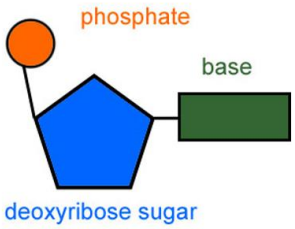
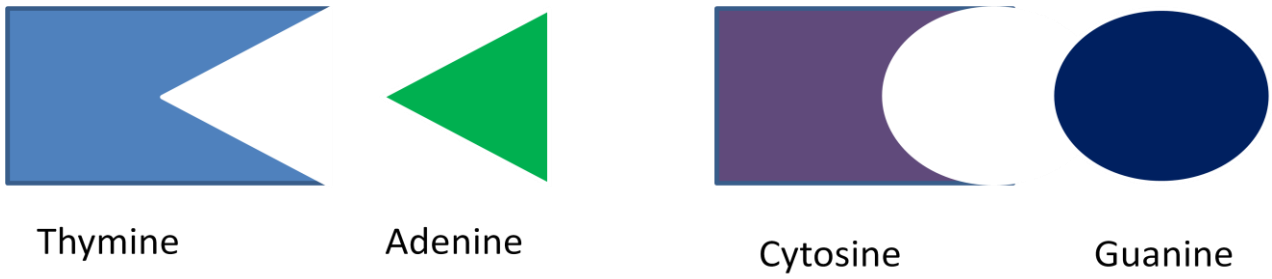
DNA Structure and Replication

DNA stores genetic information in its sequence of bases
DNA consists of two strands, each composed of repeating units called nucleotides
Each DNA nucleotide consists of a deoxyribose sugar joined to a phosphate group and an organic base

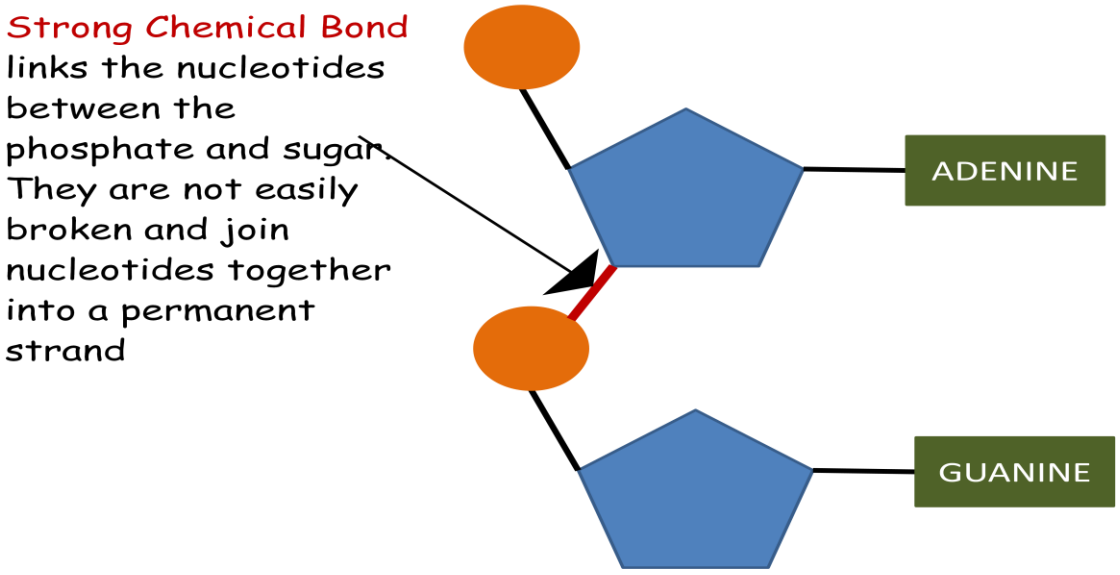


There are strong chemical bonds between the phosphate of one nucleotide and the carbon 3 of the sugar on another nucleotide
Neighbouring nucleotides become joined together forming a sugar-phosphate backbone
Hydrogen bonds form between the bases
Adenine pairs with Thymine
Cytosine pairs with Guanine

