Discovering the genetic material

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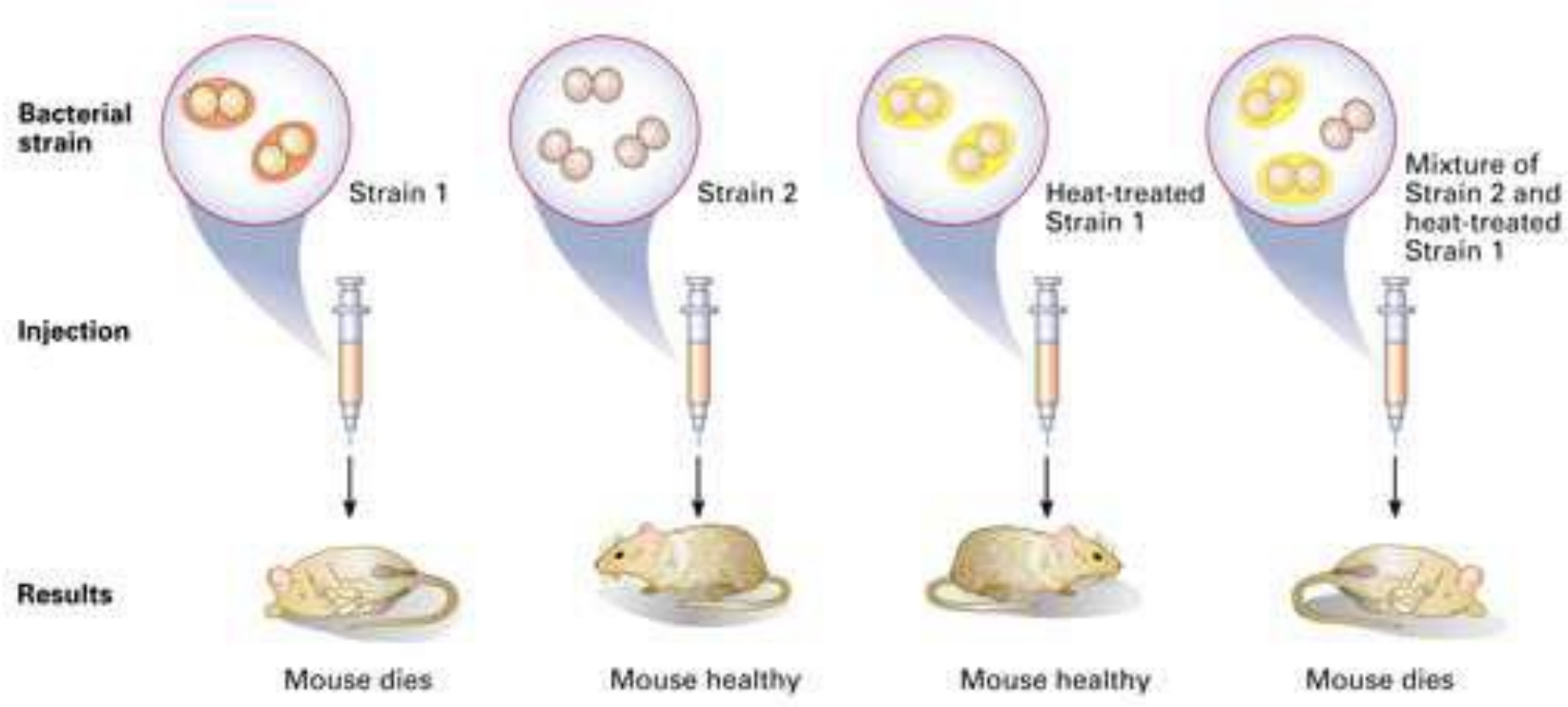
Bacterial transformation experiment

Frederick Griffith (1928):

- Pneumococcus „R” and „S” variants
- Transformation
- Conclusion:
  - Genetic material of S trasnformed R
  - The transforming material is heat resistant



