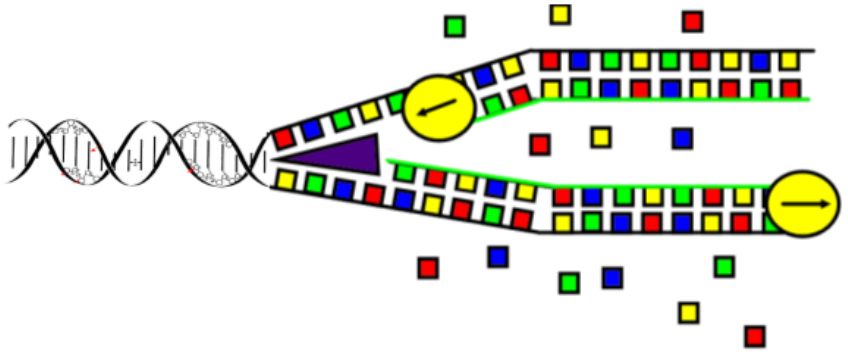
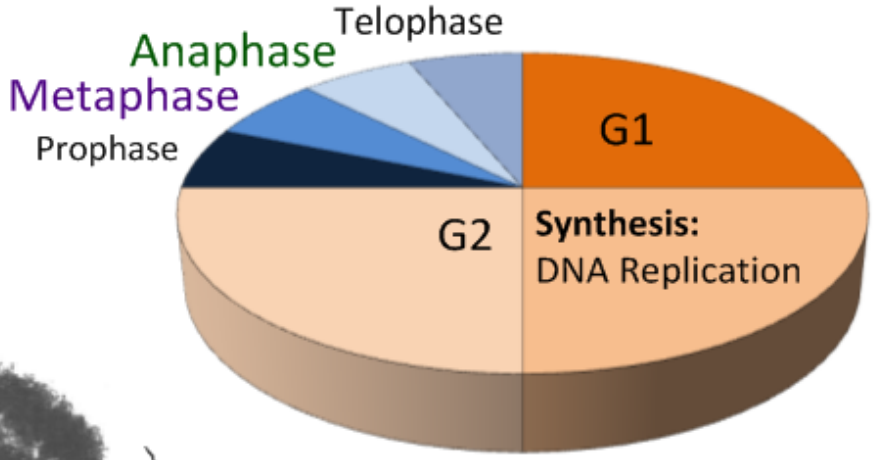


DNA Replication (Core and AHL)

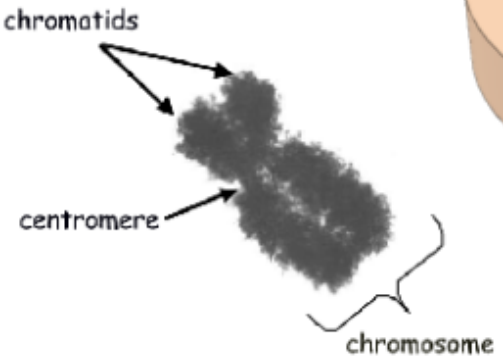
Stephen Taylor
Bandung International School

DNA Replication

DNA replication occurs during the S-phase of Interphase. Exact copies of all the DNA on all the chromosomes are made.



This gives sister chromatids - chromosomes and their copy - which will be separated in mitosis.

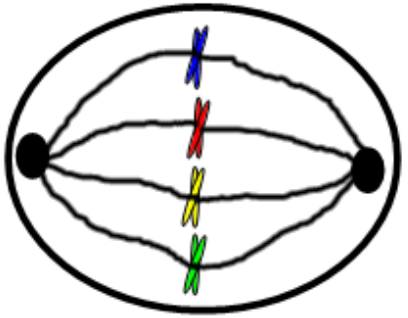


When the cell divides through mitosis, each daughter cell therefore contains a full set of DNA.

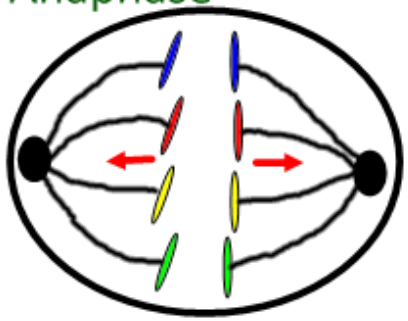
Mitosis ensures that each daughter cells gets the correct number of each chromosome through alignment at the equator (metaphase), and the separation of chromatids by spindle fibres during anaphase.

When the cell divides (cytokinesis), there is a full set of chromosomes at each pole, forming new nuclei.

