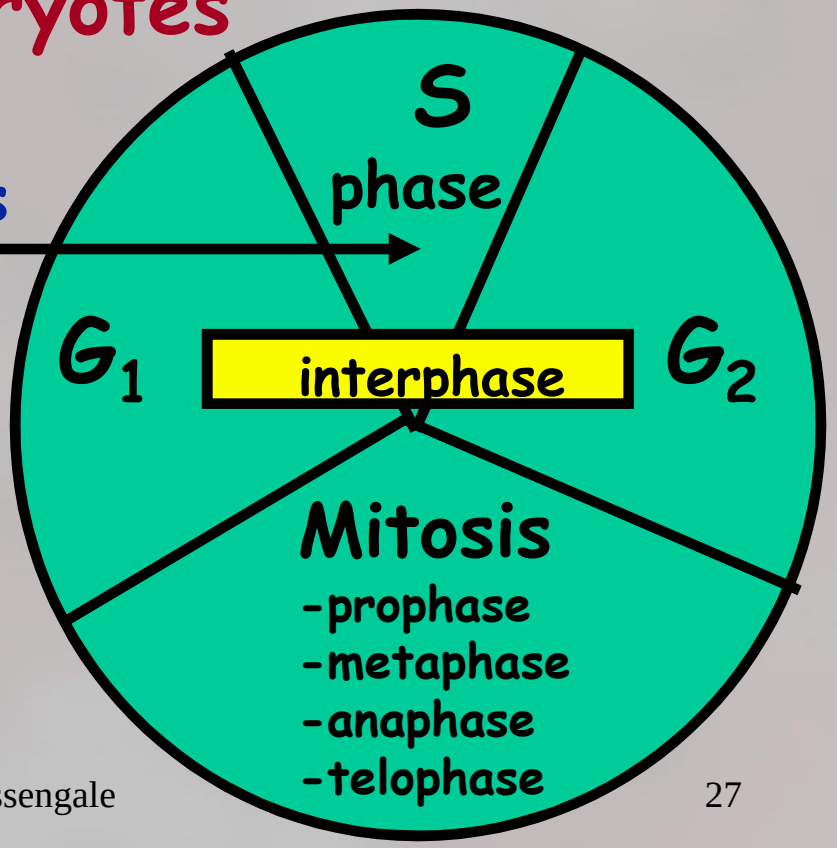
Replication Facts

- 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)

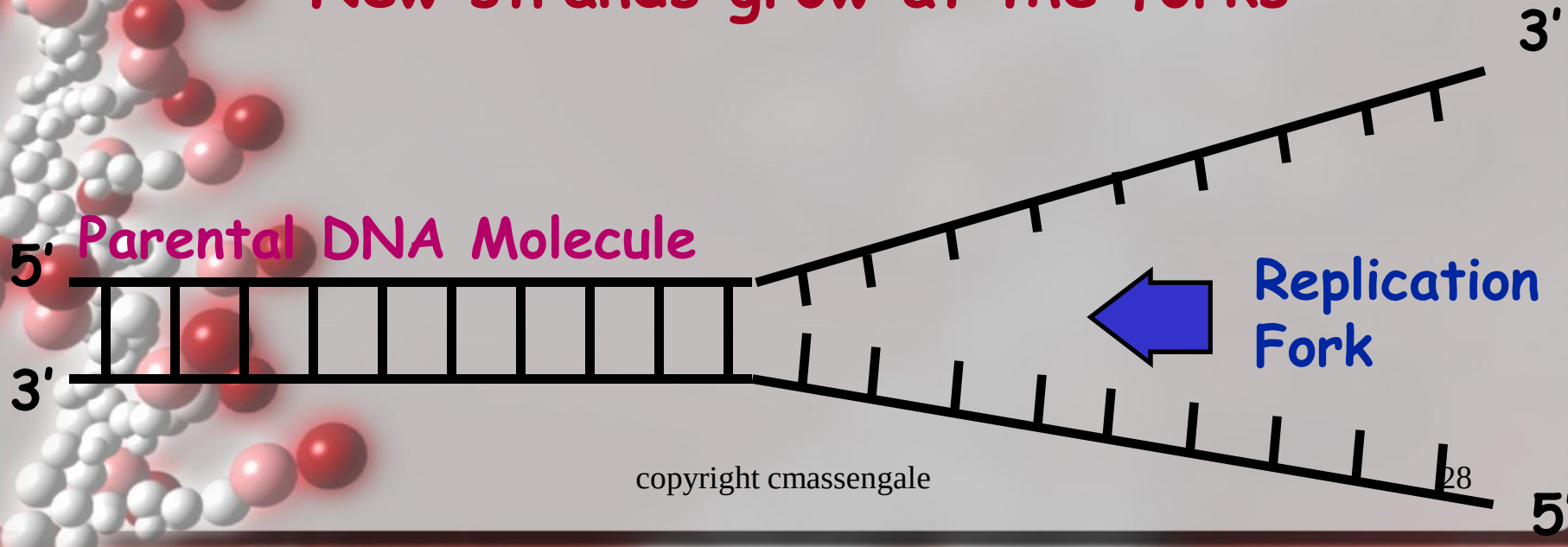
- S phase during interphase of the cell cycle
- Nucleus of eukaryotes

DNA replication takes place in the S phase.



