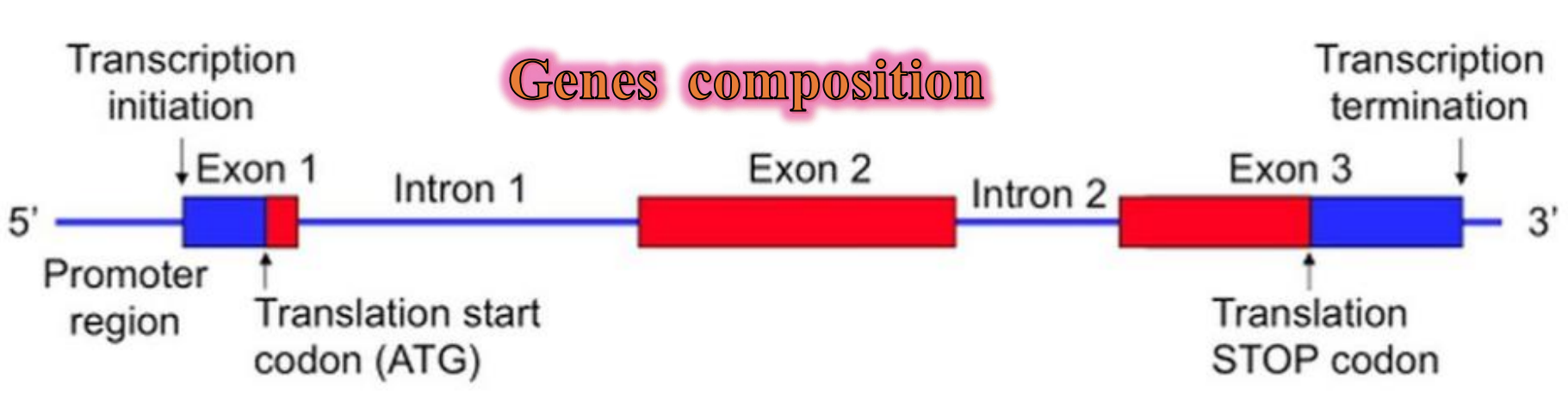
Genes composition



Gene promotor TATA box

- A piece of 100-1000 bp non coding segment; made up of repeating units of A (adenine) and (T)thymine.
- It is the place wherein molecules of the transcriptional machinery (TATA binding proteins) bind to TATA box like RNA polymerase or transcription factors.

Transcription area

- A piece of the gene wherein mRNA polymerase can do the primary transcription . It is subdivided into:=

Exons

- Active part of the transcription ar remains after gene splicing

Introns

- Inactive part of the transcription area of the gene that is removed by gene splicing (secondary transcription

Terminator region

- A place wherein RNA polymerase stops transcription. It is rich in guanine and cytosine.

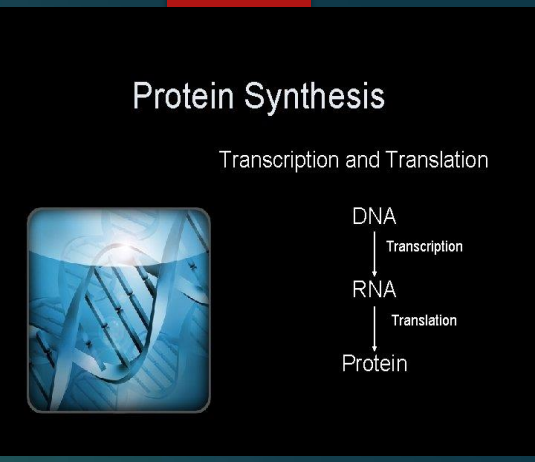
DNA FUNCTIONS

Gene expression
- Synthesis of RNA
- Direction of protein synthesis in ribosomes

Gene replication
- Duplication of the genetic materials to prepare for cell division

GENE EXPRESSION

Gene expression is a two step process involves transcription and translation



Transcription
- Use od DNA as a template to produce RNA.

Translation
- Duplication of the genetic materials to prepare for

GENE TRANSCRIPTION

Transcription = formation of mRNA strand using DNA template

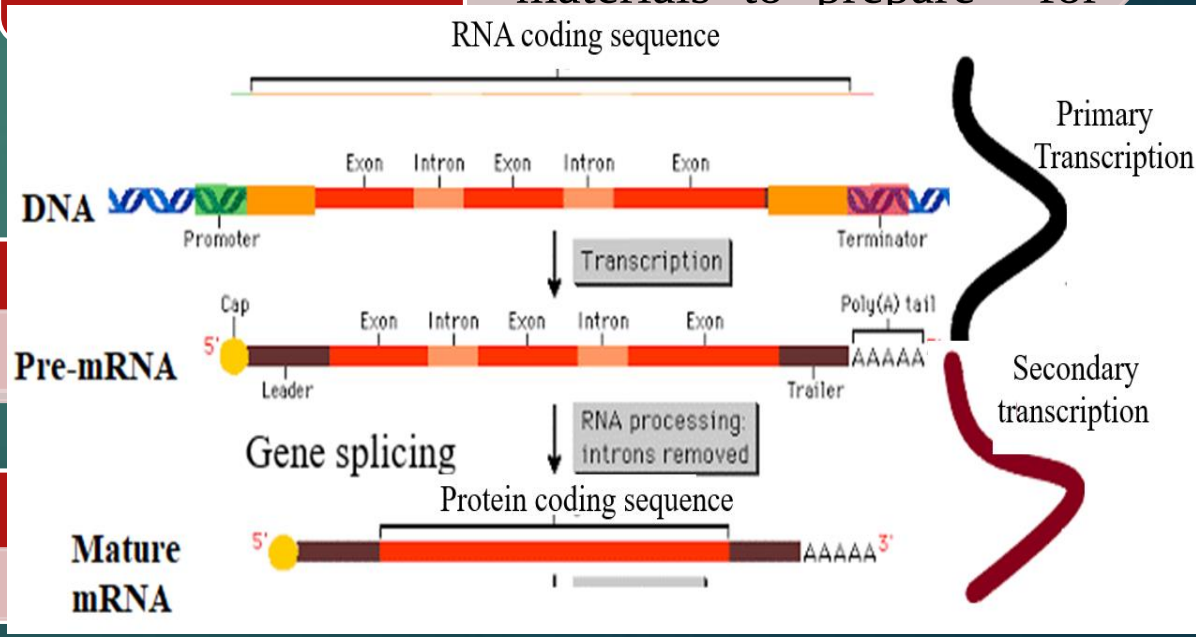
Transcription process is a two step process involves

Primary transcription

Use of DNA as a template to produce the premature RNA (Pre-mRNA) using RNA polymerase