Metaphase

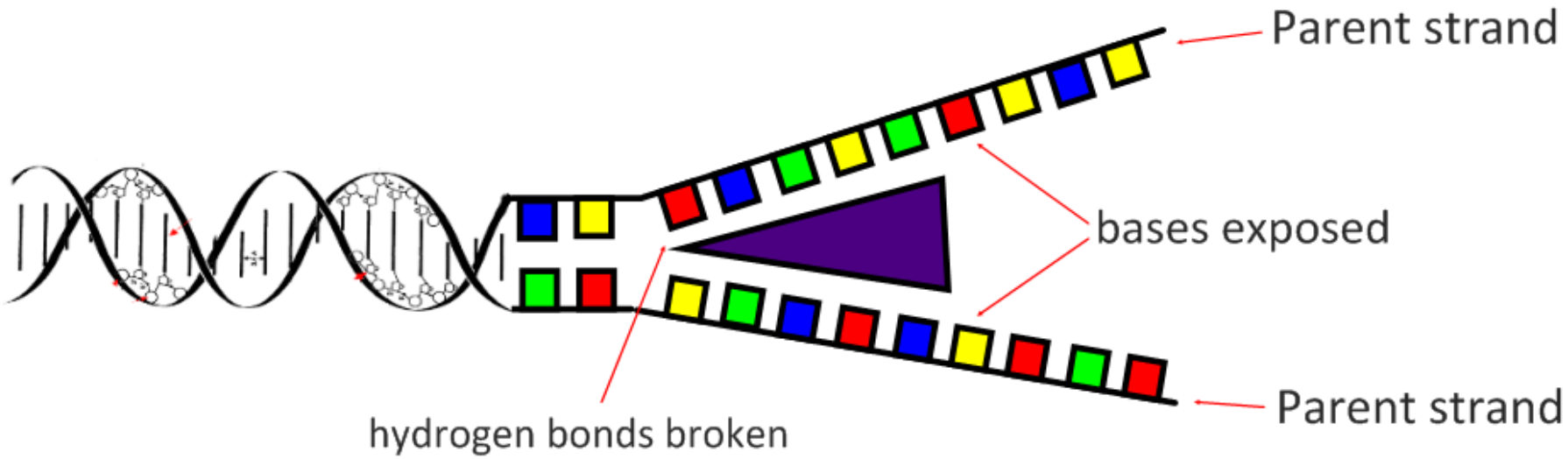


Anaphase



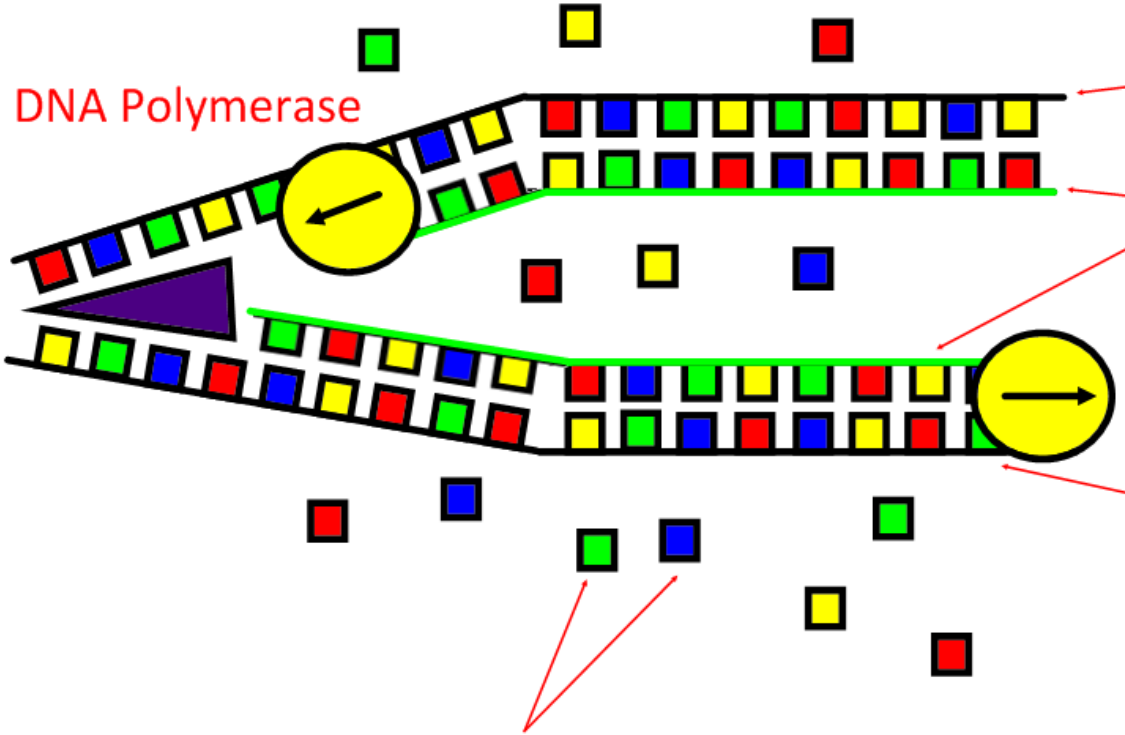
DNA Replication: Standard Level

1. DNA Helicase unwinds and unzips DNA



DNA Replication: Standard Level

2. DNA Polymerase creates complementary strands



Parent strand

Complementary strands

DNA polymerase moves in opposite directions on each strand

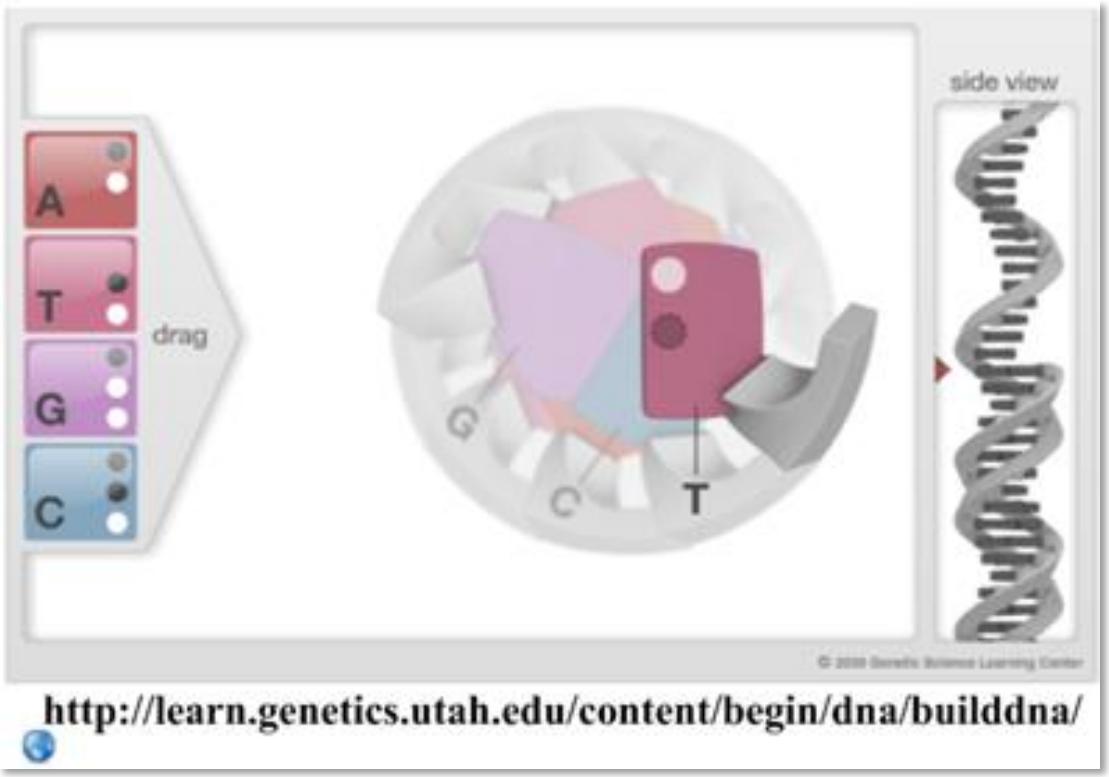
Parent strand

Free nucleotides are collected by DNA polymerase and attached to the new strand by complementary base pairing.

Complementary Base Pairing ensures identical copies of DNA

The parent strands act as a template for the new (complementary) strands.

Adenine pairs only with Thymine
Cytosine pairs only with Guanine



This ensures the new DNA molecules is identical to the original - no mistakes are made - so the base-sequence of nucleotides is conserved.

Have a go at this DNA Builder from Learn.Genetics.

This is important as the base-sequence of DNA provides the genetic information for the organism. A mistake in the order of bases may result in a mistake in gene expression, which could be detrimental (even fatal) to the cell or organism.

DNA Replication: Standard Level

3. DNA Replication is semi-conservative:

How do we know this?

So, as Watson and Crick had predicted, DNA is used as a template to replicate itself. DNA polymerase is the enzyme that makes it happen.