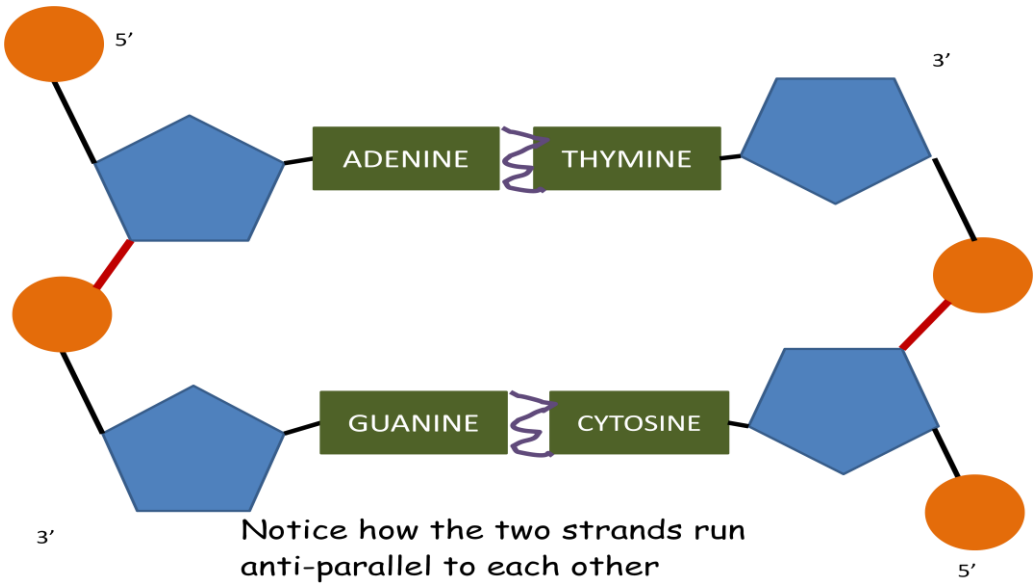
Each base can only join with one other base.



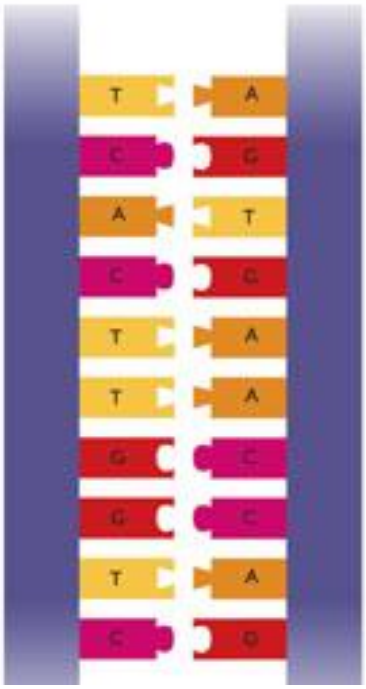
This is always the case in DNA – G-C, T-A pairs