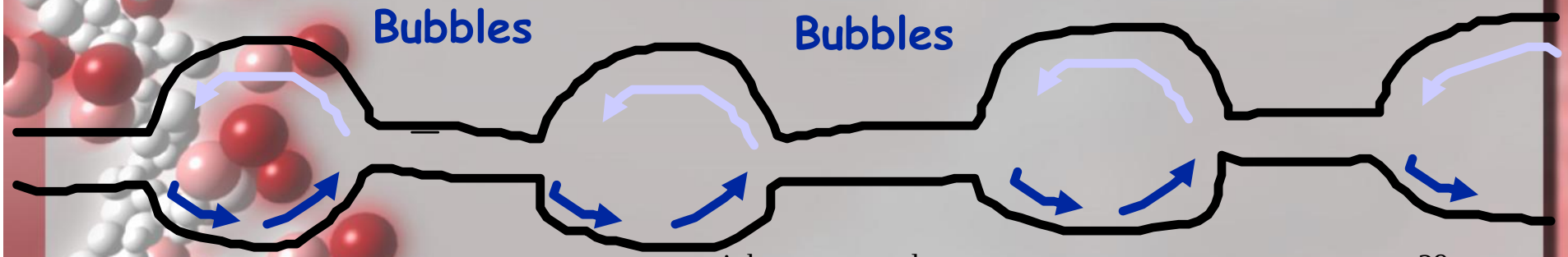
DNA Replication

- 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
- Prokaryotes (bacteria) have a single bubble
- Eukaryotic chromosomes have MANY bubbles