Secondary transcription

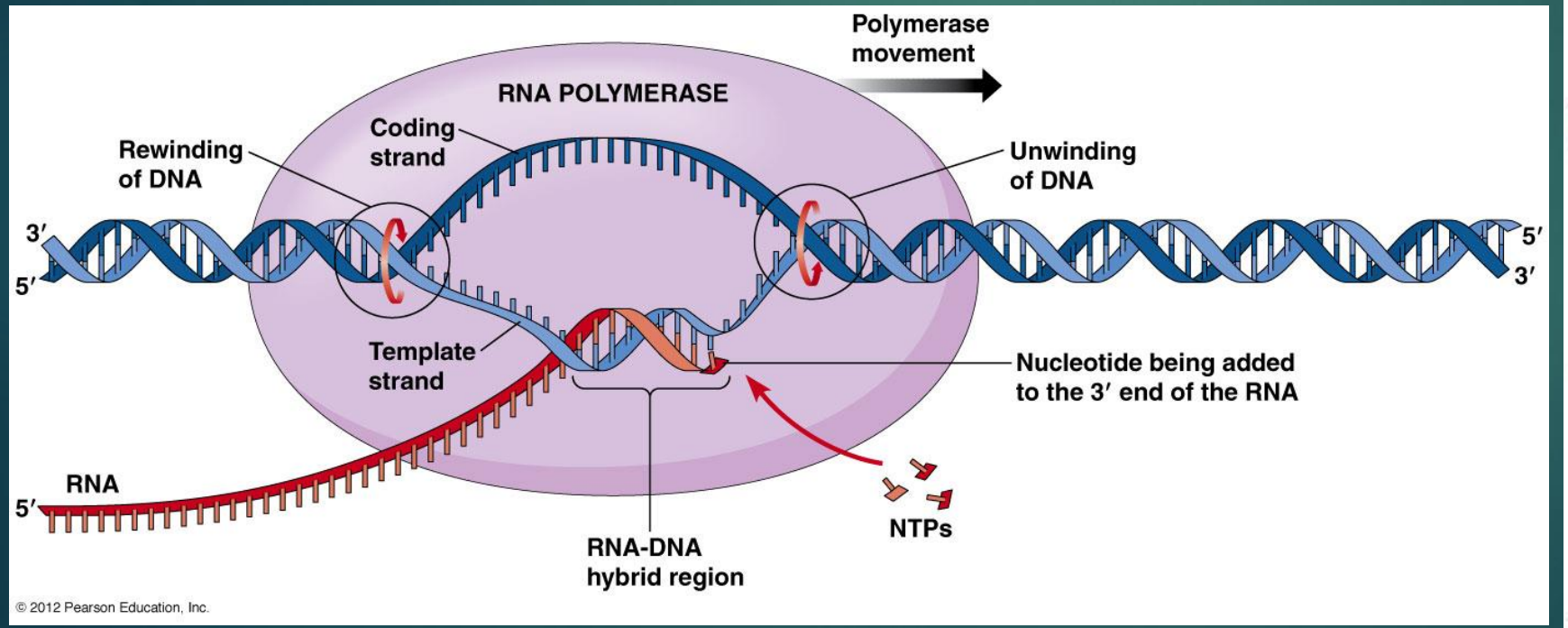
Removal of introns and formation of a segment made of the genes exons ion

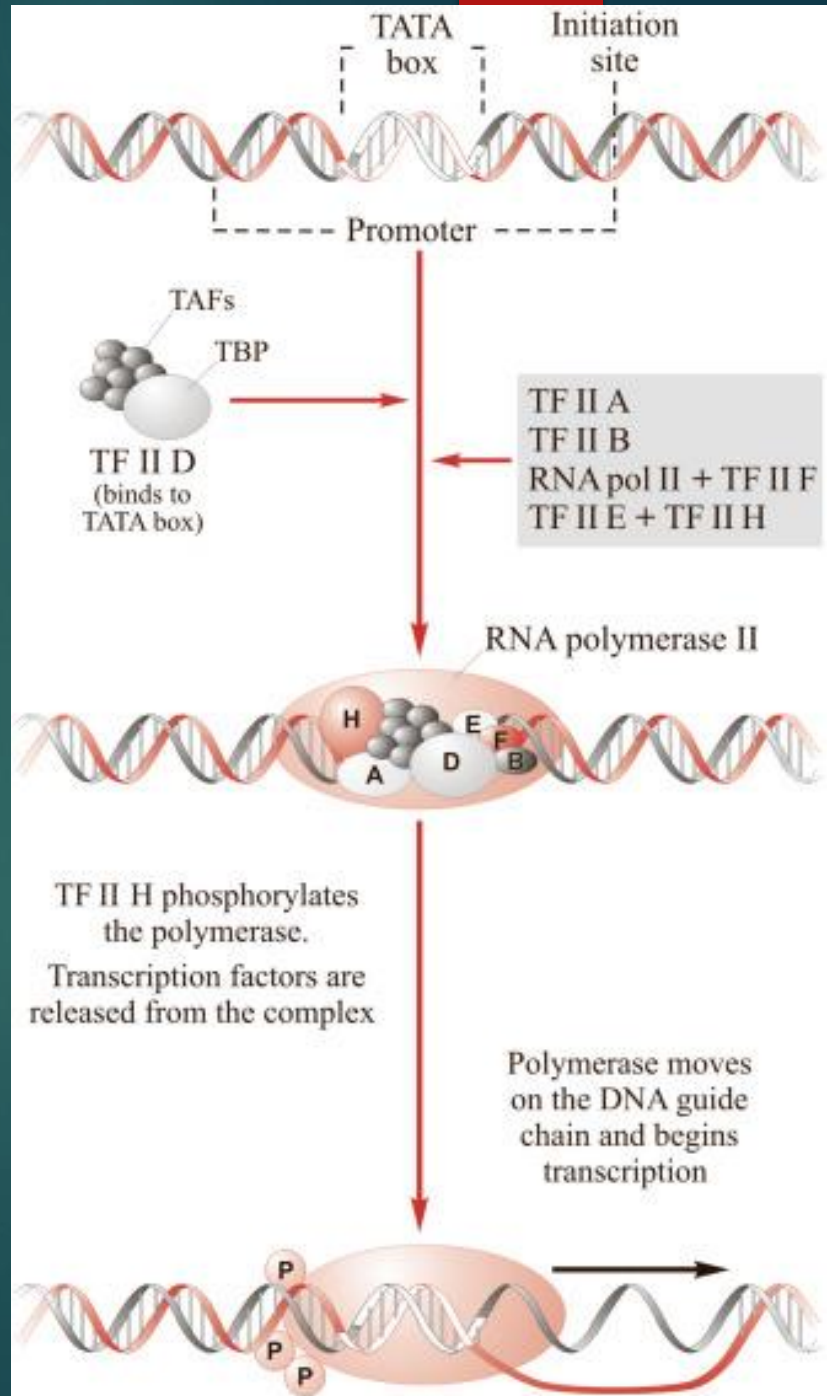


GENE TRANSCRIPTION

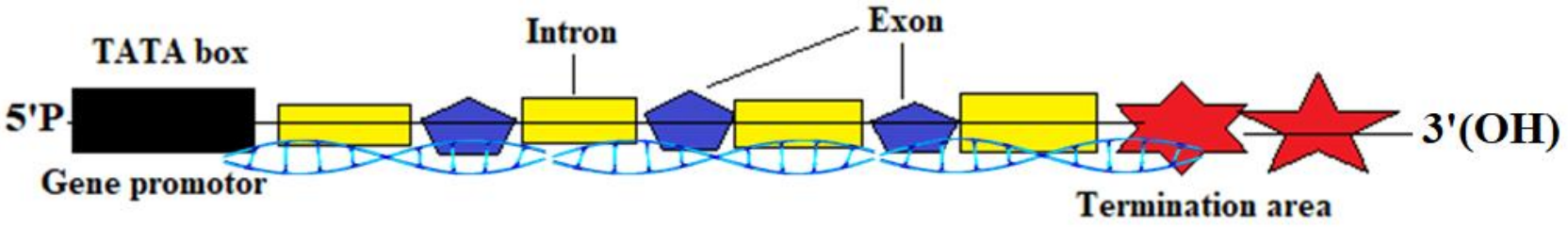
RNA polymerase enzyme

RNA polymerase enzyme introduces complementary nucleotides into their pertinent position within the DNA template