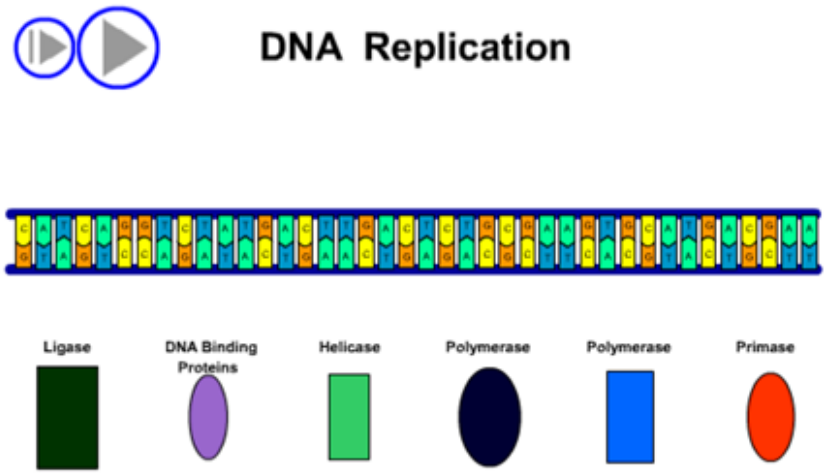
MOUSE OVER TUBE TO SEE CONTENTS

http://www.learnerstv.com/animation/biology/con20ani.swf

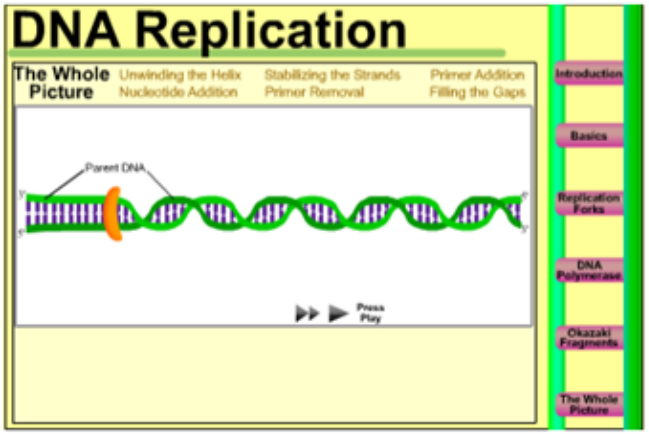
DNA Replication: Higher Level

Use the following animations to help you discover the roles of the following enzymes:

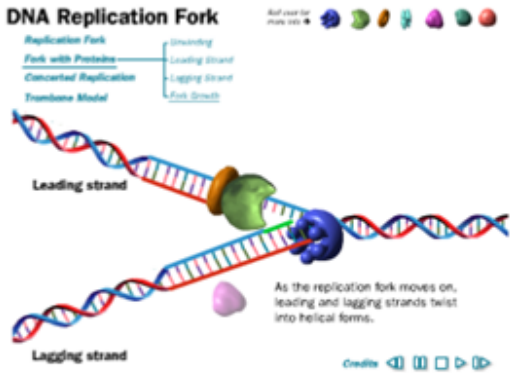
DNA Helicase DNA Polymerase III RNA Primase DNA Polymerase I DNA Ligase



http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/dna-rna2.swf

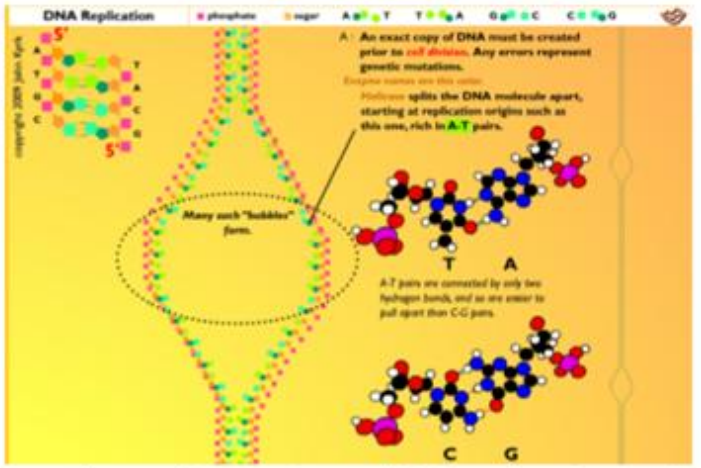


http://www.wiley.com/legacy/college/boyer/0470003790/animations/replication/replication.swf



http://www.mcb.harvard.edu/Losick/images/TromboneFINALd.swf

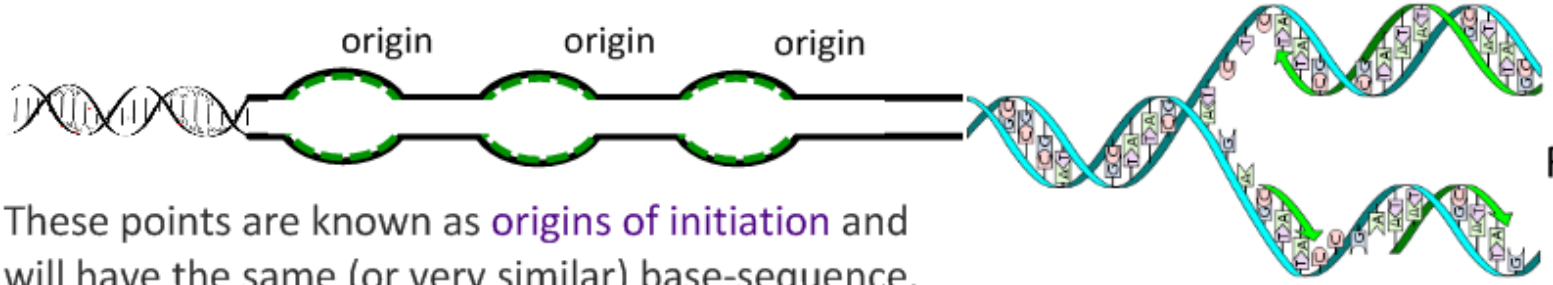
Extend Page



http://www.johnkyrk.com/DNAreplication.html

DNA Replication is initiated at many points in eukaryotes:

This makes DNA replication faster and more efficient.



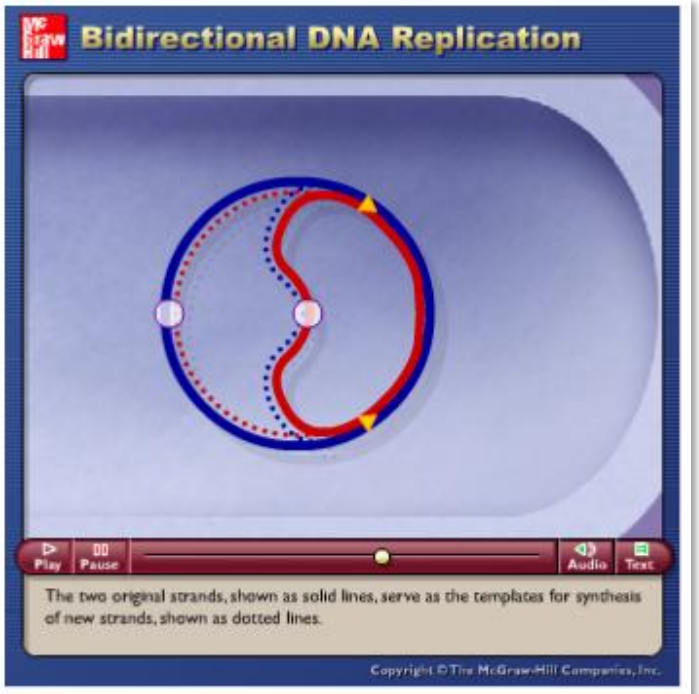
These points are known as origins of initiation and will have the same (or very similar) base-sequence.