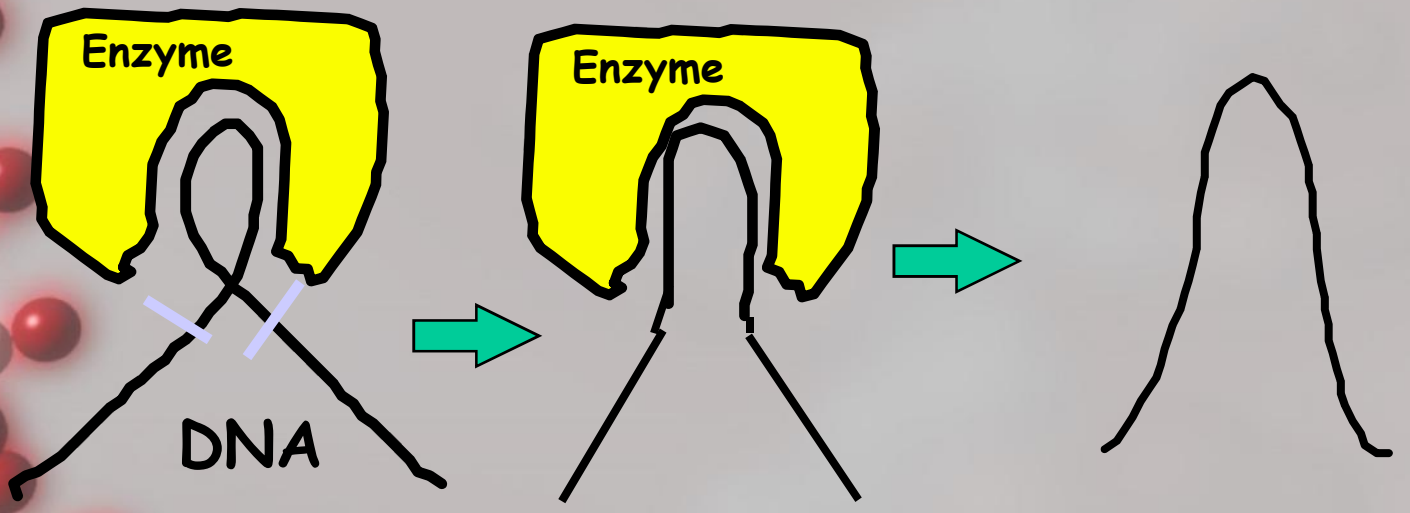


DNA Replication

- 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

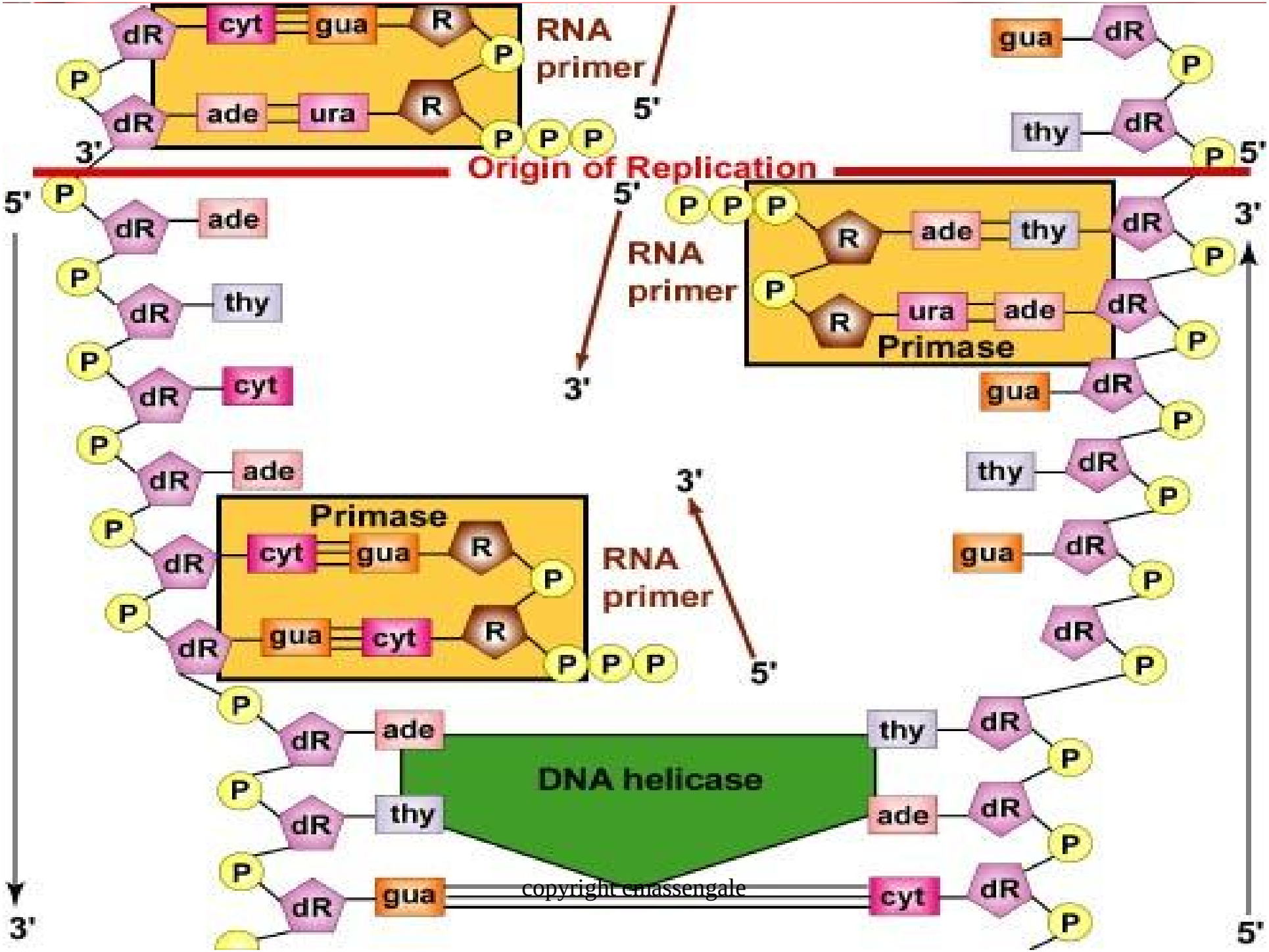
DNA Replication

- Enzyme **Topoisomerase** attaches to the 2 forks of the bubble to **relieve stress** on the DNA molecule as it separates