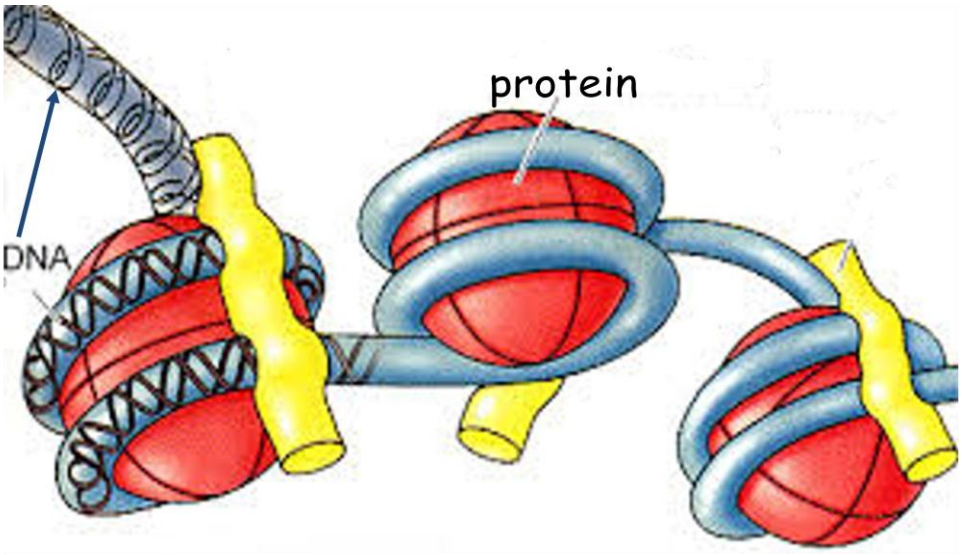


A DNA chain is only able to grow by adding nucleotides to its 3' end
The two strands with their sugar-phosphate backbones running in opposite directions is described as 'Antiparallel'
For bases to align, DNA takes the form of a twisted coil – 'double helix'
A DNA strand is several thousand times longer than a cell
DNA becomes tightly coiled and packaged around bundles of protein



The 2 strands are arranged in a twisted coil called a DOUBLE HELIX. It is often likened to a spiral ladder, where the sugar-phosphate backbone is the railing and the base are the steps





DNA is tightly coiled and packaged around bundles of protein

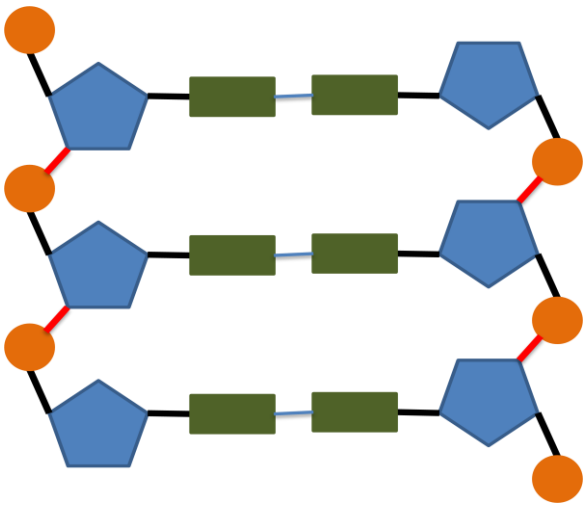
Replication takes place as follows –

- A starting point on the DNA is ‘recognised’
- DNA unwinds
- Hydrogen bonds break, strands ‘unzip’
- Template strands become stabilised and expose their bases at a Y-shaped ‘Replication Fork’

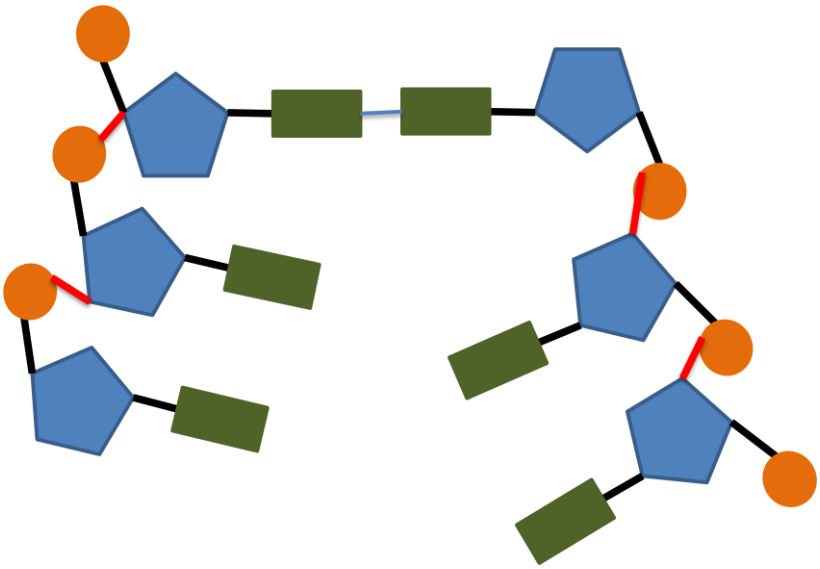
Primer – short sequence of nucleotides formed at the 3’end of the parental DNA strand