Proteins called Origin Recognition Complexes will bind here and then DNA Helicase will be able to attach, to begin replication. Replication forks will move along the DNA strand in the same direction.

Replication in prokaryotes is bidirectional and initiated from a single origin.

This is because prokaryote DNA is looped, as opposed to the long strands of eukaryotes.

Other processes are essentially the same...

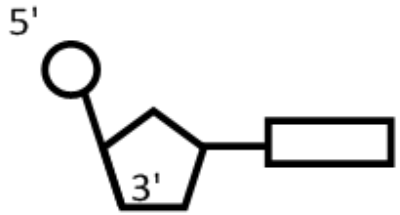


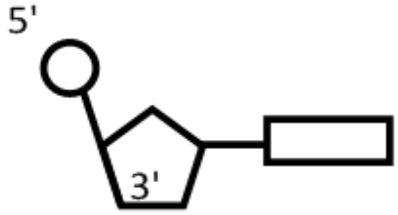
http://tinyurl.com/y9e89rh

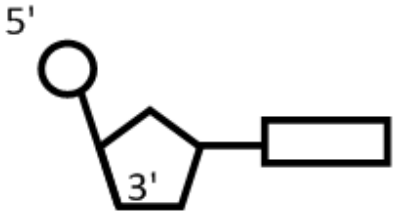
DNA replication moves in a 5' to 3' direction

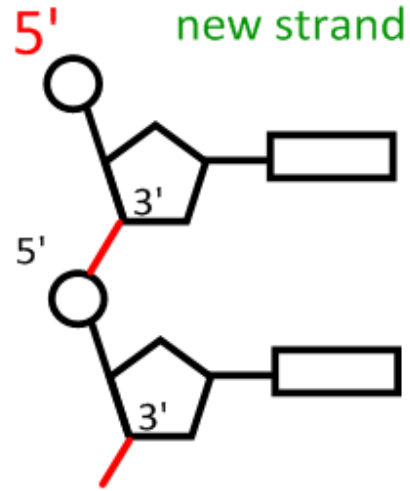
- This means the 5' end of the new strand

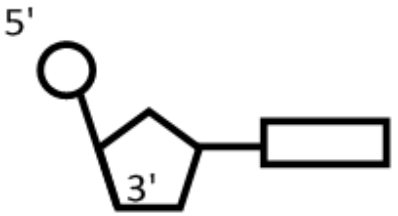
Free nucleotides in the nucleus
(deoxynucleoside triphosphates)











DNA replication moves in a 5' to 3' direction

- This means the 5' end of the new strand

Free nucleotides in the nucleus
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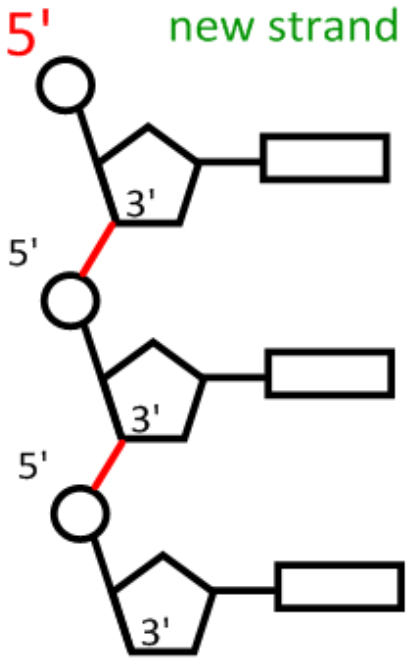
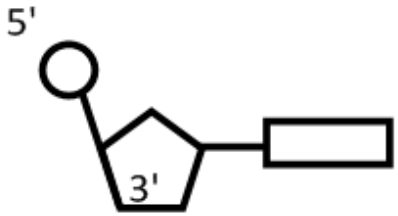
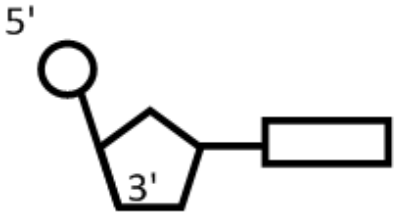
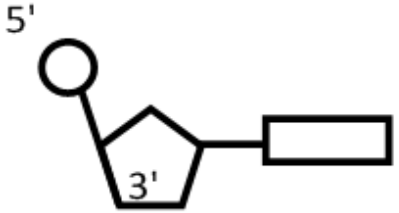
The 5' end of the next nucleotide attaches to the 3' carbon of the last one to join the new strand.









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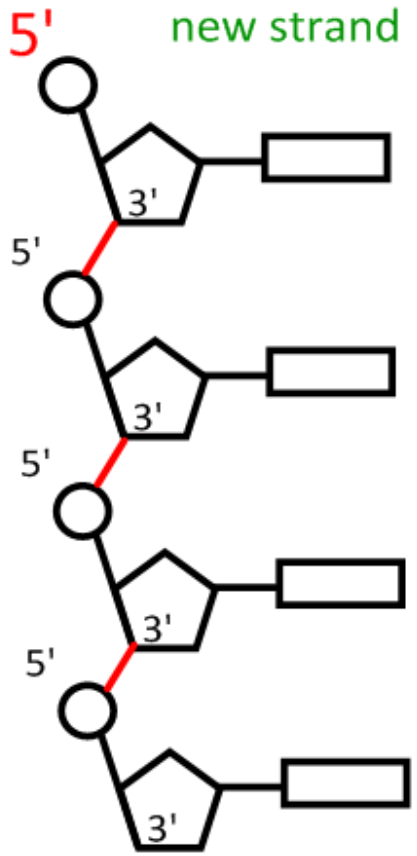
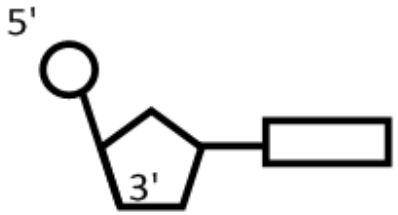
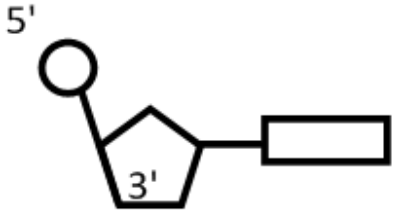