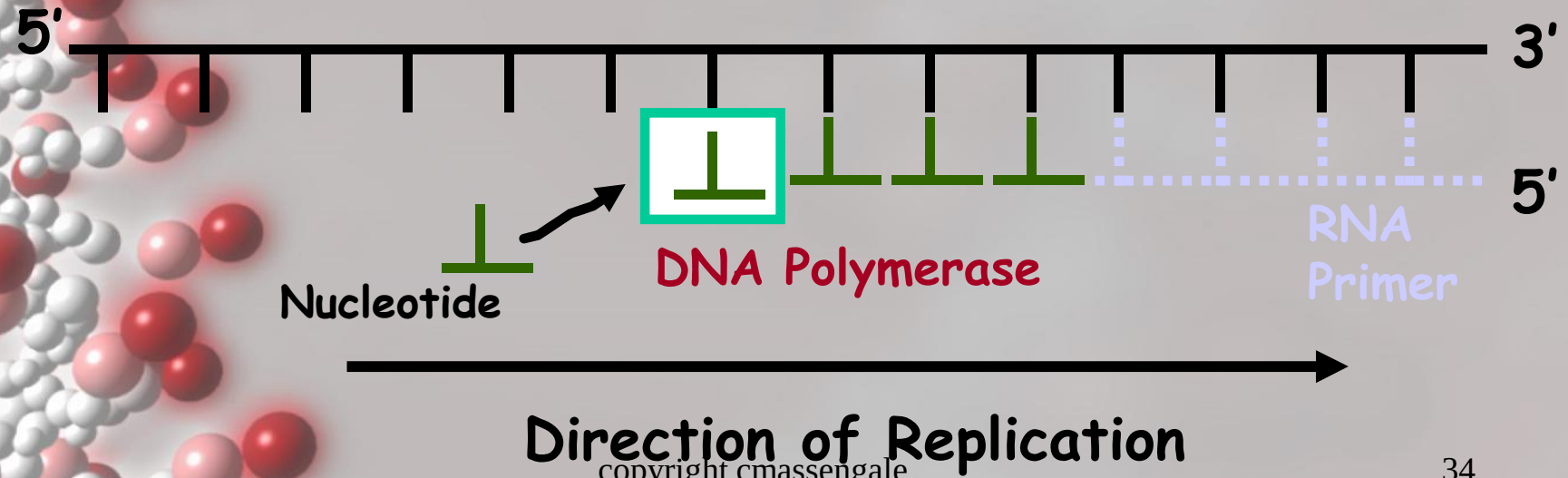
DNA Replication

- Before new DNA strands can form, there must be RNA primers present to start the addition of new nucleotides
- Primase is the enzyme that synthesizes the RNA Primer
- DNA polymerase can then add the new nucleotides

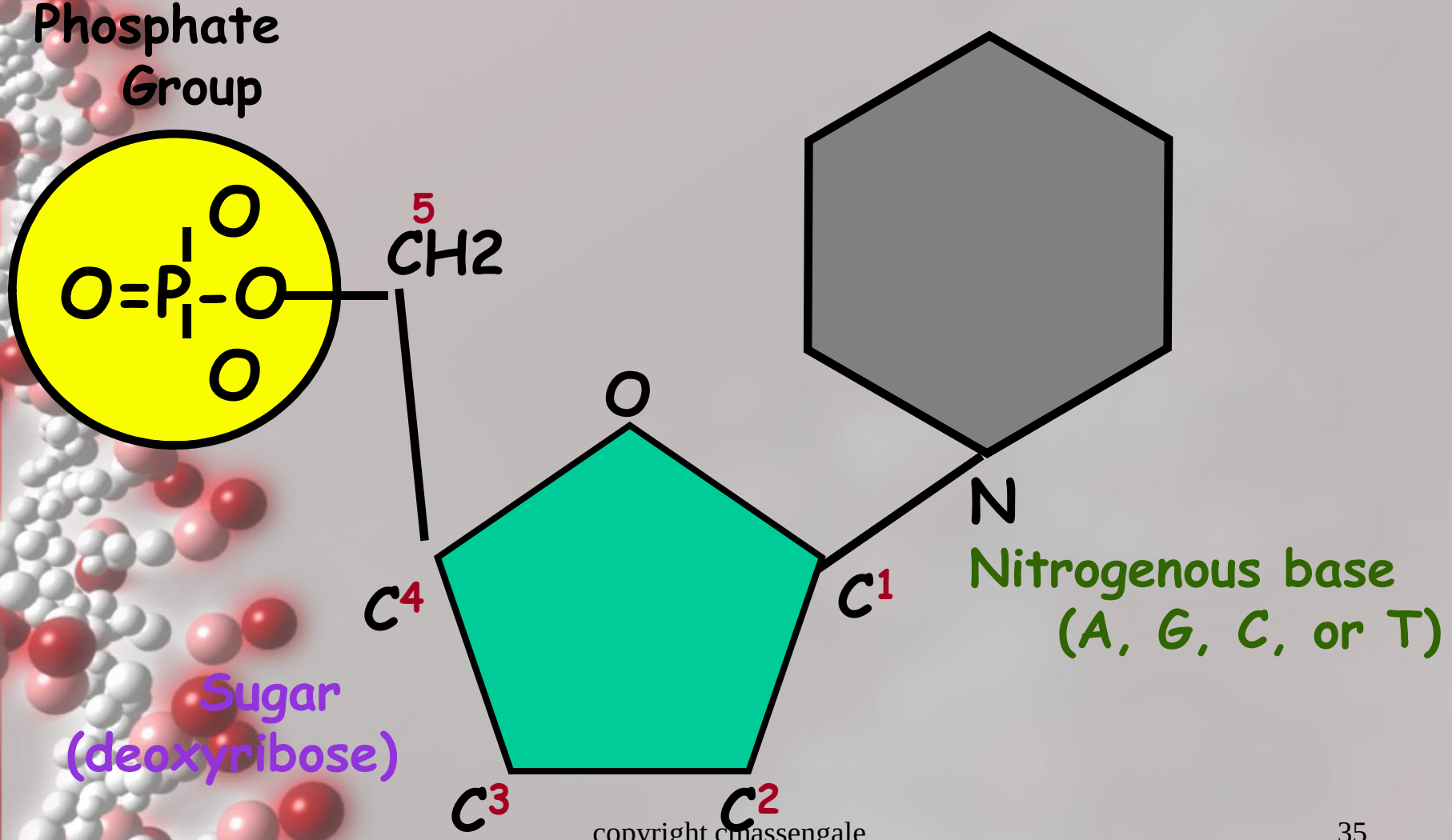

RNA primer
5'
3'
Origin of Replication
5'
3'
RNA primer
Primase
3'
5'
RNA primer
Primase
DNA helicase
3'
5'
copyright cnassengale