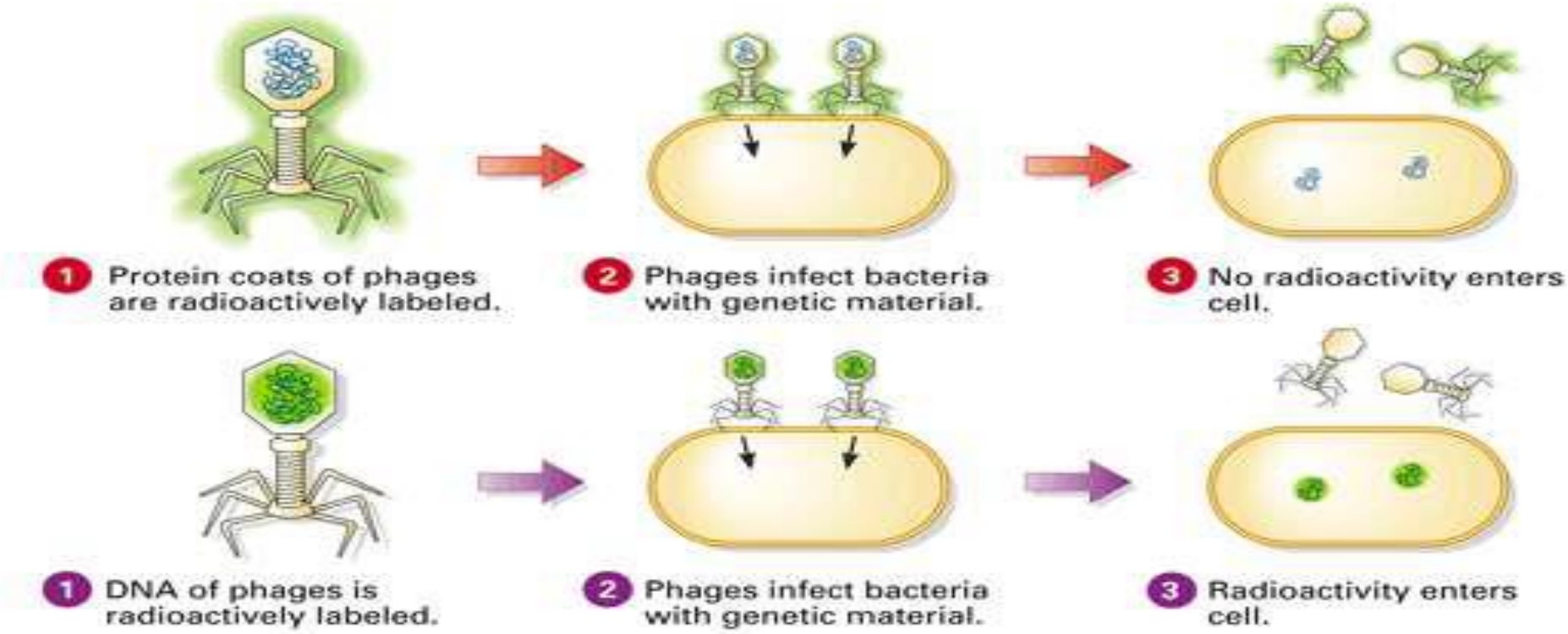
(http://biologytb.net23.net/text/chapter11/concept11.1.html)

Bacterial transformation experiment

- Oswald **Avery**, Colin MacLeod, and Maclyn McCarty:
  - Purified DNA
  - Disproved that proteins are the hereditary genetic material
  - Proved that the DNA is the genetic material

Phage infection experiment

- Alfred **Hershey** and Martha **Chase**:
  - DNA contains the genetic information and responsible for the multiplication of phages