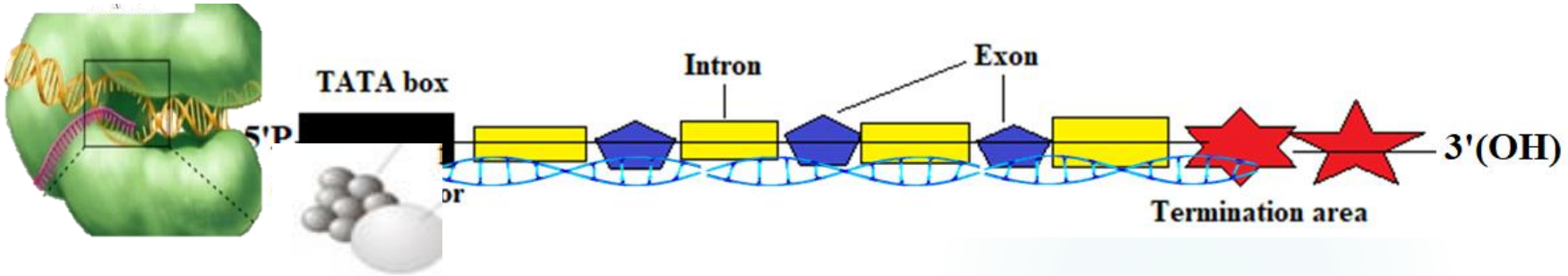


GENE TRANSCRIPTION



STEP I

Transcription factor binds to the gene promotor region (TATA box) and facilitates binding of the RNA polymerase into that region.

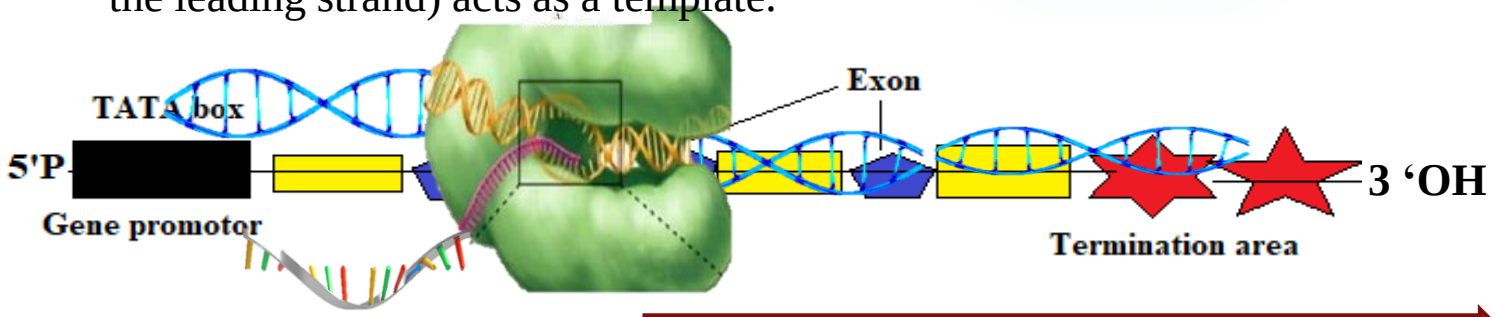


STEP II

1-The transcription factor detaches from the TATA box



2-The RNA polymerase stats unwinding the DNA strand (one of the strands; the leading strand) acts as a template.

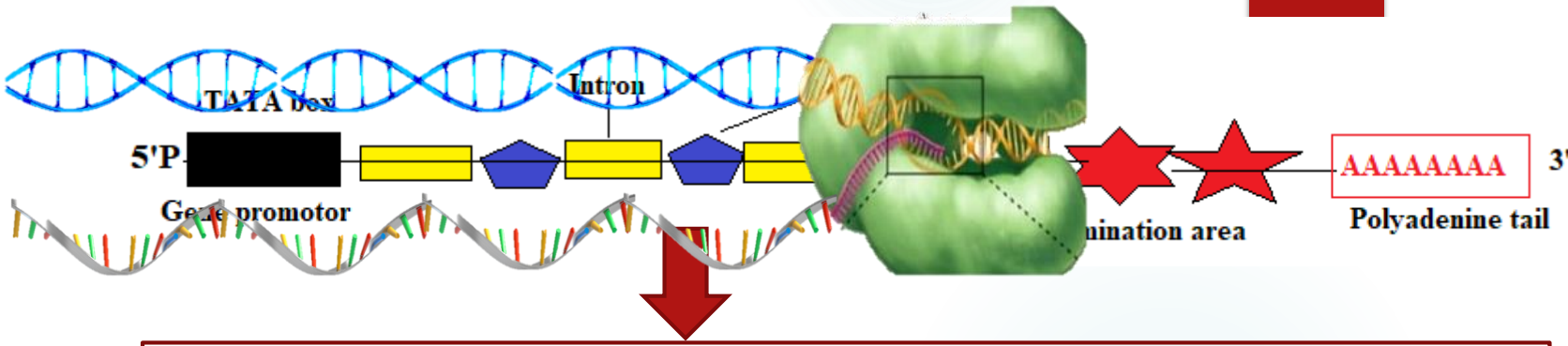


3-Then, RNA polymerase starts Moving along the downstream nucleotide in a 5' toward 3' direction

4- Insertion of the pertinent complementary RNA nucleotide as per the base pair rule

STEP III

-RNA polymerase continues to move along the downstream nucleotides till reaching the termination area