DNA Replication

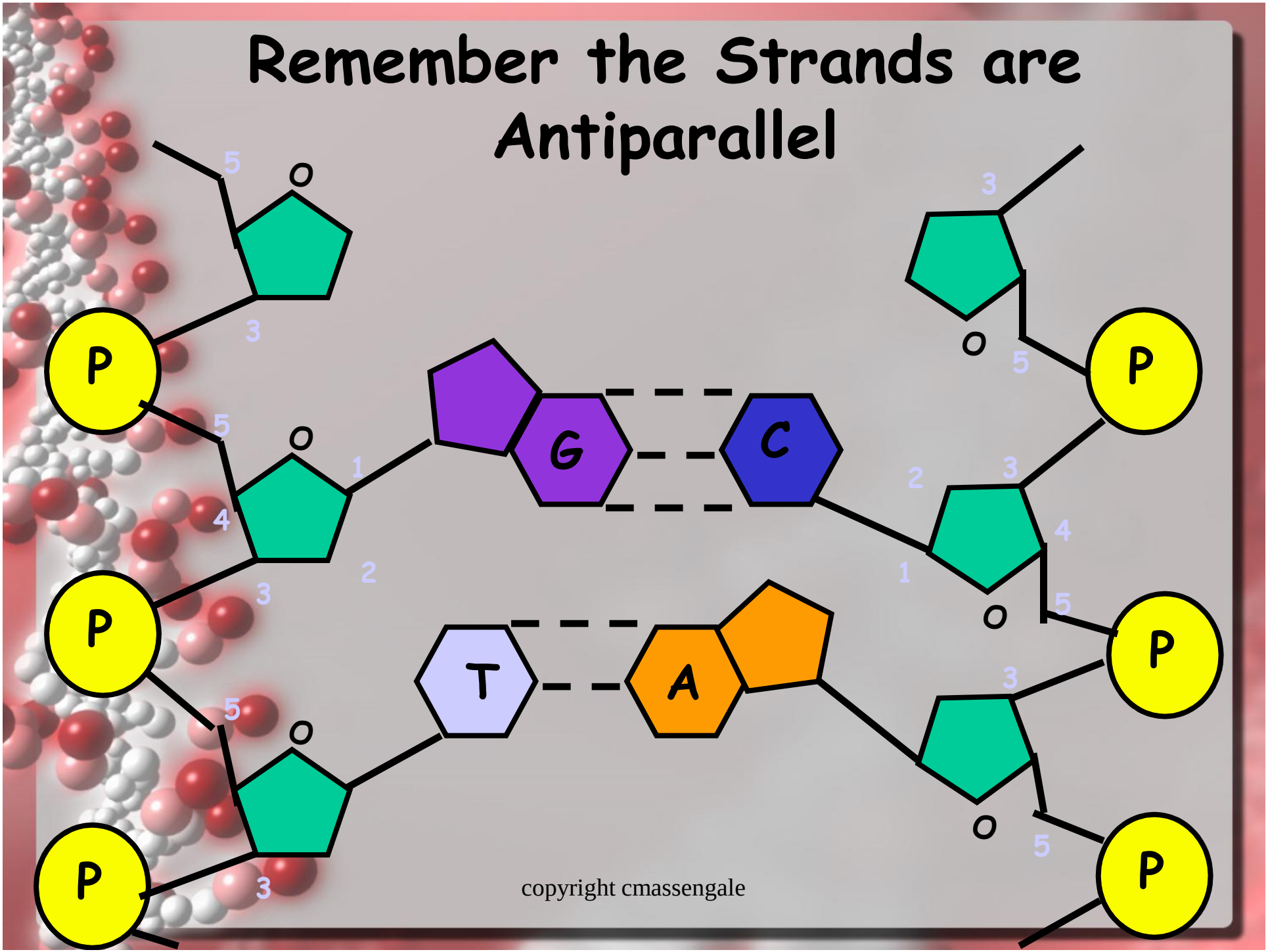
- DNA polymerase can only add nucleotides to the 3' end of the DNA
- This causes the NEW strand to be built in a 5' to 3' direction



Remember HOW the Carbons Are Numbered!