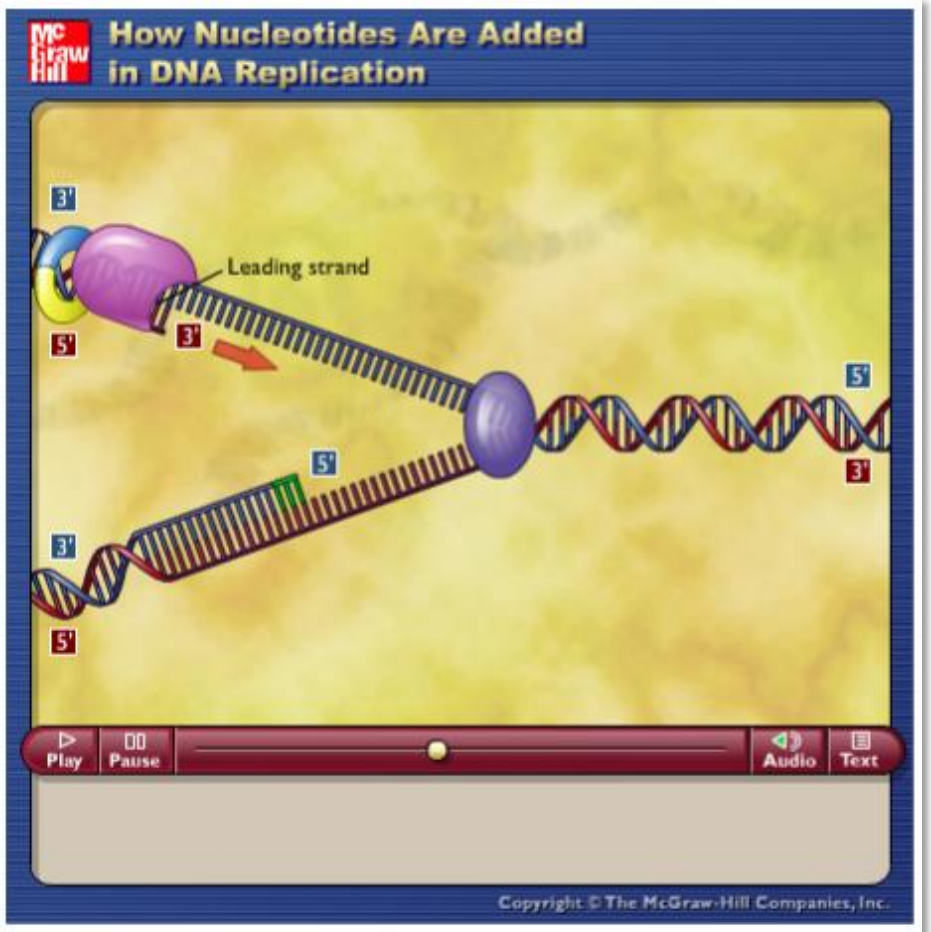




DNA replication moves in a 5' to 3' direction

- This means the 5' end of the new strand

How are deoxynucleoside triphosphates added?



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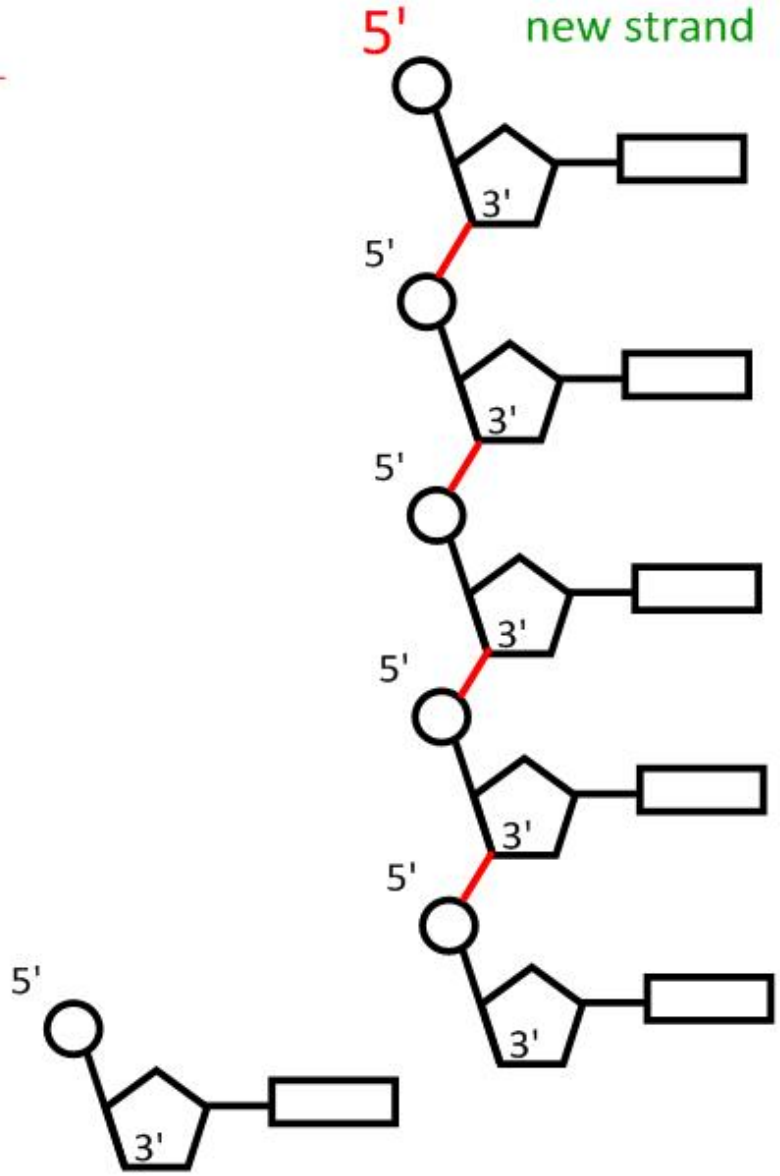
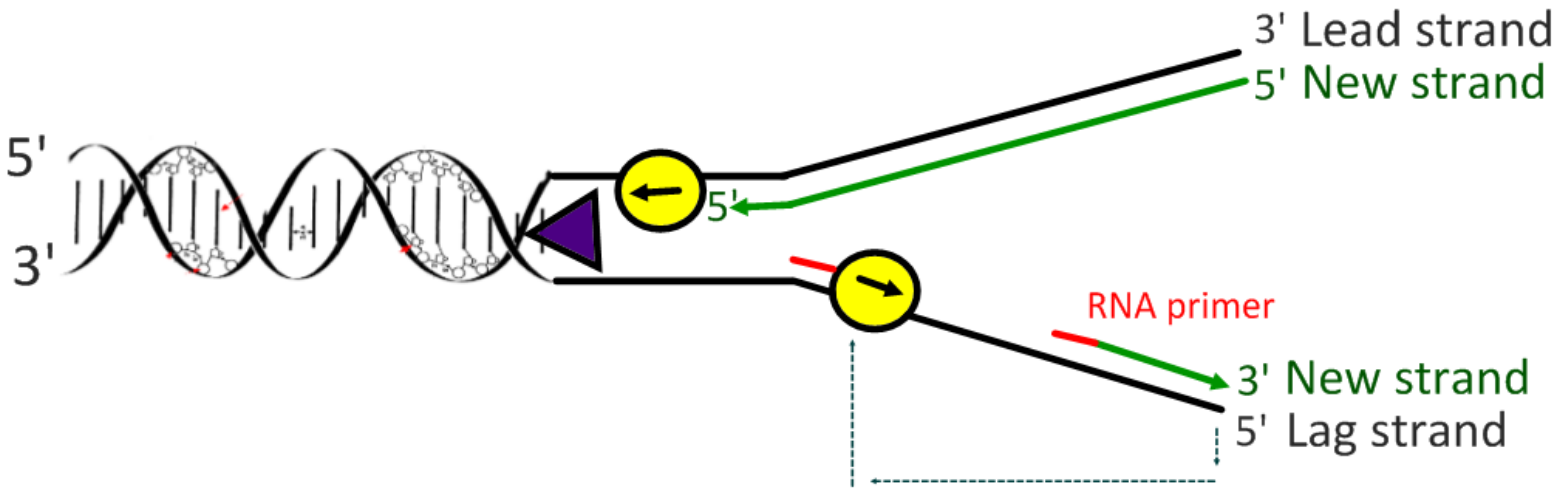