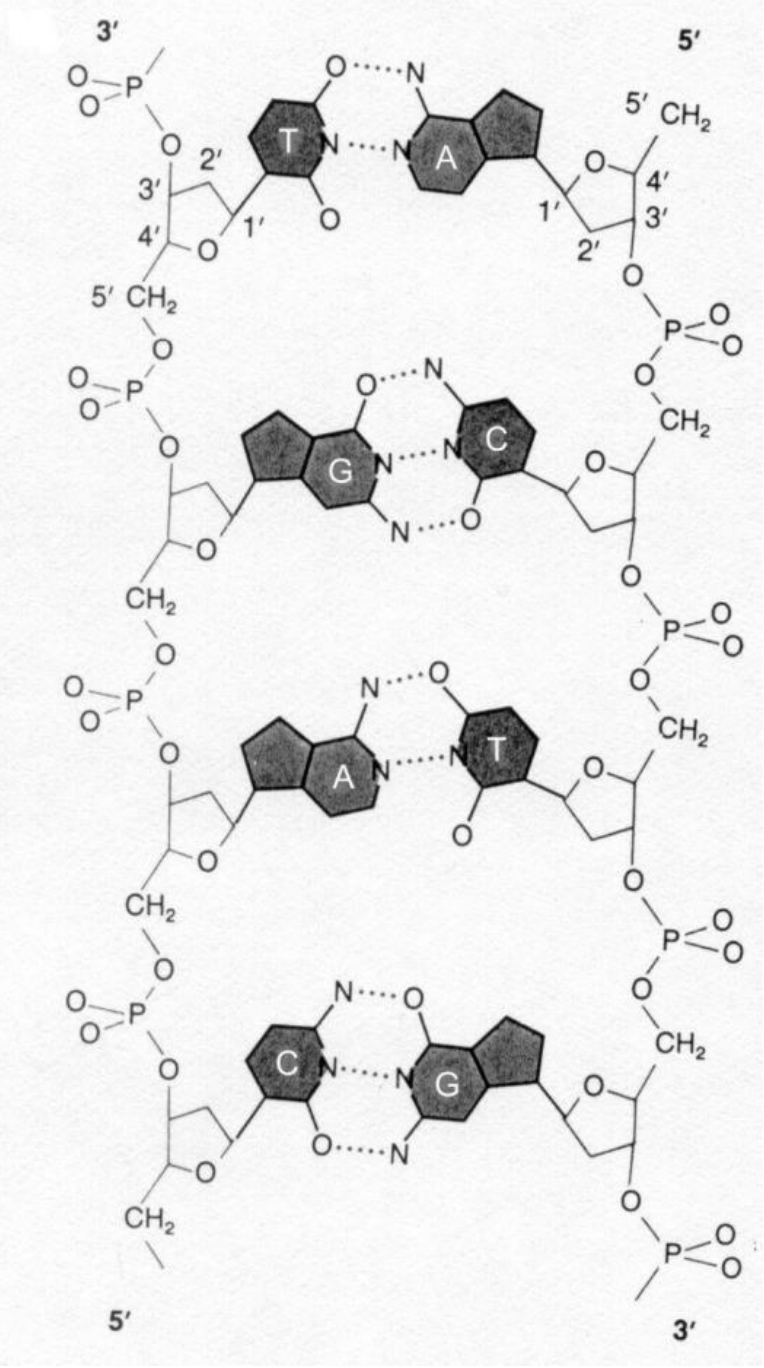


(http://biologytb.net23.net/text/chapter11/concept11.1.html)

Replication

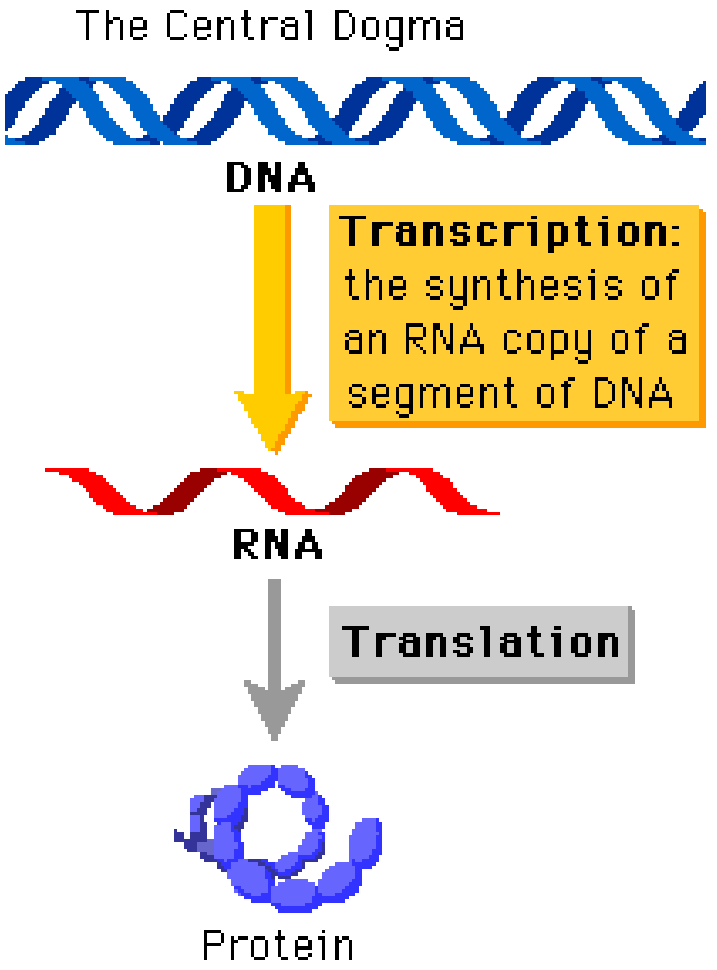
DNA molecule

- **What are the building blocks of DNA?**
  - Nucleotides
- **What kind of bond is formed between them?**
  - Phosphodiester bond
- **How do we name the two ends of a nucleic acid chain?**
  - 5’ end (where the phosphate group is located) and 3’ end (where the free –OH group is located)
- **What is the relation between the two strands of the DNA?**
  - Complementarity
  - Antiparallelity