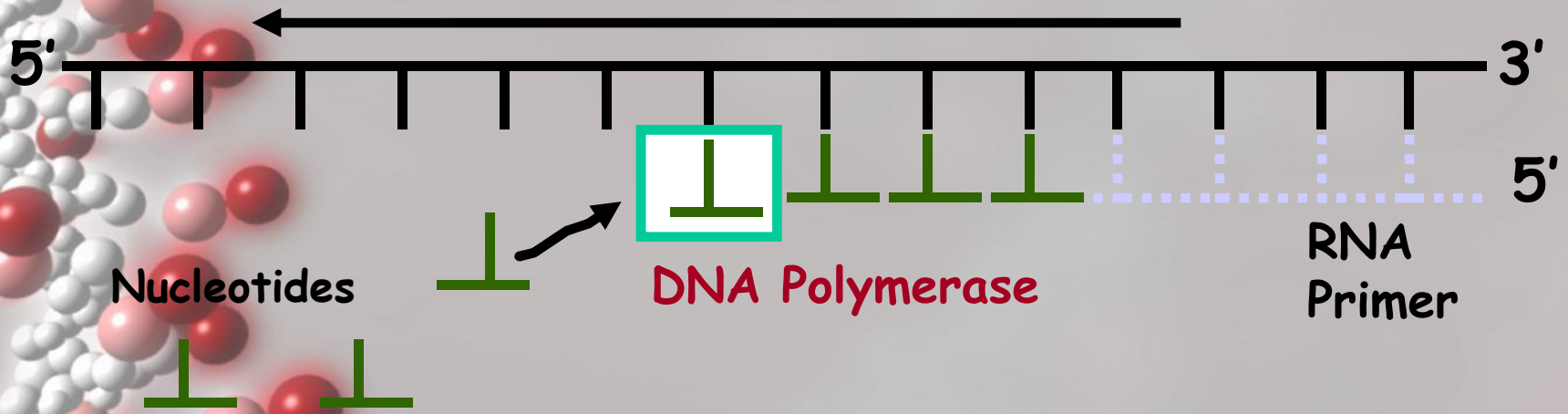


Remember the Strands are Antiparallel



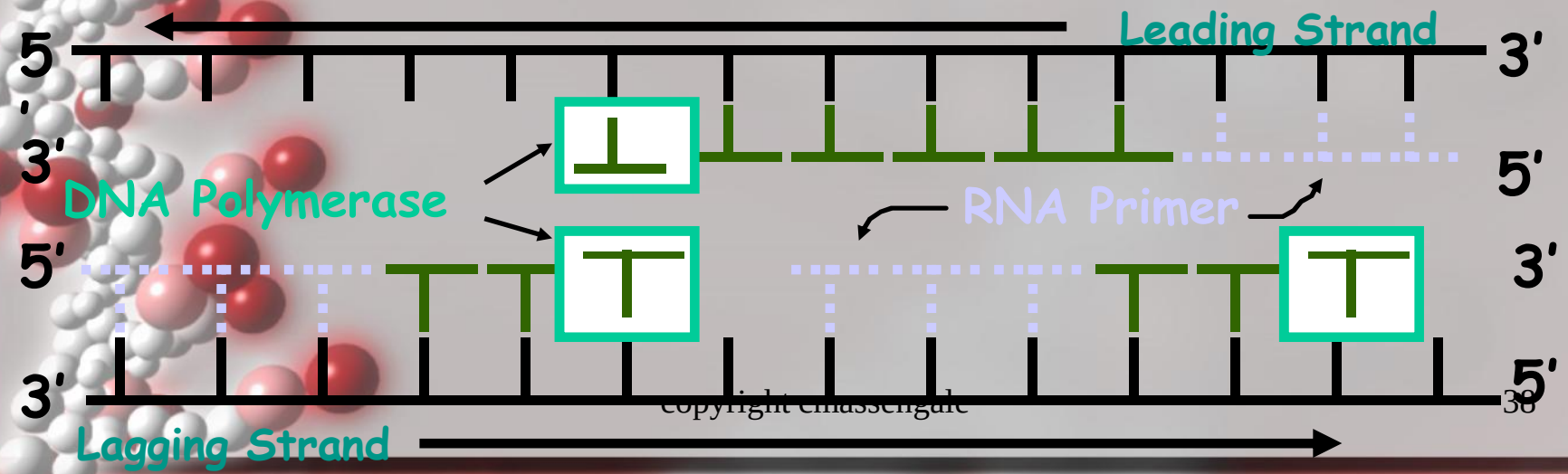
Synthesis of the New DNA Strands

- The **Leading Strand** is synthesized as a single strand from the **point of origin toward the opening replication fork**