DNA Polymerase – the enzyme that controls the sugar-phosphate bonding of the new DNA strand

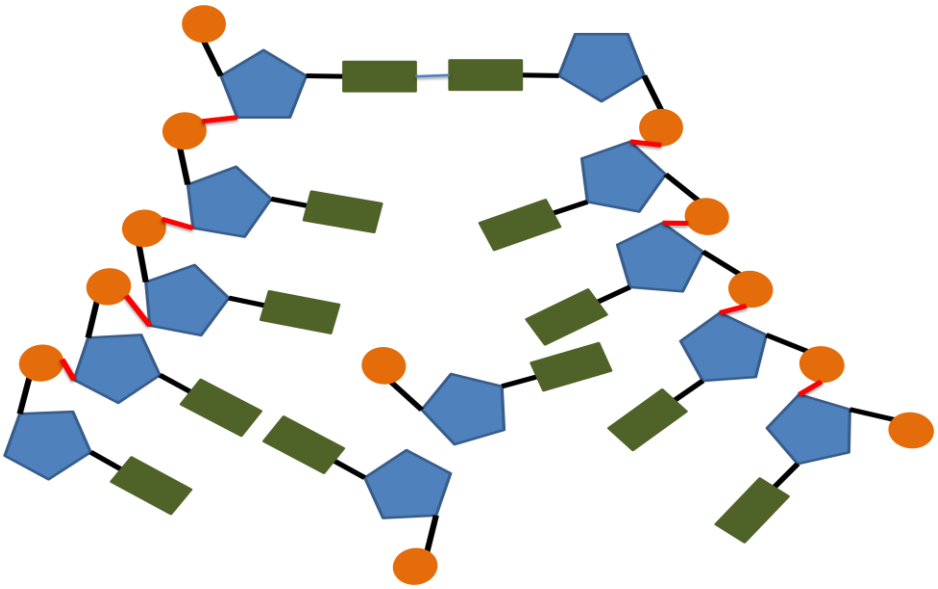
Stage 1 – DNA double helix unwinds



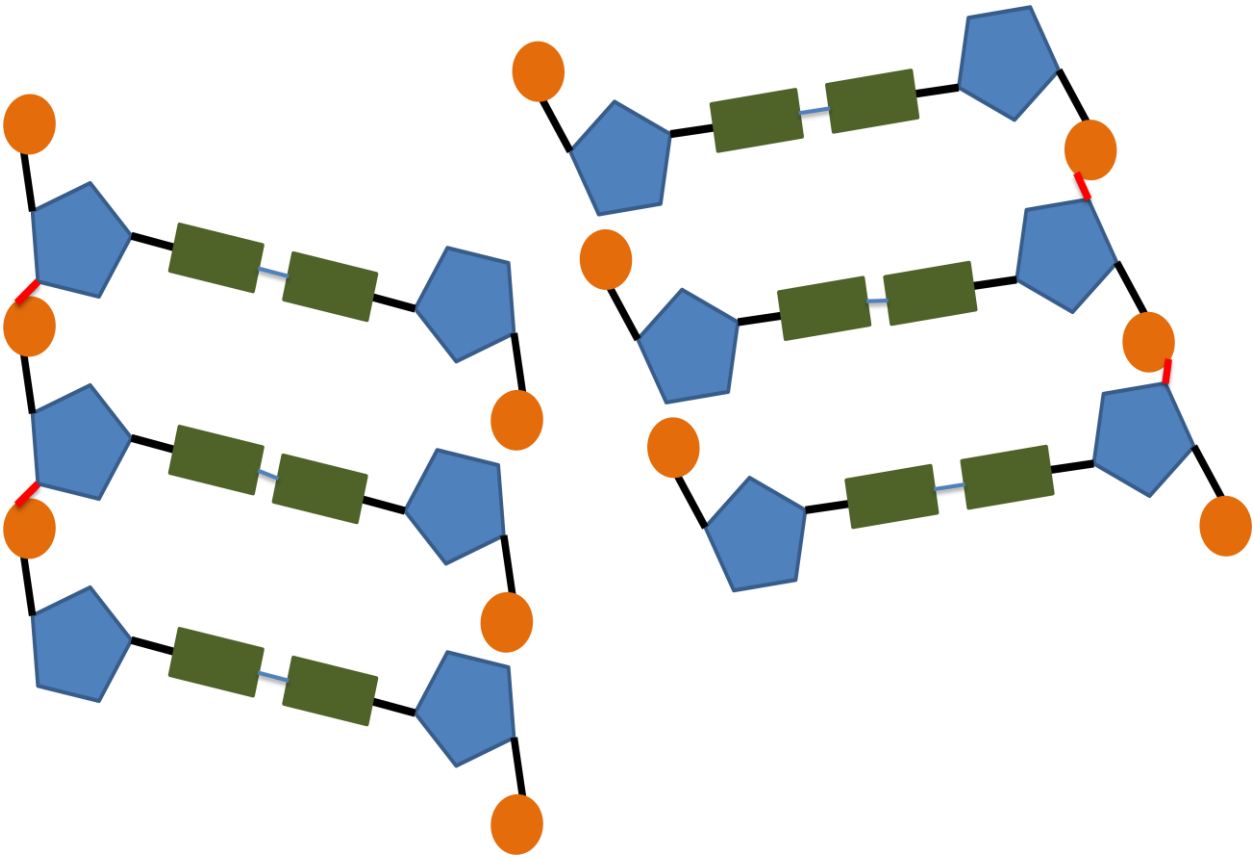
Stage 2 – Weak hydrogen bonds break causing the two strands to separate