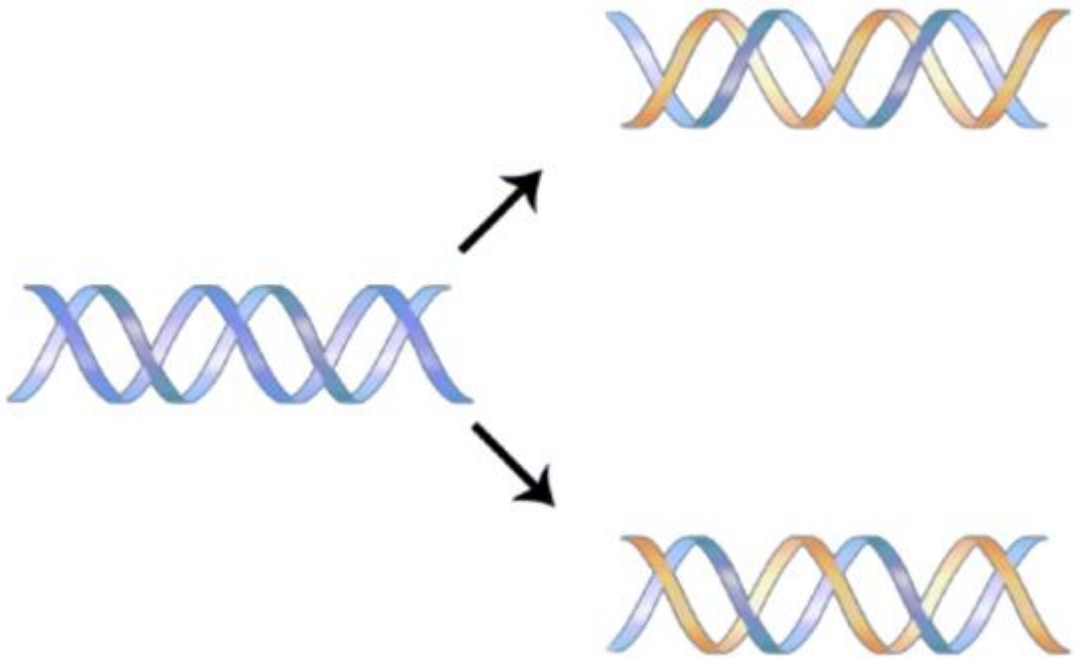


Central dogma of molecular biology

- DNA:
  - Carries genetic information
  - Is inherited to daughter cells during cell division
- Flow of genetic information: DNA → RNA → protein
- Transcription/RNA synthesis: DNA → RNA
- Translation/protein synthesis: mRNA → protein



http://www.phschool.com/science/biology_place/biocoach/transcription/overview.html

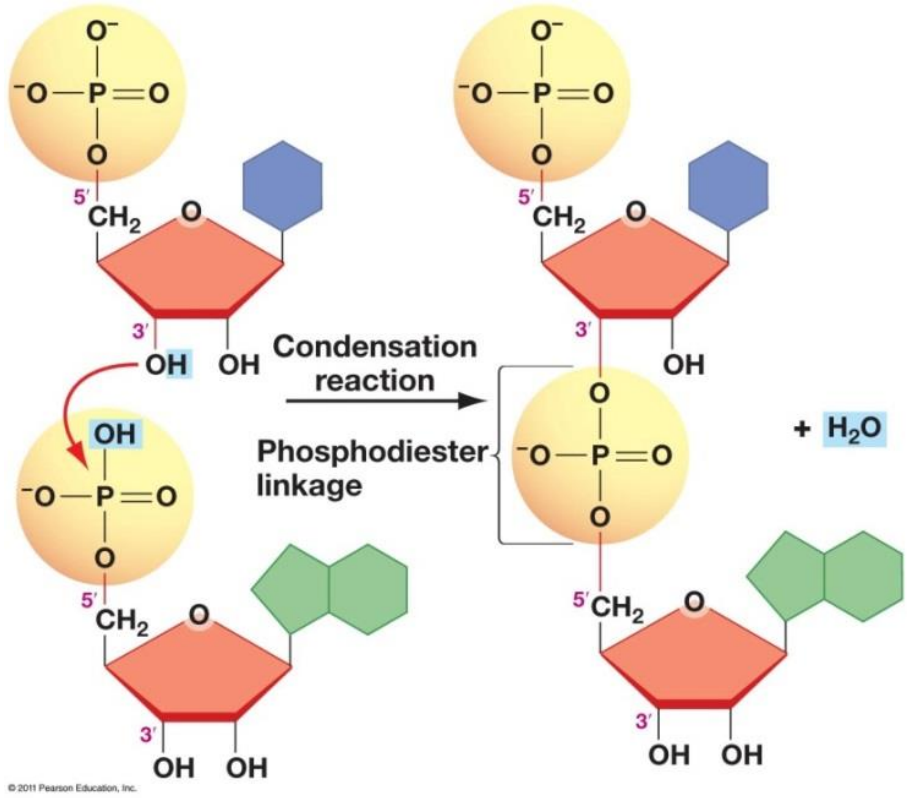


https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Free_and_Easy_(Ahern_and_Rajagopal)/05%3A_Flow_of_Genetic_Information/5.01%3A_DNA_Replication

- **DNA replication**= DNA synthesis= duplication of DNA= making 2 identical copies of DNA
- 2 double stranded DNA molecules are formed from 1 ds DNA
- It occurs before cell division (S-phase in eukaryotes)
- Significance: 2 ds DNA molecules are separated between the daughter cells

Phases of replication

- Initiation: when replication starts
- Elongation: when phosphodiester bonds are formed
- Termination: when replication ends