DNA replication moves in a 5' to 3' direction

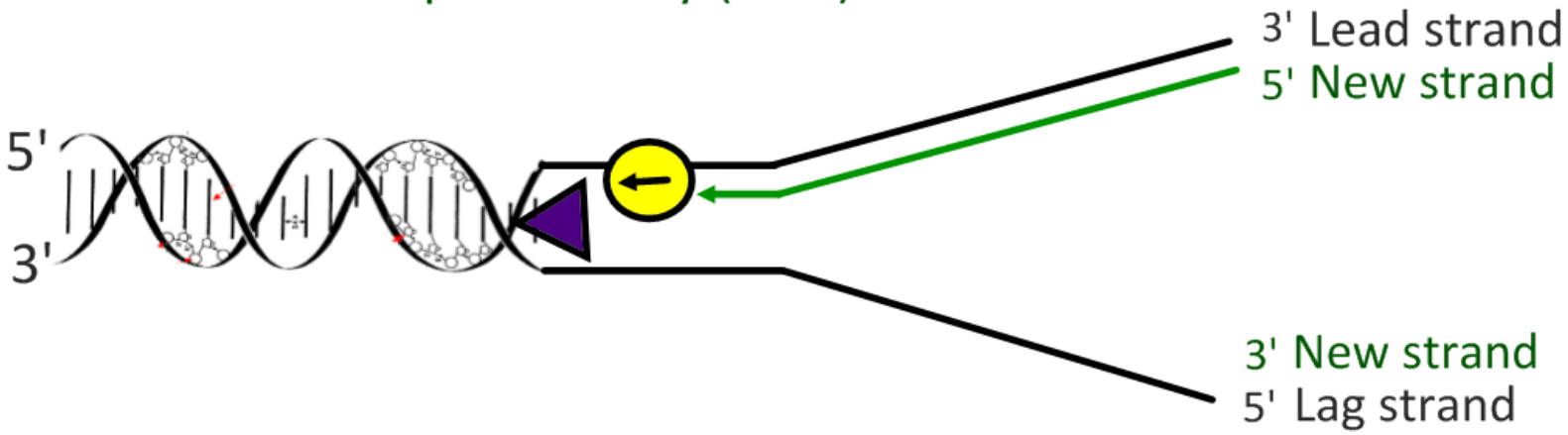
- This means the 5' end of the new strand
- Replication on the lead strand is continuous
- Replication on the lag strand 'leapfrogs'



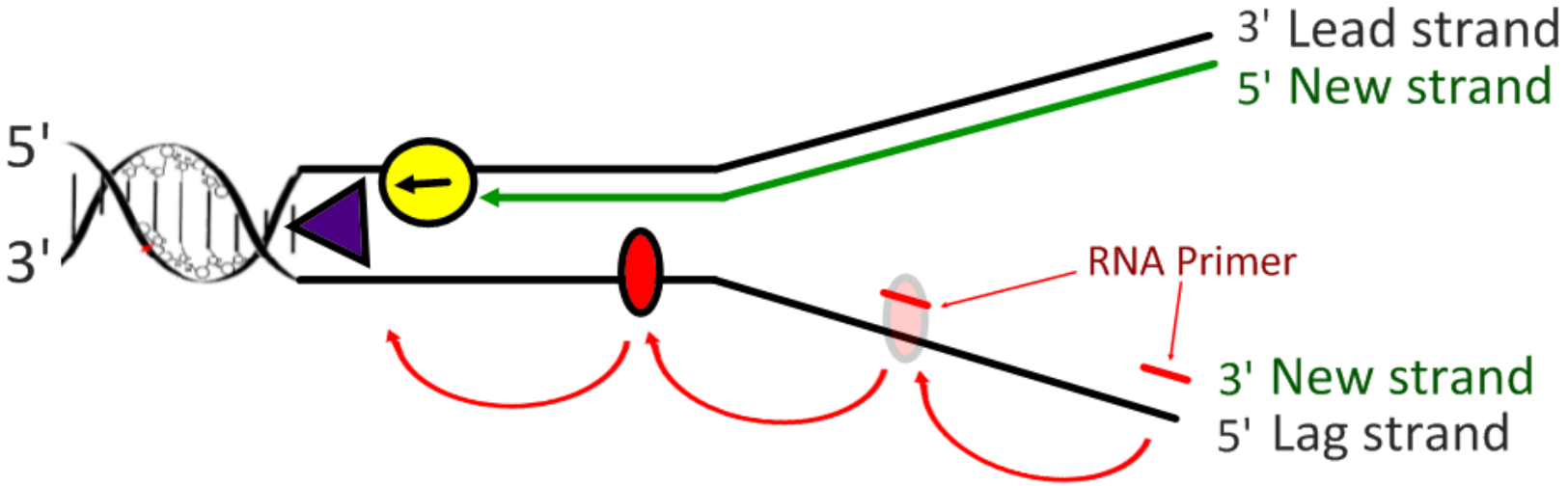
Lag strand DNA replication is more complex, as the DNA polymerase is moving in the opposite direction to the DNA Helicase. RNA primers are used to mark positions and replication goes in a 'leapfrog' (section-by-section) manner.

DNA replication in prokaryotes:

1. DNA Helicase unwinds and unzips the base pairs
2. DNA Polymerase makes a complementary strand on the leading strand - adding nucleotides to the 3' end of the complementary (new) strand.