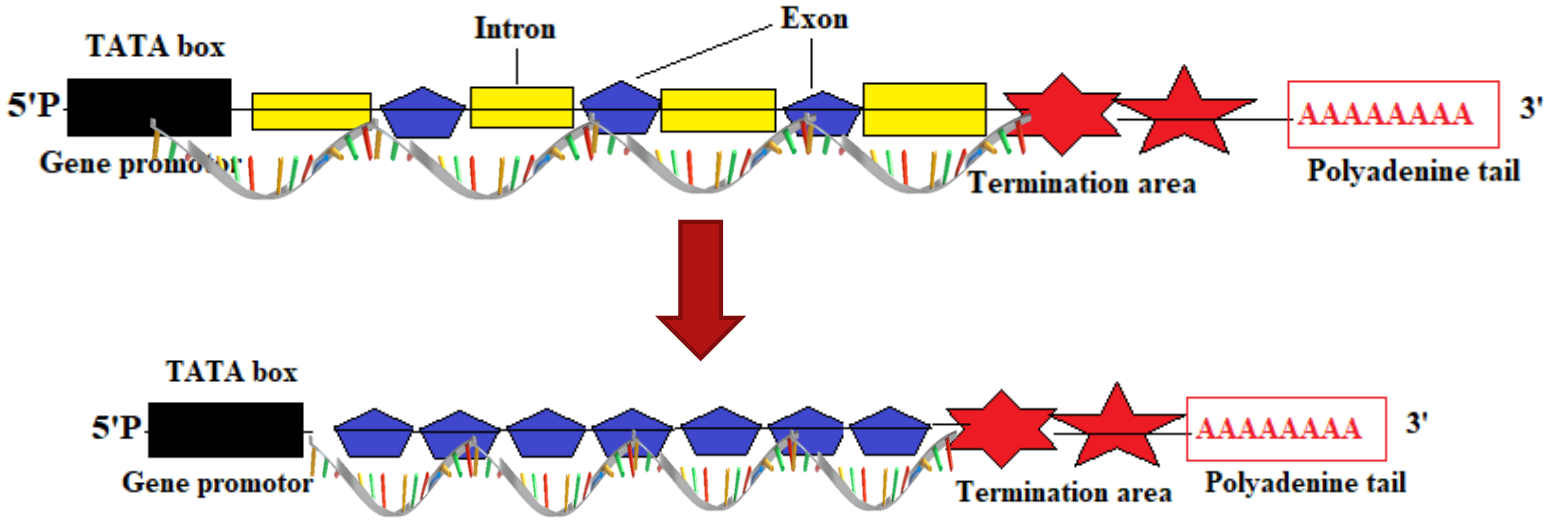
-The DNA template recoils and a new RNA strand is formed (pre-mRNA)

-Polyadenylation at the end of the termination area

-The poly-adenyl tail is crucial for translation and maintenance of mRNA stability

STEP IV (GENE SPLICING)

-Removal of introns by DNA endonuclease enzyme to form mature mRNA.



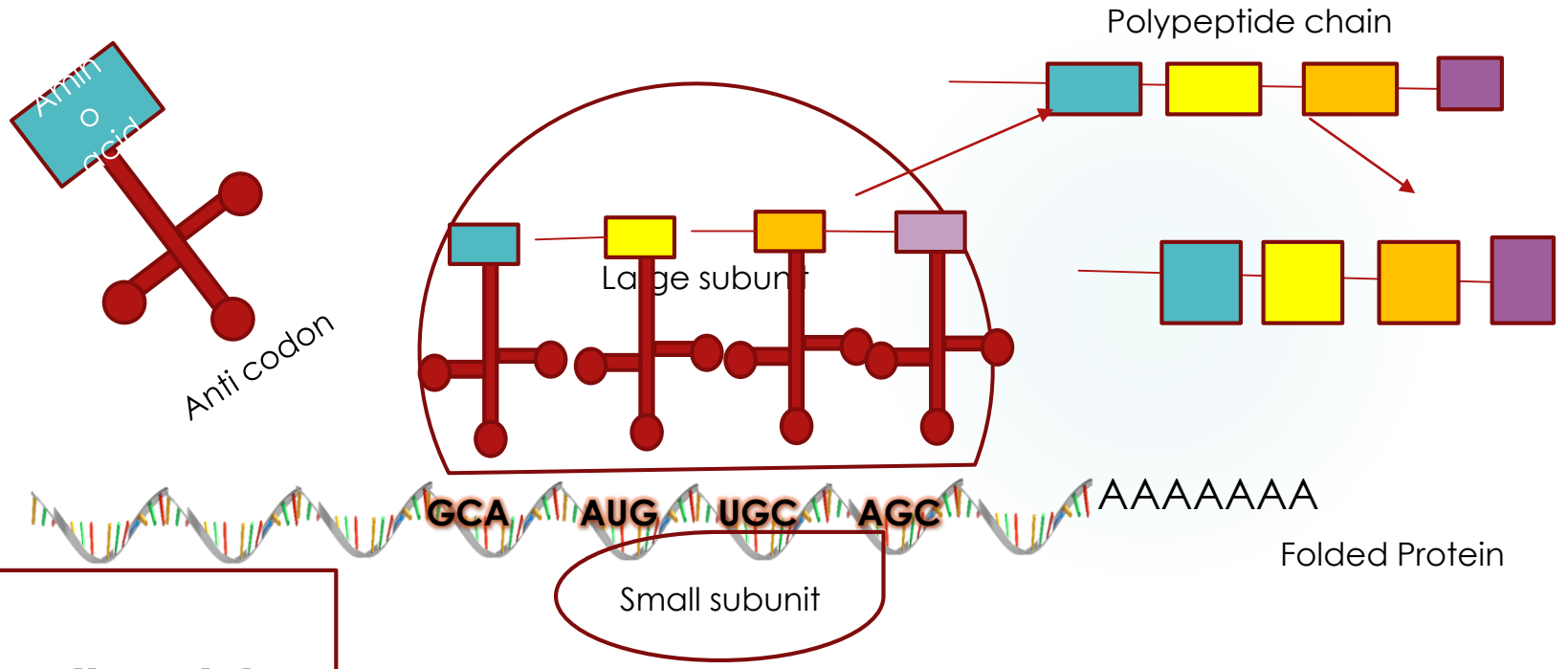
GENE TRANSLATION

Translation is the process of decoding f the mRNA inside the ribosomes to form a polypeptide sequence. It is a multi-steps process involves the followings

1-INITIATION

Transfer of mRNA to the cytoplasm and assembly of the ribosome around it.

Transfer of tRNA that carried specific amino acids into the ribosomes.



2-ELONGATION

. The tRNA molecules arrange sequentially and the amino acids form peptide linkage (transpeptidtion).

. Then the ribosome translocate to the neighboring codon. And tRNA with a complementary anticodon comes over.

3- TERMINATION

. The ribosome reaches the stop codon or the poly-adenine tail to terminate the process and release the protein.

TRANSCRIPTION FACTORS.

T.F are series of proteins that either switch on or off the active gene and control rate of gene expression

They make sure that the gene is expressed in the right cell at the right.