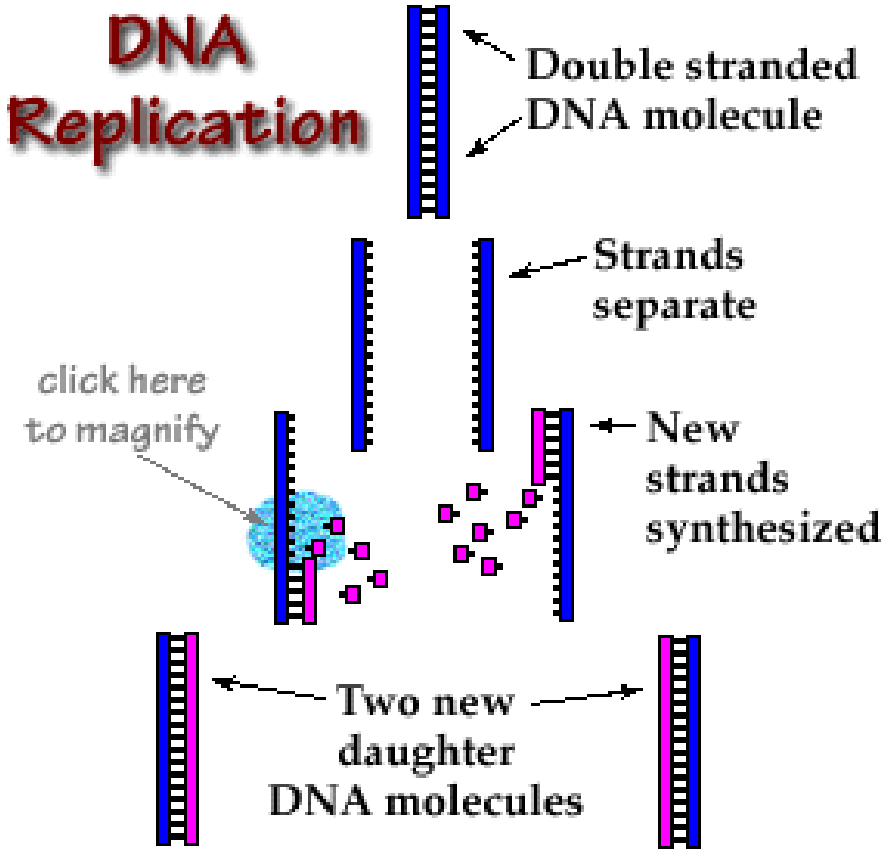


http://www.uic.edu/classes/bios/bios100/lectures/chemistry.htm

General features of DNA replication

Semiconservative

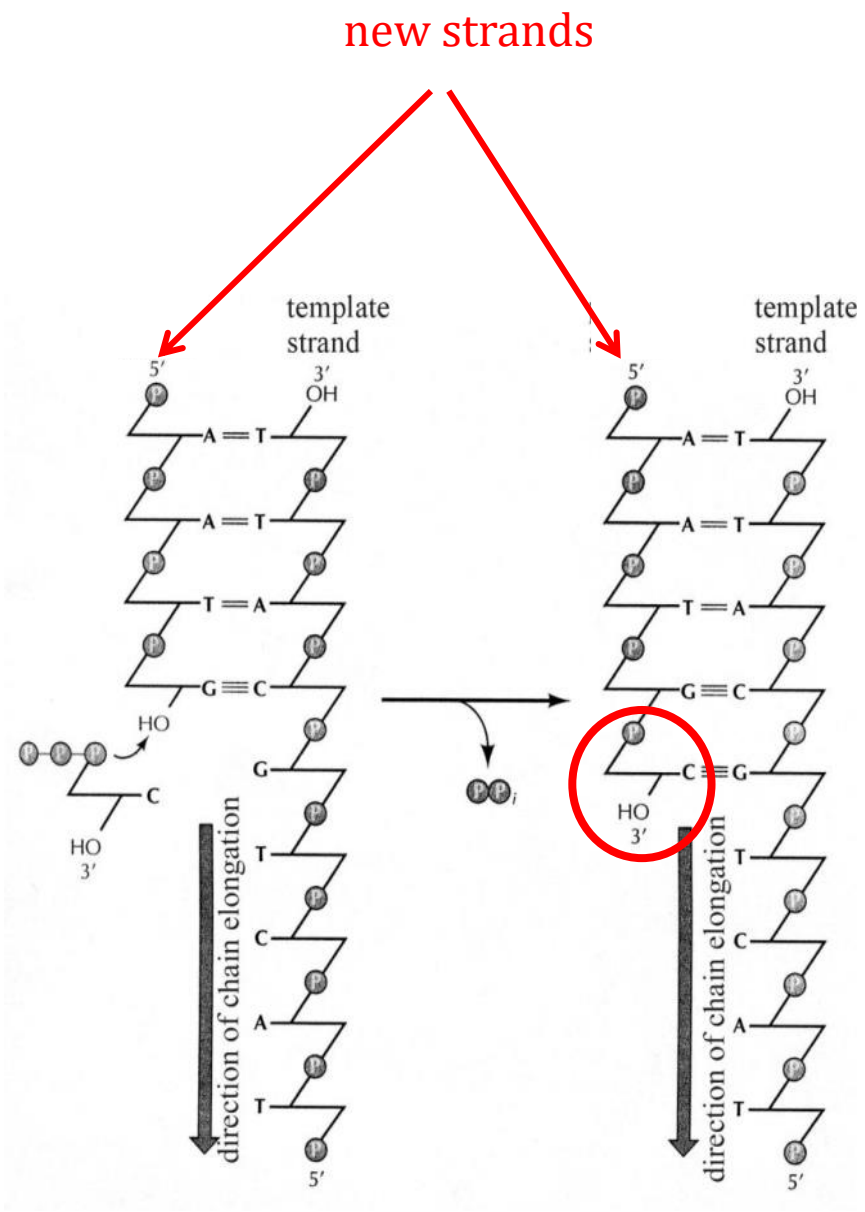
- One strand is „old” (this is the template strand) and the other strand is newly synthesized
- 2 DNA strands
  - *Complementary base pairing* (A-T and G-C)
  - *Antiparallel:*
    - 5’-3’ orientation of one strand
    - 3’-5’ orientation of the other strand