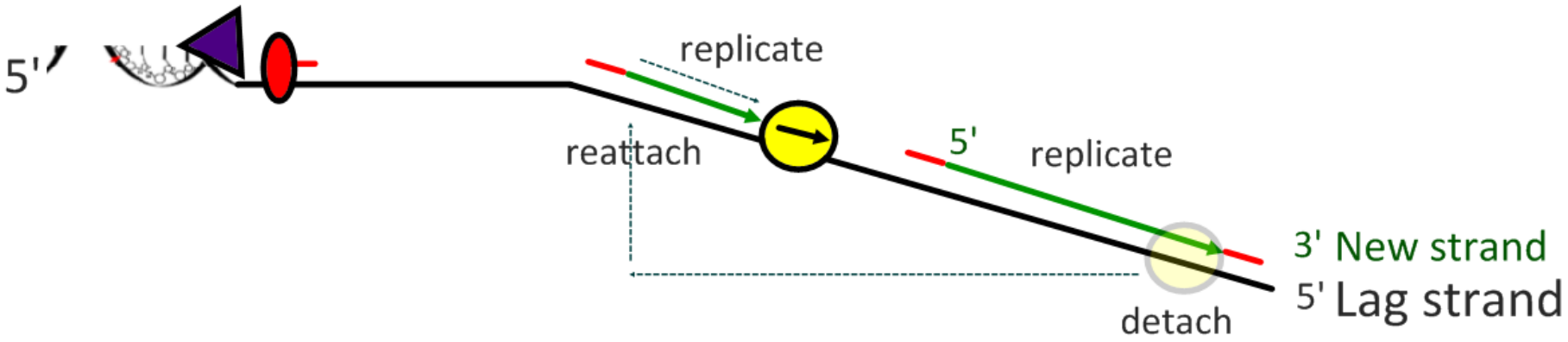


DNA replication in prokaryotes:



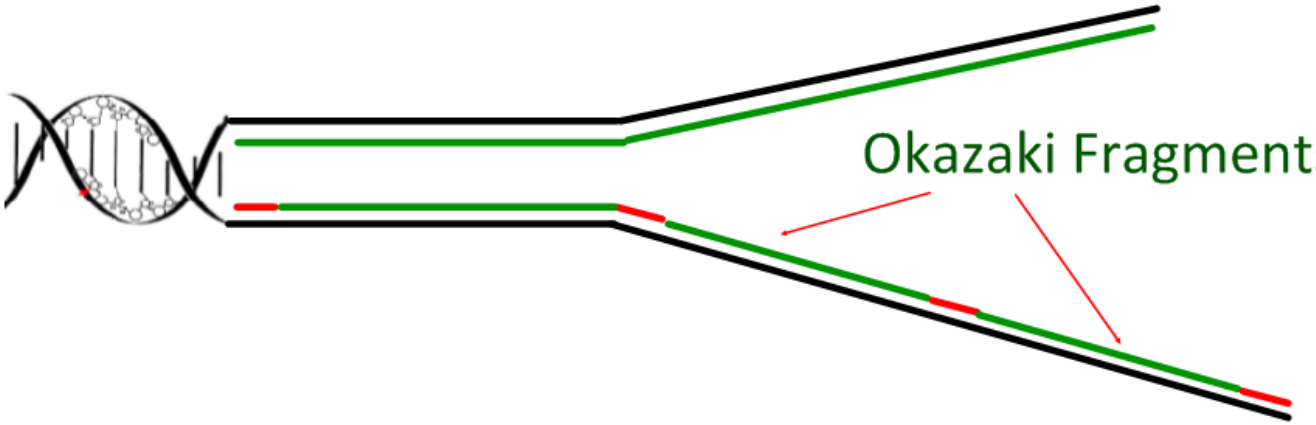
3. RNA Primase follows helicase, leaving RNA Primers.
   These are markers for initiation of DNA Polymerase on the lag strand.

DNA replication in prokaryotes:



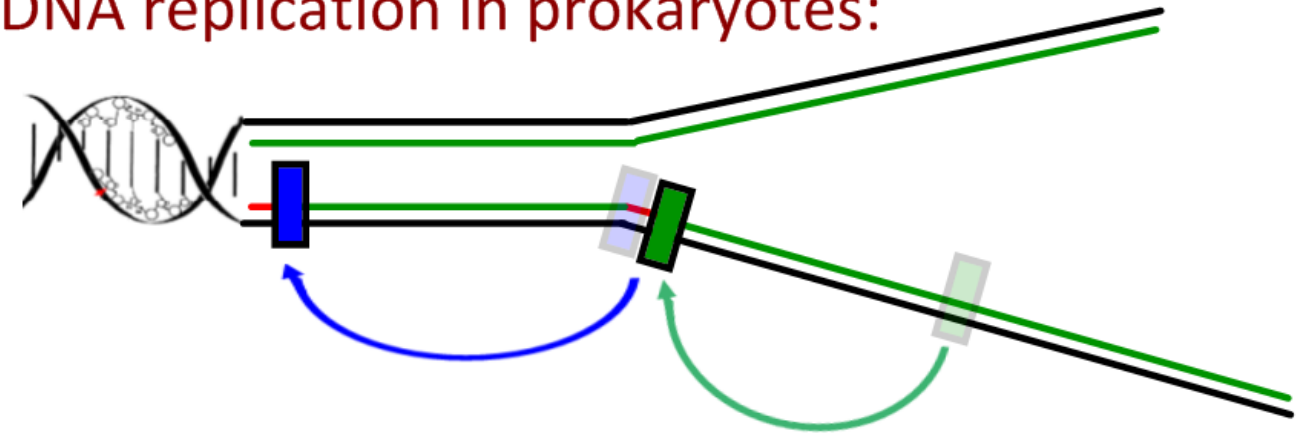
4. DNA Polymerase attaches to an RNA Primer and replicates DNA in a 5' to 3' direction.

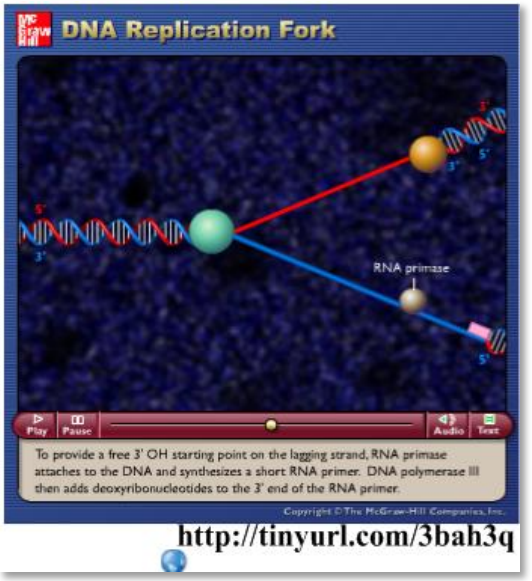
5. When it reaches another RNA primer, it detaches and 'leapfrogs' to next primer following the helicase.



are the sections of copied DNA between RNA primers on the lag strand of the replication fork.