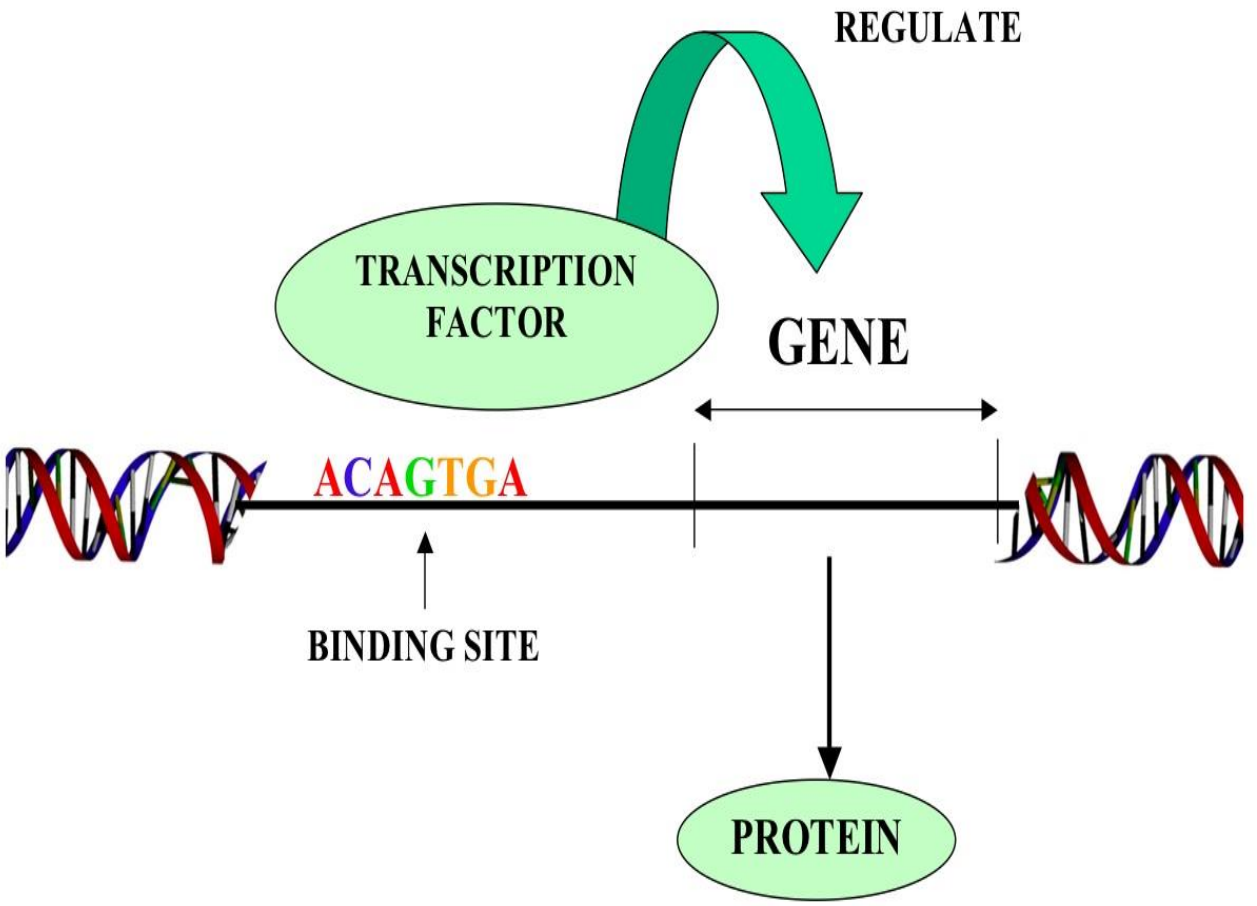
They are coded by other genes that constitute about 10% of the total genome size.

The are classified into:

1- Repressors

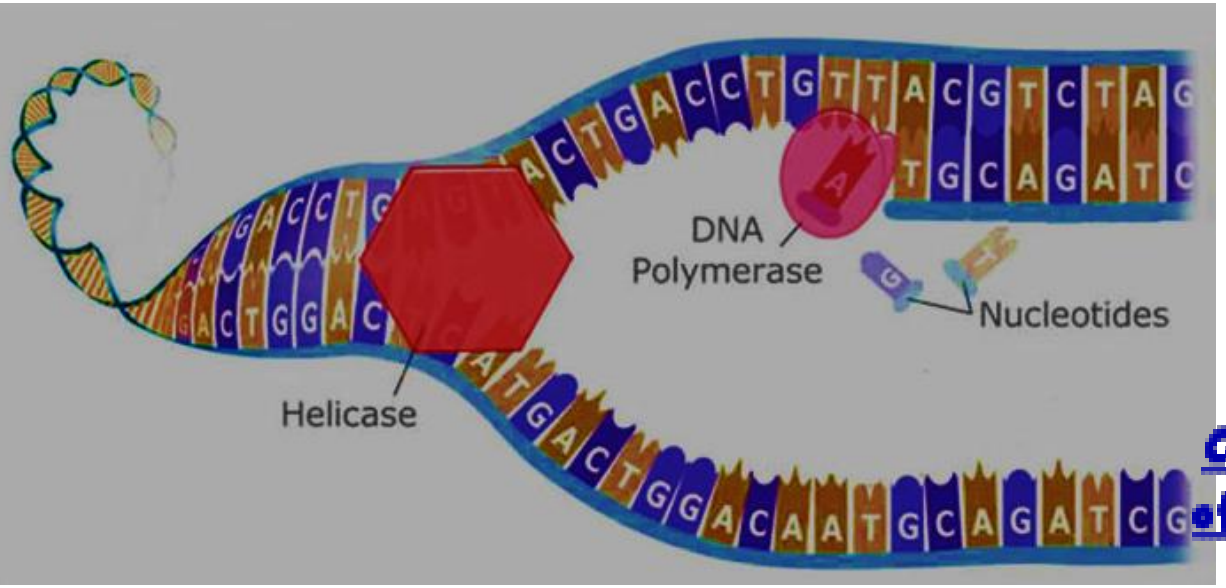
2- Promotors

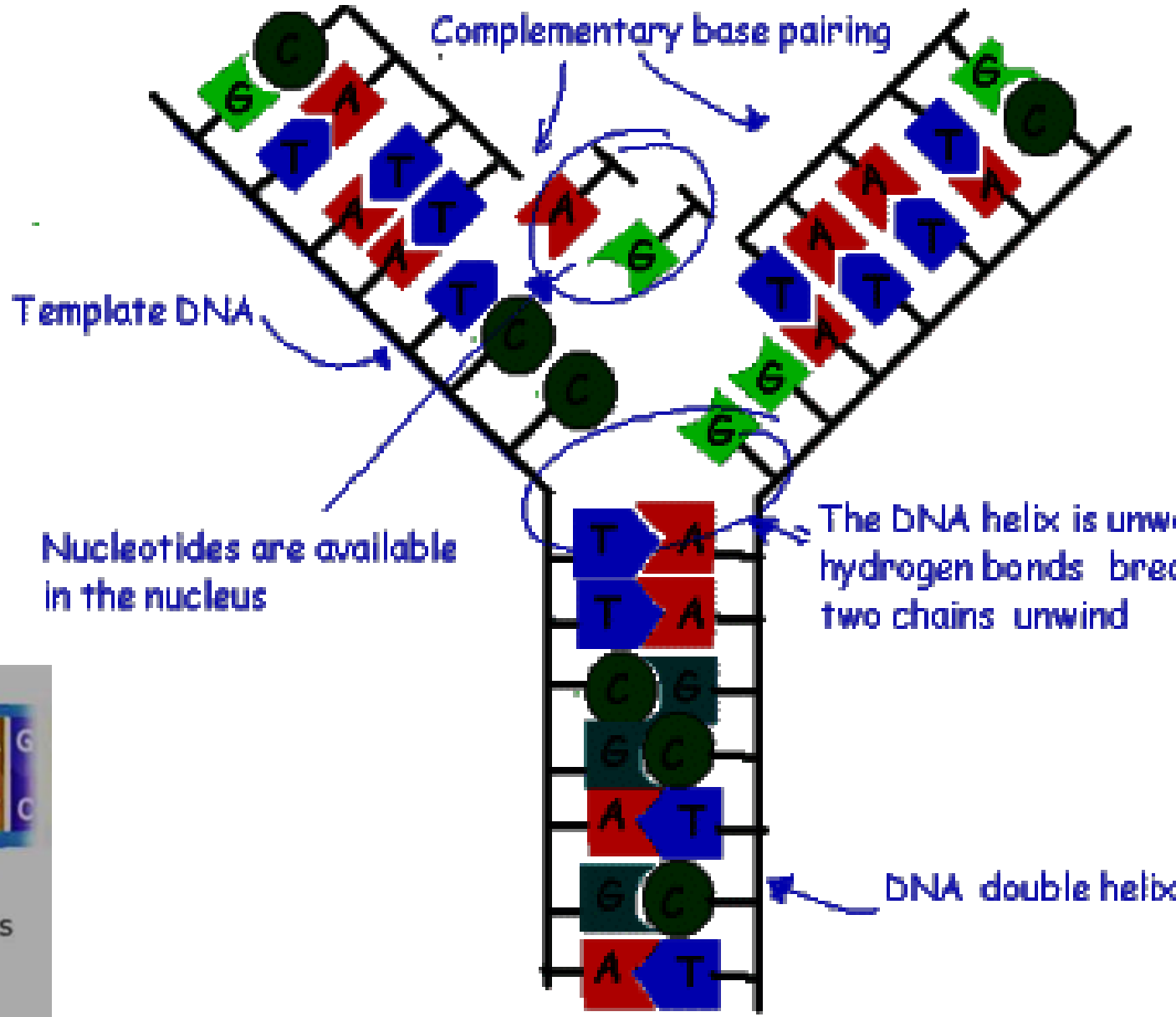
Legend: A transcription factor molecule binds to the DNA at its binding site, and thereby regulates the production of a protein from a gene.