https://www.google.hu/search?q=dna+replication+semiconservative&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiP4-WxtafjAhVCi8MKHXHBDaEQ_AUIECgB&biw=1920&bih=963#imgrc=A6r9HnYnXVTUxM:

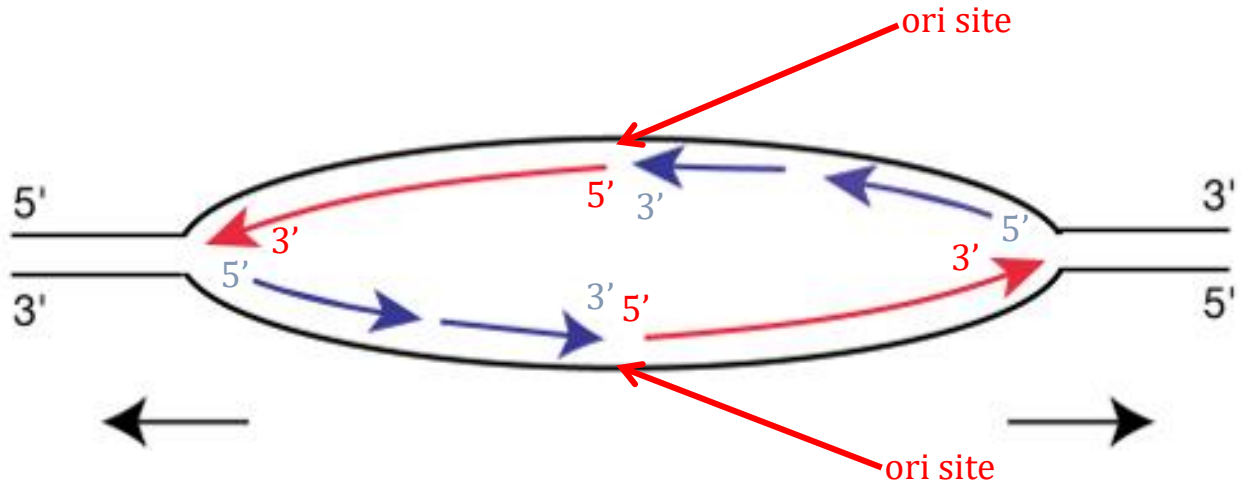
Template-and primer dependent

- Both strands of the old DNA are templates for the synthesis of the new DNA strands
- The **template strand** determines the sequence (base order) of newly synthesized DNA by complementary base-pairing
- Between A and T= 2 H bonds
- Between G and C= 3 H bonds
- **Primer dependent**: DNA polymerase cannot start replication without free –OH group. Primer is complementary oligonucleotide to template strand and provides free –OH group for DNA polymerase
- The primer is RNA in a living cell