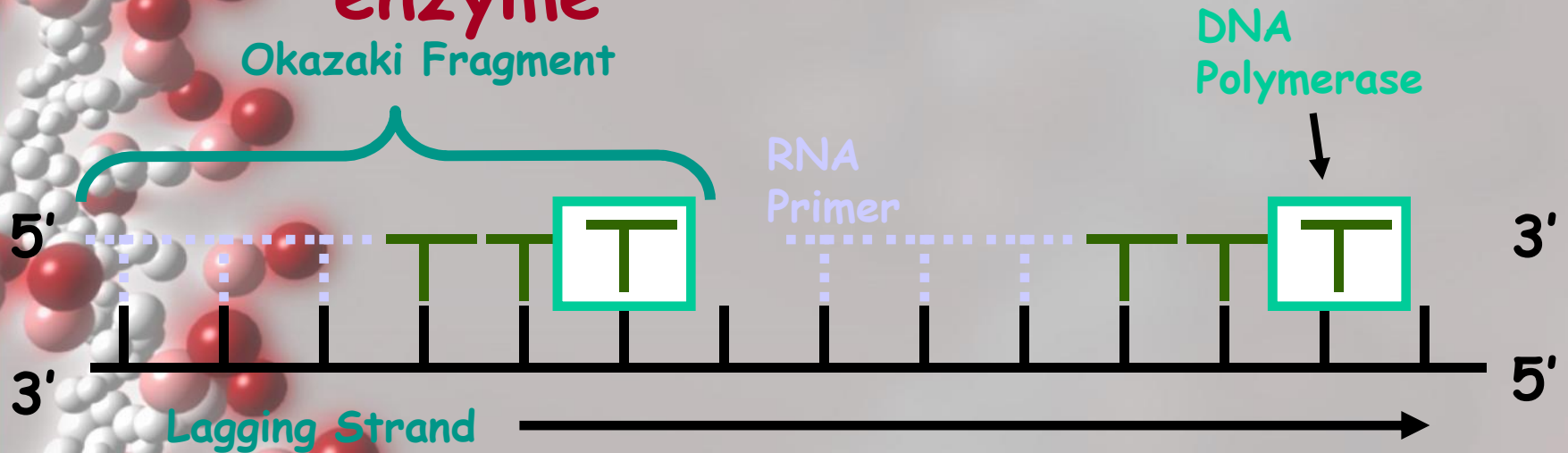
Synthesis of the New DNA Strands

- The Lagging Strand is synthesized discontinuously against overall direction of replication
- This strand is made in MANY short segments It is replicated from the replication fork toward the origin



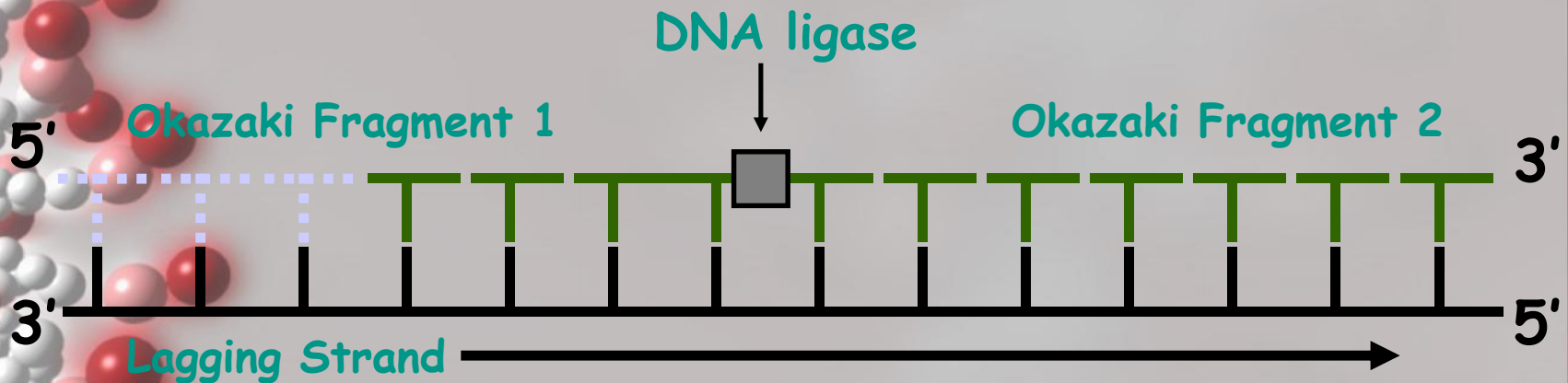
Lagging Strand Segments

- **Okazaki Fragments** - series of short segments on the **lagging strand**
- **Must be joined together by an enzyme**