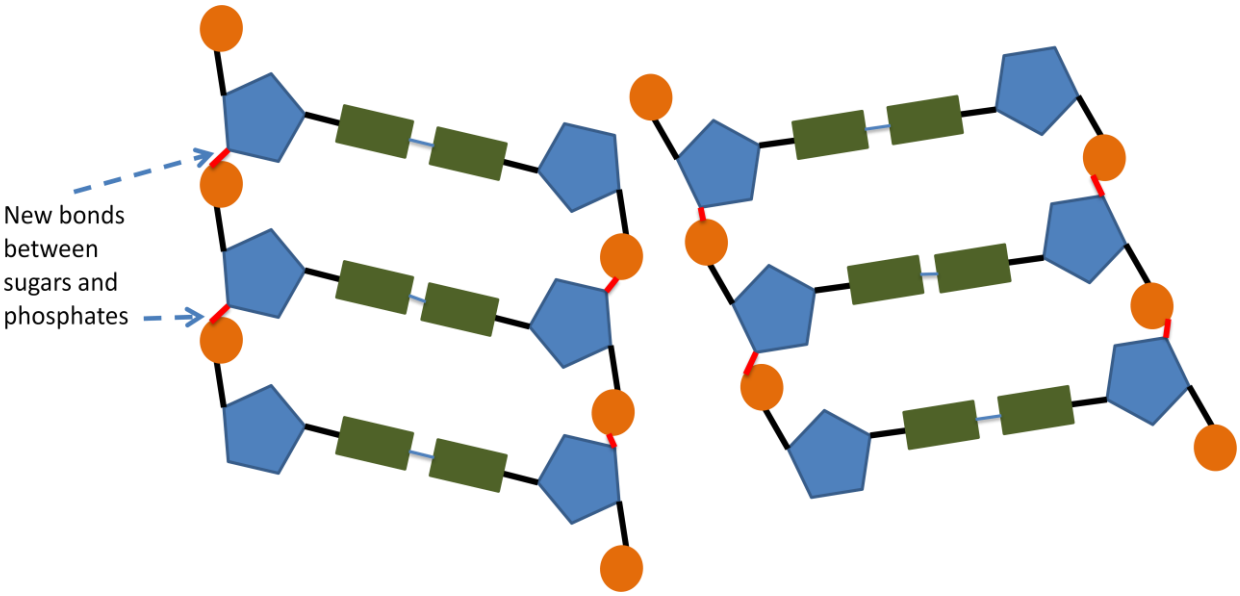
Stage 3 - Free DNA nucleotide joins complimentary one on open strand