Bidirectional

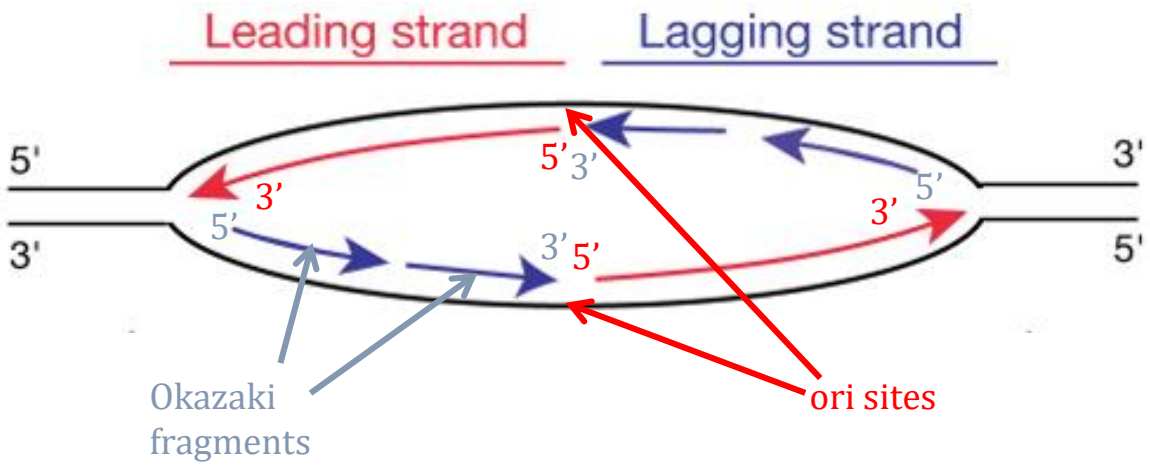
- Starts at ori (=origin of replication) and goes both directions
- Replicetion bubble is formed, contains 2 replication forks
- Direction of DNA synthesis: 5’ → 3’
- In prokaryotes: 1 ori/DNA, in eukaryotes: several/DNA



http://www.birmingham.ac.uk/research/activity/mds/domains/Cancer/cancer-genetics-dna-damage/chromosomal-replication/index.aspx

Semidiscontinuous

- Synthesis of leading strand is continuous, the lagging strand is synthesized is parts (Okazaki-fragments)
- Later the Okazaki fragments are connected to each other



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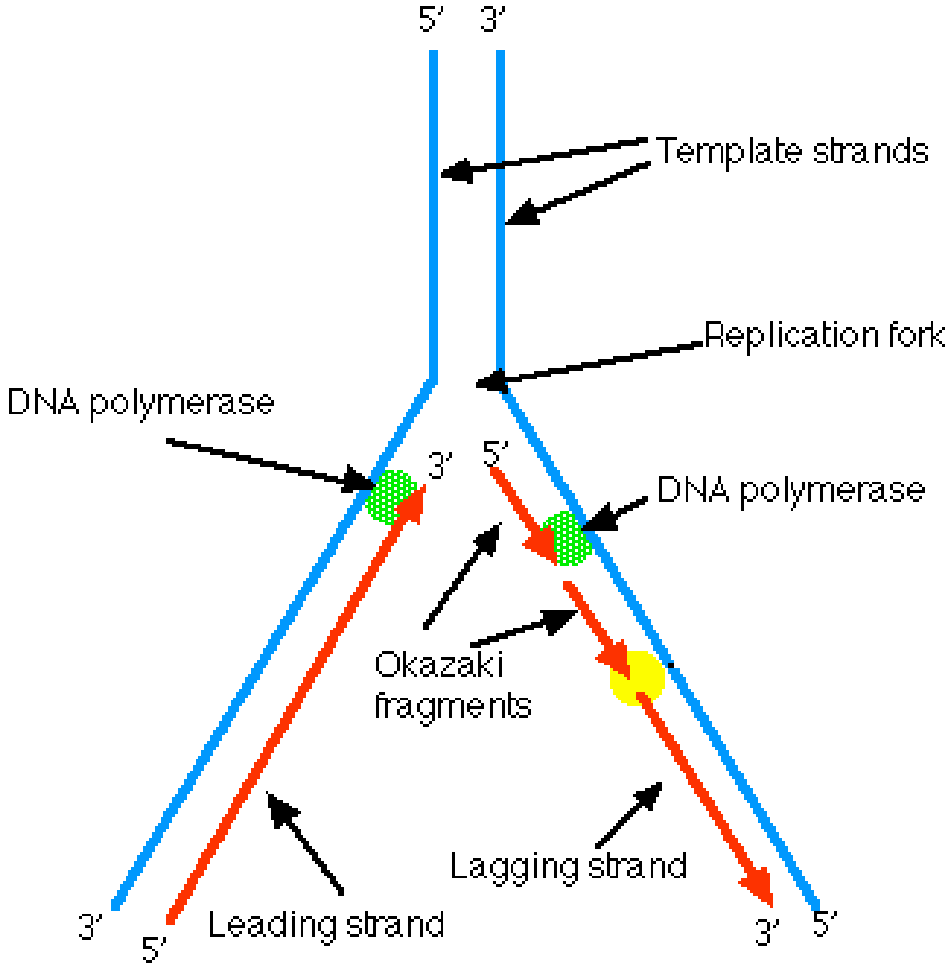


(http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/D/DNAReplication.html)