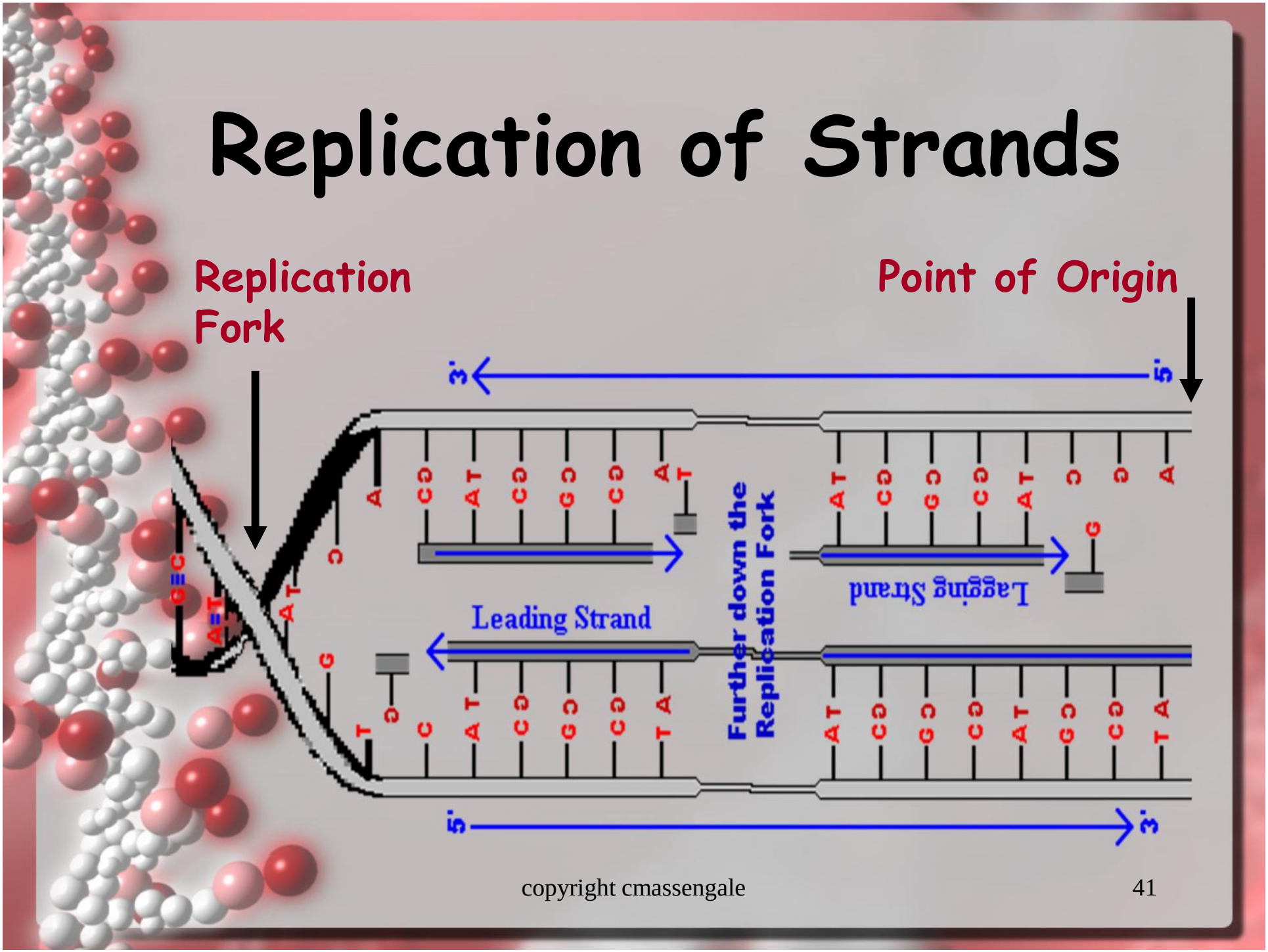


Joining of Okazaki Fragments

- The enzyme **Ligase** joins the Okazaki fragments together to make one strand



Replication of Strands

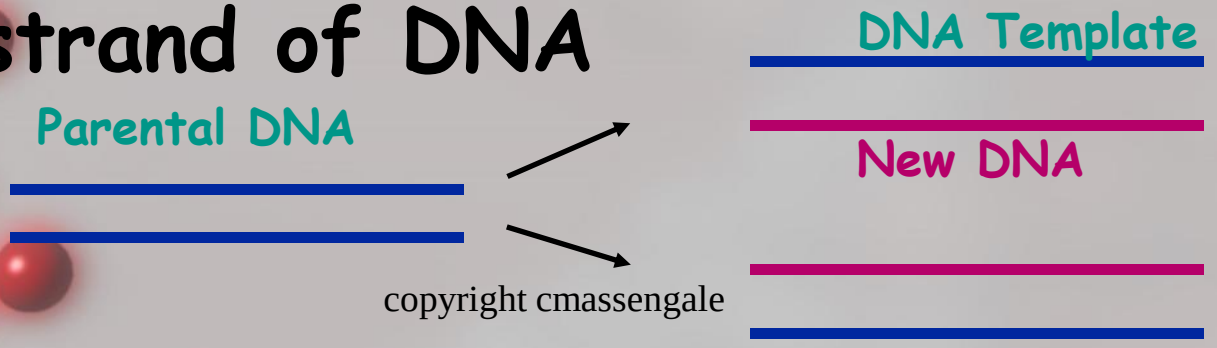


Proofreading New DNA

- 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

Semiconservative Model of Replication

- Idea presented by **Watson & Crick**
- The two strands of the parental molecule separate, and each acts as a **template** for a **new complementary strand**
- New DNA consists of 1 PARENTAL (original) and 1 NEW strand of DNA



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'-CGTATG-3'

DNA 3'-GCATAC-5'