- The DNA strands uncoil at certain points by helicase enzyme.

  - DNA polymerase enzyme starts introducing the required complementary nucleotides into the pertinent site to form the DNA strand.





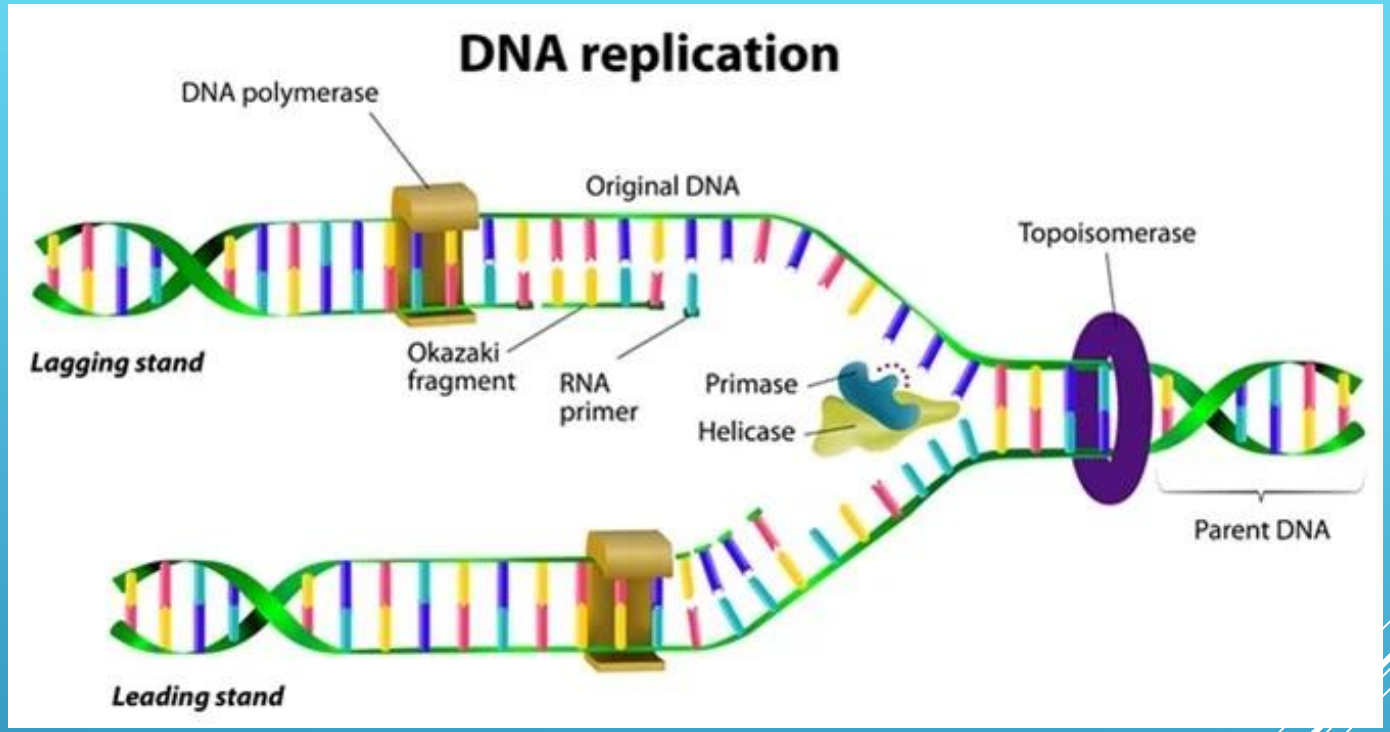
Crick and Watson model for the replication of DNA