Mechanism of DNA replication

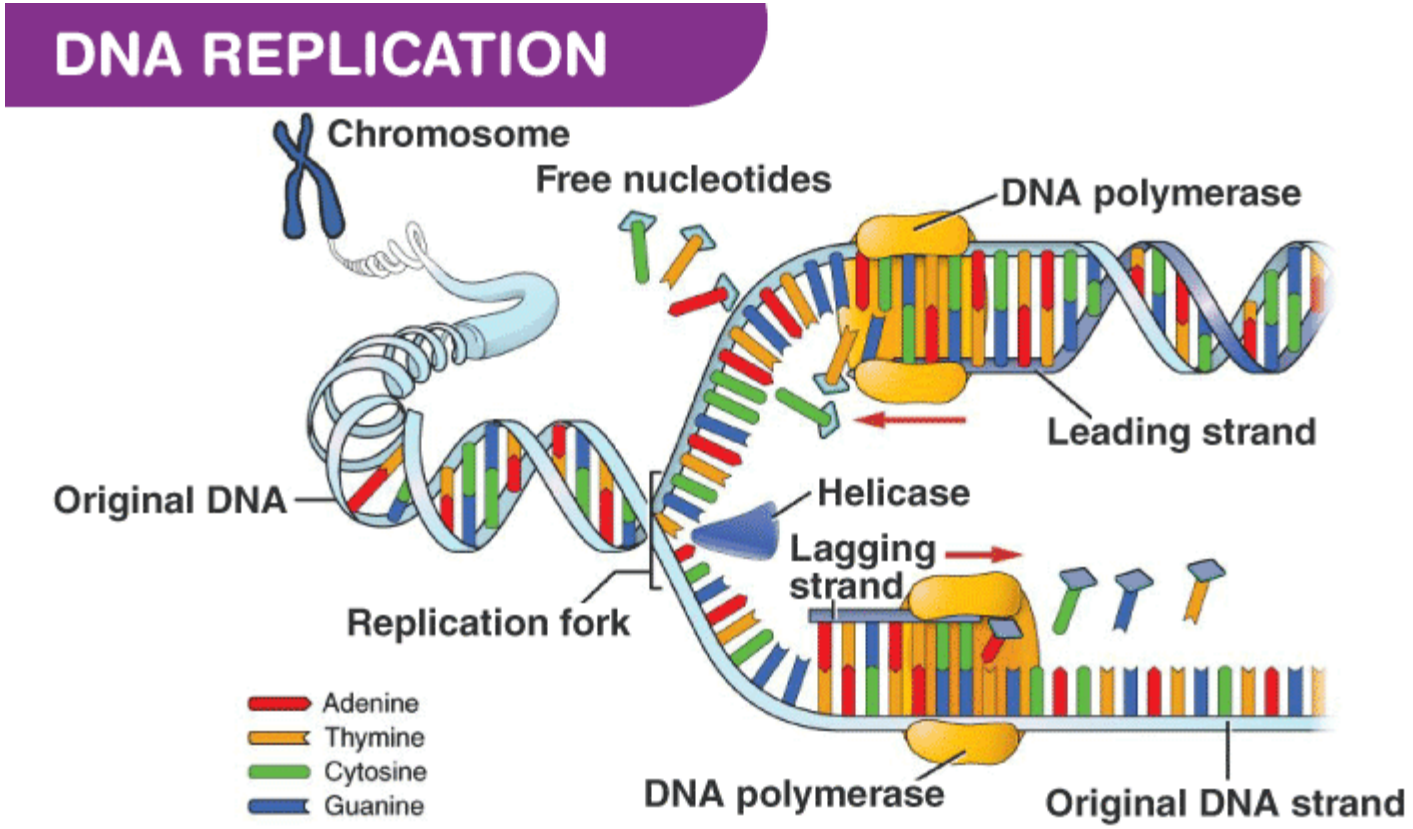
- **Ori:** recognized by specific proteins
- **DNA helicase:** cleaves H-bonds between the 2 DNA strands→denaturation of DNA → replication bubble forms
- **Ssb (single-strand binding) proteins:** prevent renaturation
- **Primase:** synthesizes short RNA primers, free 3’ OH-group is formed
- **DNA polymerases:** synthesize new strands
  - Leading strand
  - Lagging strand: Okazaki fragments, enzymes are needed to join them

Mechanism of DNA replication

Termination:

- Prokaryotes: simple termination, circular DNA
- Eukaryotes: more complicated, linear DNA
  - DNA polymerase cannot replicate the very end of lagging strand (telomer)
  - An enzyme (telomerase) is needed for **telomer** replication
    - Significance: prevent the degradation of important sequences
    - low telomerase activity → chromosomes shorten →physiological aging
    - high telomerase activity in somatic cells → cancer formation

Mechanism of DNA replication



https://www.google.hu/search?q=DNA+replication&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjj9IGGgKrjAhXmk4sKHcr6CroQ_AUIECgB&biw=1920&bih=963#imgrc=COf-au_xWj5CQM:

A little help

- https://www.youtube.com/watch?v=yDkSWd_ZbbE
- https://www.youtube.com/watch?v=TNKWgcFPHqw

Thank you for your attention!