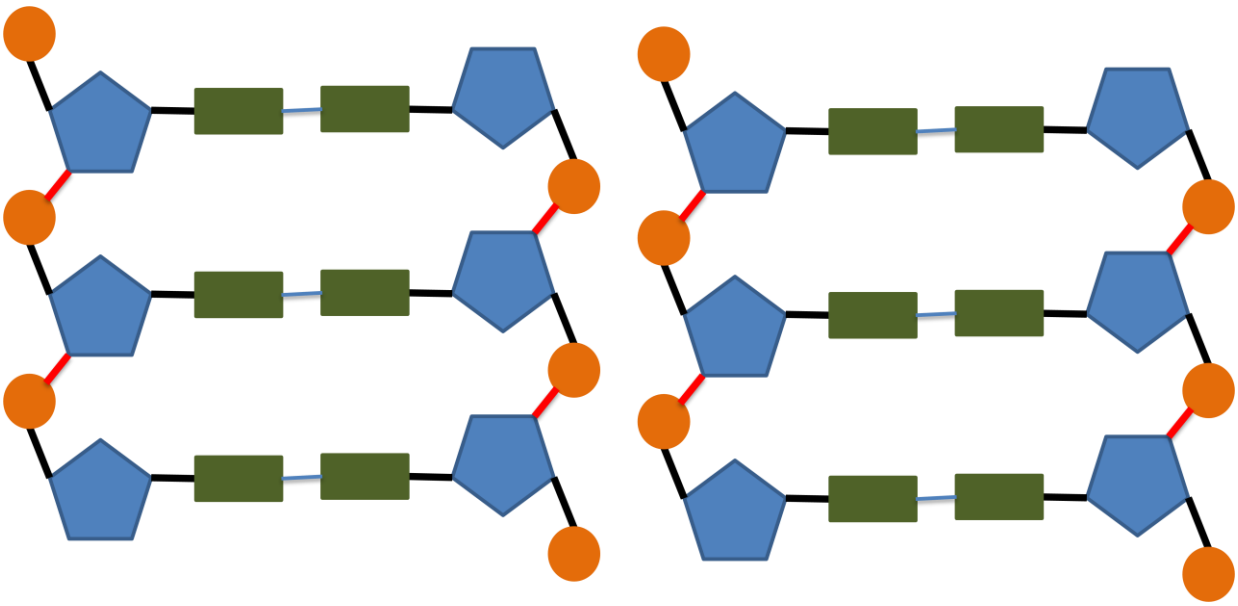
Stage 4 – Weak hydrogen bonds reform between base pairs



Stage 5 – Strong chemical bond forms between both nucleotides, controlled by an enzyme called **DNA POLYMERASE**