DNA REPLICATION

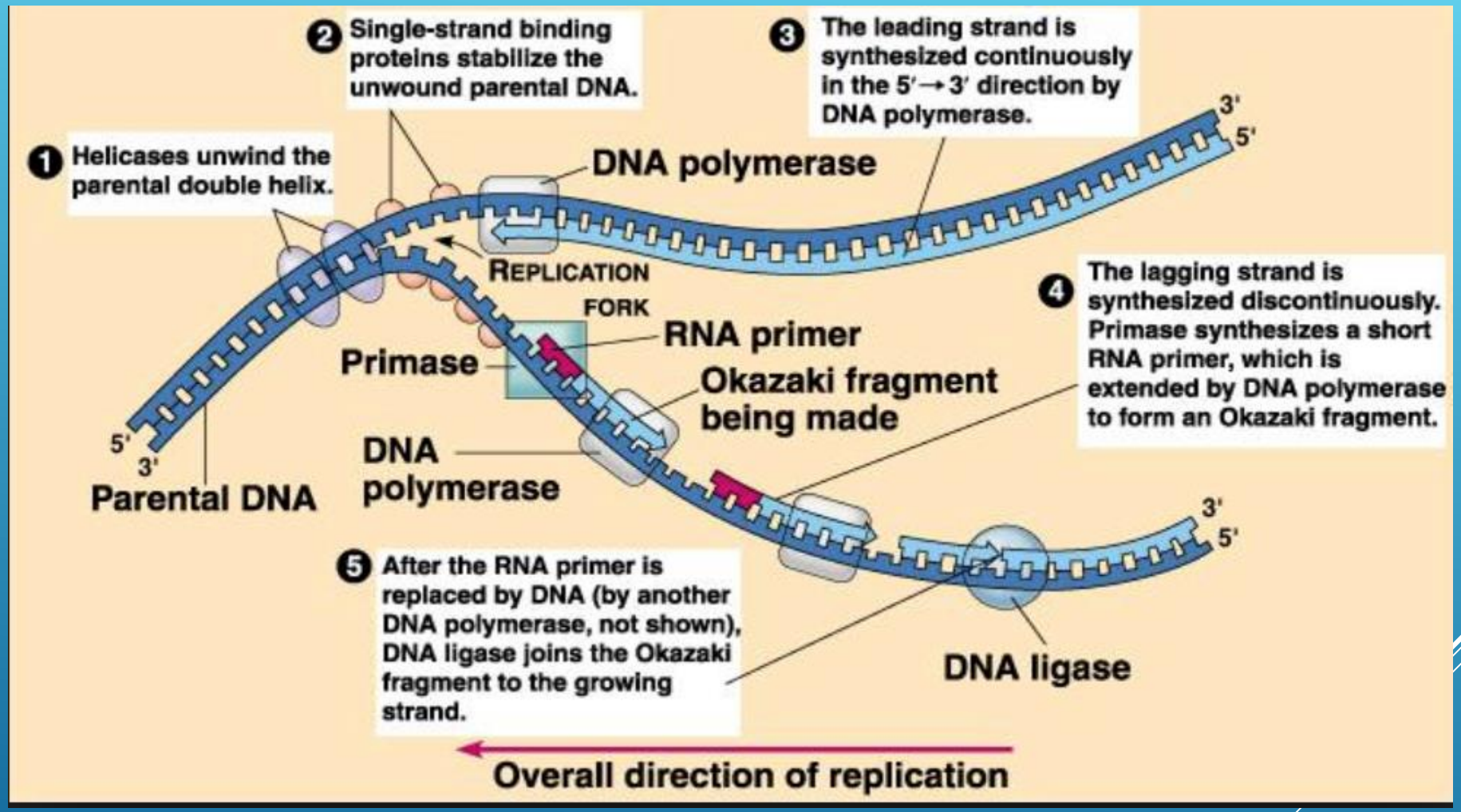
- ▸ - The DNA strands uncoil or unzip at certain points by helicase enzyme.
- ▸ - The double stranded DNA (ds-DNA) splits into two single-stranded DNA (ss-DNA) strands

One of them called the leading strand while the other is called the lagging strand)

The direction of the sequence of the leading strand is from 5'prime-3'prime ends; which is the preferred direction of the DNA polymerase enzyme



- ▸ -First, DNA primase acts on specific region of the strand to introduce a primer
- ▸ -Primer is a short sequence of RNA formed during the initial stage of DNA replication and by primase enzyme in 5'-3' direction and then is splited by 5'-3' exonuclease which splits it and prepare the area for DNA polymerase.
- ▸ - DNA polymerase enzyme introduces the required complementary nucleotides into the ss-DNA in the direction of 5 prime to 3 prime.
- ▸ - The leading ss-DNA does not face any problem as its direction cofrom with that of DNA polymerase.
- ▸ - In the lagging strand, DNA polymerase has to work against the preferred direction, so the complementary strand is formed discontinuously as Okasaki fragements which are ligated later using DNA ligase enzyme.


2 Single-strand binding proteins stabilize the unwound parental DNA.
3 The leading strand is synthesized continuously in the 5′→3′ direction by DNA polymerase.
1 Helicases unwind the parental double helix.
DNA polymerase
3'
5'
REPLICATION FORK
4 The lagging strand is synthesized discontinuously. Primase synthesizes a short RNA primer, which is extended by DNA polymerase to form an Okazaki fragment.
RNA primer
Primase
Okazaki fragment being made
5'
3'
Parental DNA
DNA polymerase
3'
5'
5 After the RNA primer is replaced by DNA (by another DNA polymerase, not shown), DNA ligase joins the Okazaki fragment to the growing strand.
DNA ligase
Overall direction of replication

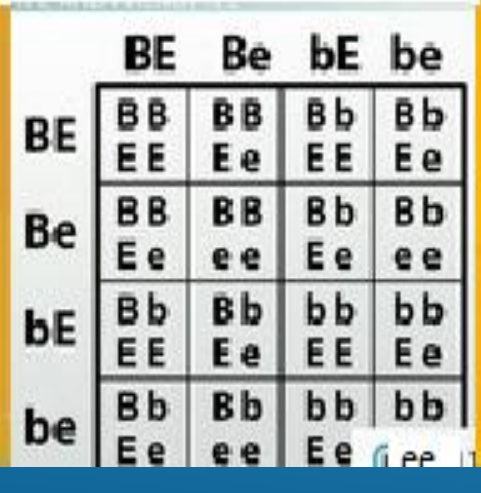
Mendel's Laws

Law of Dominance: if the two alleles at a locus differ, then one, the **dominant allele**, determines the organism's appearance; the other, the **recessive allele**, has no noticeable effect on the organism's appearance

Law of Segregation: the two alleles for a heritable character separate (segregate) during gamete formation and end up in different gametes

Law of Independent Assortment: each pair of alleles segregates independently of other pairs of alleles during gamete formation

Summary of Mendel's laws

LAW	PARENT CROSS	OFFSPRING
DOMINANCE For genes controlled by single allele	Crossing TT with tt 	100% Tt Heterozygous dominant
SEGREGATION For genes controlled by one alleles	Crossing Aa with Aa 	75% Dominant 25% Recessive
INDEPENDENT ASSORTMENT For genes controlled by more than one allele		9/16 carry dominant characters of the two genes 3/16 Carry the dominance of one gene the recessiveness of the other 3/16 Carry the dominance of one gene the recessiveness of the other 1/16 Carry the recessive character of both genes