DNA replication in prokaryotes:



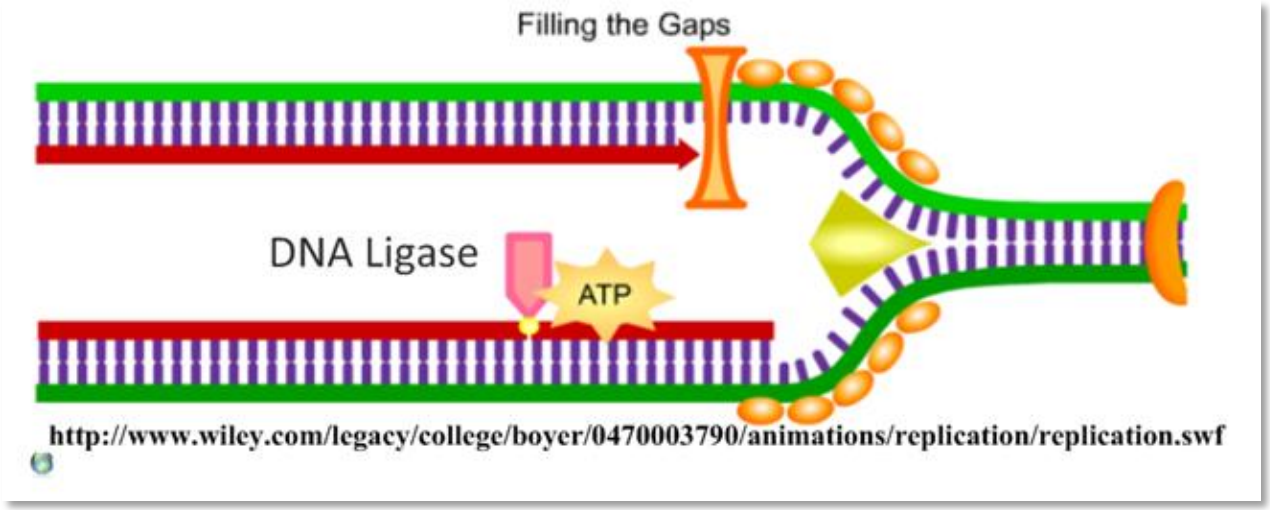


http://tinyurl.com/3bah3q

6. DNA Polymerase I moves along the replication fork removing the RNA primers.

7. DNA Ligase attaches the Okazaki fragments into a continuous strand of DNA.

This process uses ATP.



The Enzymes and Molecules of DNA replication:

Helicase — Unwinds DNA and breaks H-bonds between base pairs

DNA Polymerase III

RNA Primase

RNA Primers

Okazaki fragments

DNA Polymerase I

DNA Ligase

Sections of new DNA on the lag strand

Leaves RNA primers on the lag strand

Attaches Okazaki fragments together

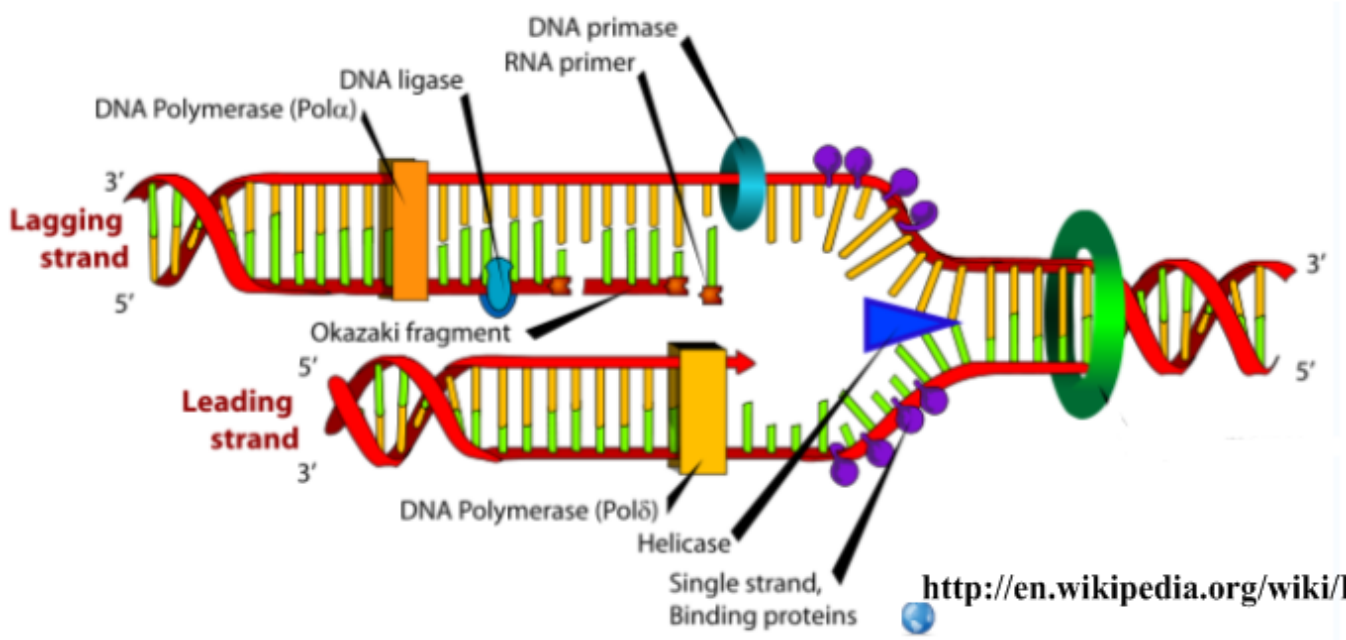
Attaches nucleotides in a 5' - 3' direction

Removes RNA primers

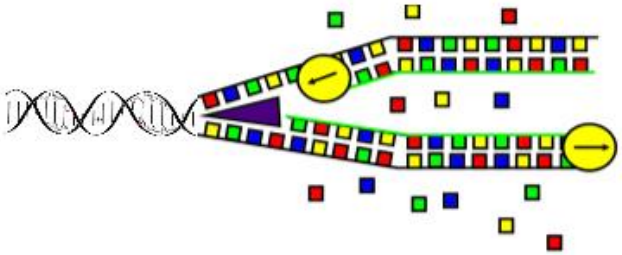
Initiation sites for DNA polymerase III on the lag strand

The Enzymes and Molecules of DNA replication:

Helicase	Unwinds DNA and breaks H-bonds between base pairs
DNA Polymerase III	Attaches nucleotides in a 5' - 3' direction
RNA Primase	Leaves RNA primers on the lag strand
RNA Primers	Initiation sites for DNA polymerase III on the lag strand
Okazaki fragments	Sections of new DNA on the lag strand
DNA Polymerase I	Removes RNA primers
DNA Ligase	Attaches Okazaki fragments together



http://en.wikipedia.org/wiki/DNA_replication



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