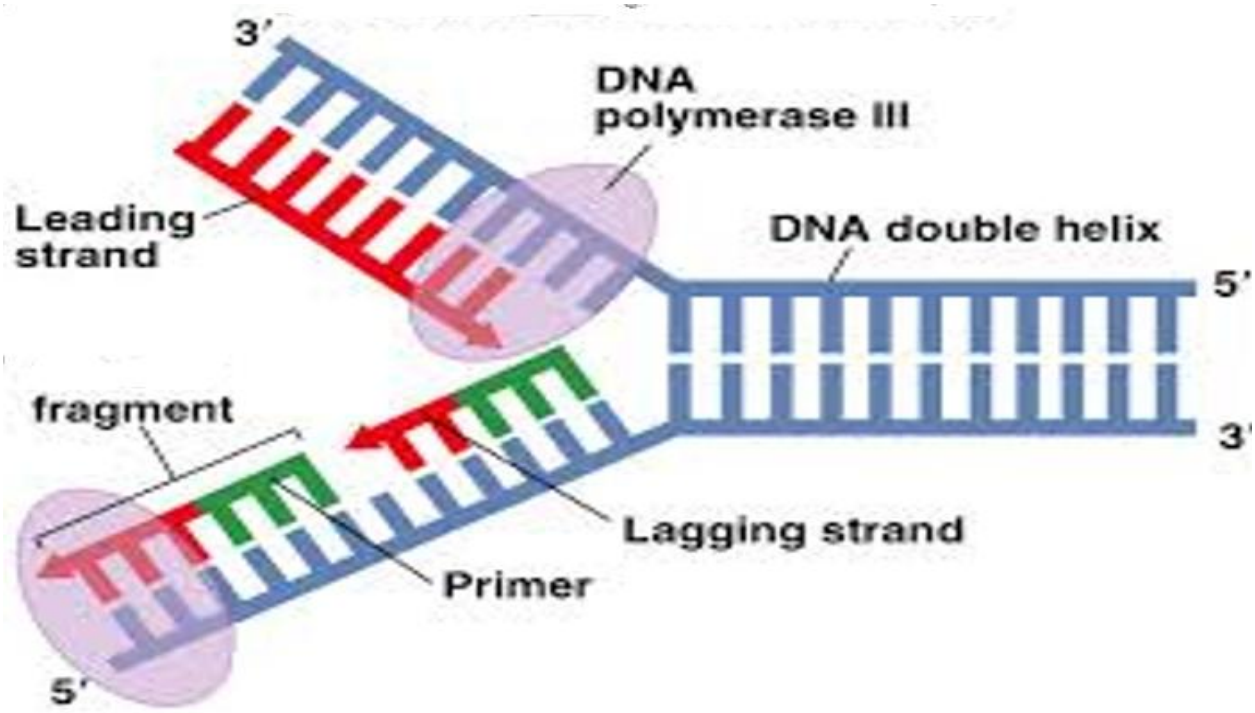


Stage 6 – Newly formed daughter DNA, identical to original, begins to wind into double helix



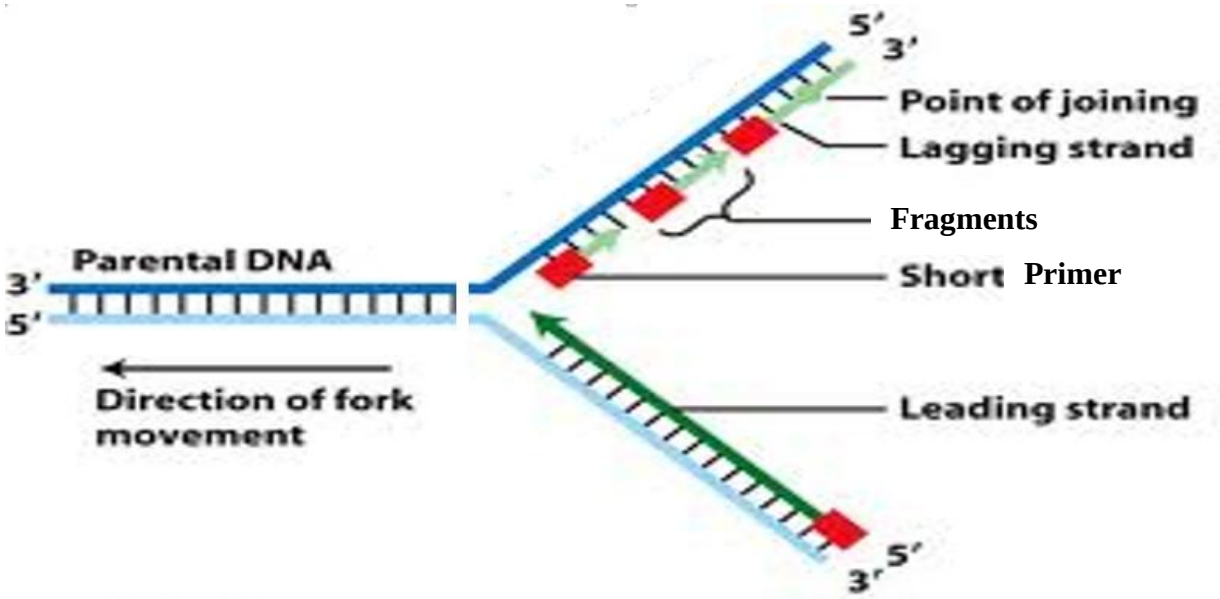
Leading strand

- DNA polymerase moves and builds from the 5’ to 3’ end
- DNA polymerase can only add nucleotides to a pre existing chain i.e. the primer
- DNA polymerase is only able to add nucleotides to the free 3’ end of a growing strand
- Replication of the parental DNA strand that has the 3’ end is ‘continuous’ and forms the ‘leading strand’ of the replicated DNA



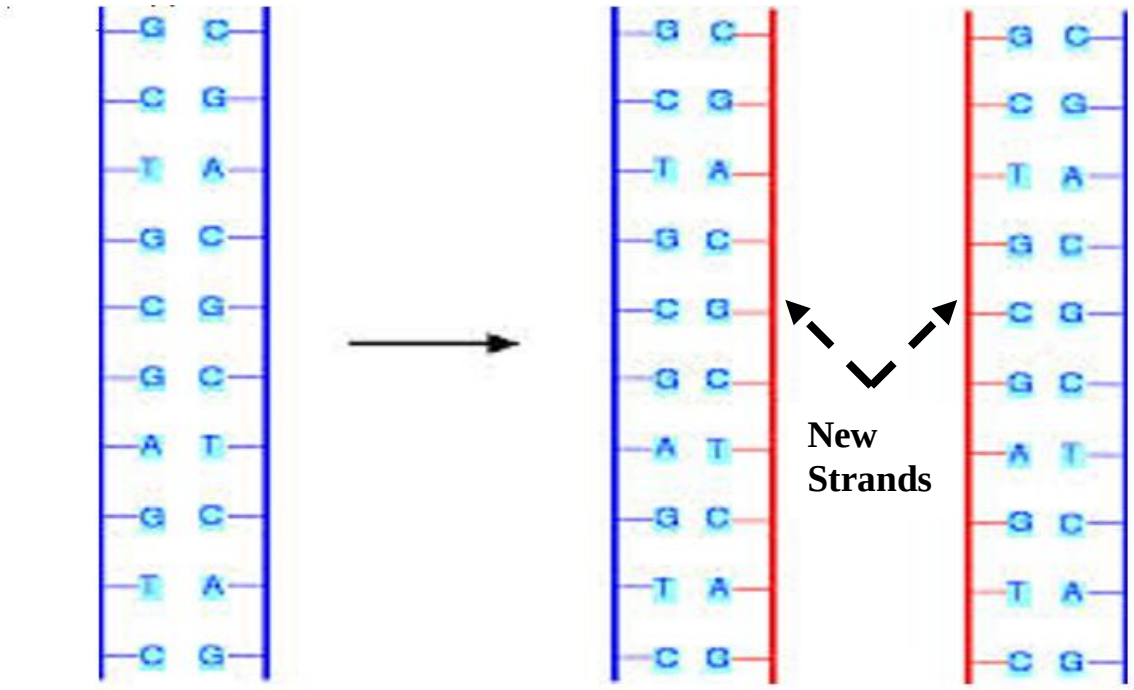
Lagging strand

- The DNA parental template that has the 5’end has to be replicated in fragments, starting at the 3’end of the primer
- Once replication of a fragment is complete, its primer is replaced by DNA
- Ligase joins the fragments together
- The strand formed is called the ‘lagging strand’ of replicated DNA – it is described as discontinuous
- Note !
- With a long chromosome, there are many replication forks operating simultaneously during replication



Requirements for replication –

- DNA template
- Primers
- Supply of the 4 types of nucleotide
- DNA polymerase (joins nucleotides)
- Ligase (Joins assembled fragments)
- ATP for energy (you will learn more about this soon)



Replication is semi-conservative – replication produces 2 identical DNA molecules, each containing 1 parental strand and 1 new strand