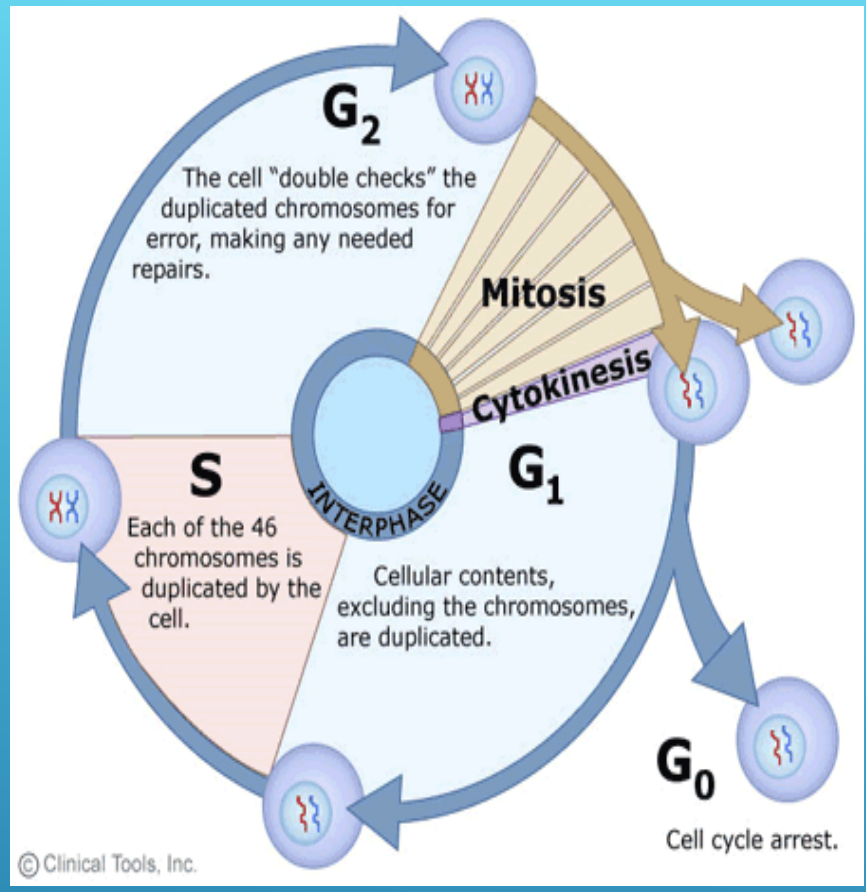
CELL CYCLE AND CELL DIVISION

Stages of the life cycle

G0	• The cell is at rest • During G0, the cells stay dormant and do not divide
G1	• Building up of most of the cellular components except for the chromosomes.
S	• Chromosomal duplication (each chromosome forms two sister chromatids.
G2	• Proofreading stage (double check for any possible error in DNA sequence (DNA repair mechanism)
M	• Meiosis and mitosis
C	• Cytokinesis and division of the cytoplasmic materials into two halves.

Interphase

M Phase



Phases of the life cycle

The cell cycle is comprised of two phases.

1- Interphase (I phase) :- The period between cell divisions. It starts from G0 of G2

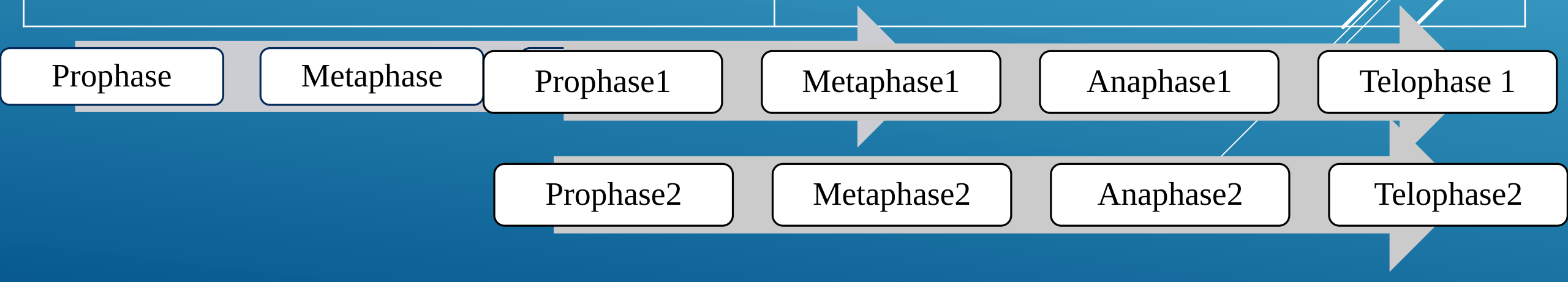
2- M Phases :-The cell splits to two daughter cells and is divided into

1-Meiotic division of gametocytes

2-Mitotic division (division of somatic cells)

MITOSIS AND MEIOSIS

Mitosis	Meiosis
1- Mitosis is used to produce two daughter cells that are genetically identical to the parent cell (produce two (2X cells) .	1- Mitosis is used to produce two gametocytes (sperm or egg) that each get half the number of chromosomes (produce two (1X) cells).
2- The copied chromosomes (homologous chromosomes) split equally to make sure that each cell receive a full set of the chromosomes	2- The copied chromosomes (homologous chromosomes) split into 4 genetically different sex cells (because of the crossing over).
3- It is made up of only one division (one cytokinesis)	3- It is made up of 2 division (2 cytokinesis)
4- Ends with diploid cells (In human, each cell receives 23 pairs of chromosomes (23 paternal and other 23 maternal chromosomes)).	4- Ends with haploid cells(In human, each cell receives 23 pairs of chromosomes (23 paternal and other 23 maternal chromosomes).
5- Plays a role in * development of embryo * human growth and * replacement of damaged tissues.	4- Plays a role in reproduction
6- It is divided into the following sub-phases	5- It is divided into subdivions (Meiosis I and Meiosis II) and each has the following sub-phases



STEPS OF MITOSIS

Prophase (4X)

1-Chromatin condensation
2- Appearance of the chromosomes (X shaped chromosomes).
3-The duplicated ce lit
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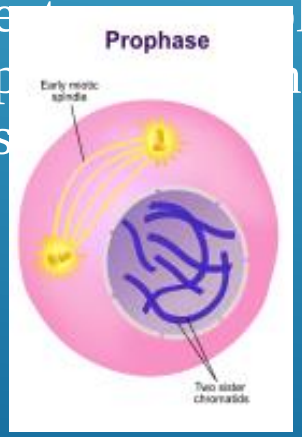
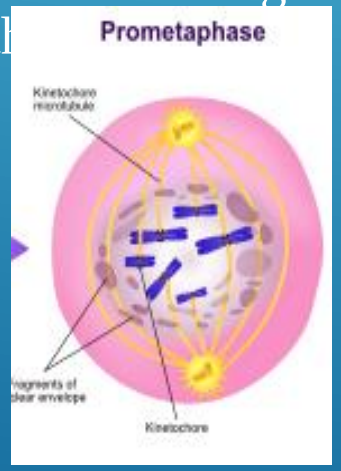


Prometaphase 4X

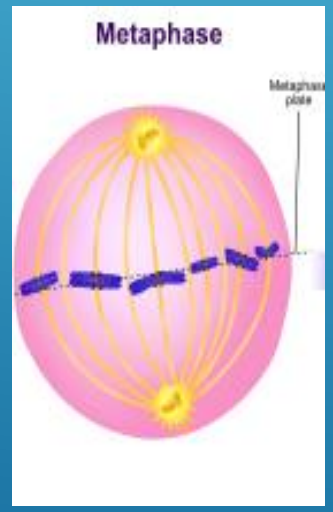
1-Complete spindle is formed.

2-The chromosomes (homologous chromosomes) start attaching to th



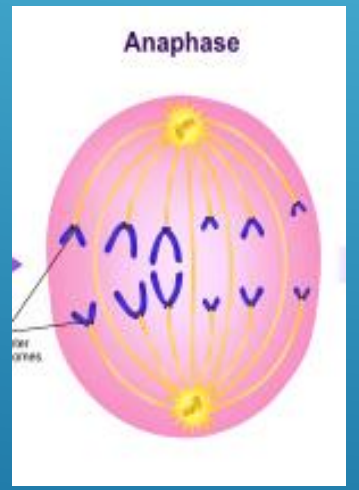
Metaphase 4X

The chromosomes align in metaphase plate.



Anaphase 4X

The homologous chromosomes split apart at each pole of the cell.



Telophase and cytokinesis (2X)

1-The chromosomes disintegrate and de-condense to form chromatin network

2- Nuclear membrane develop.

3- C
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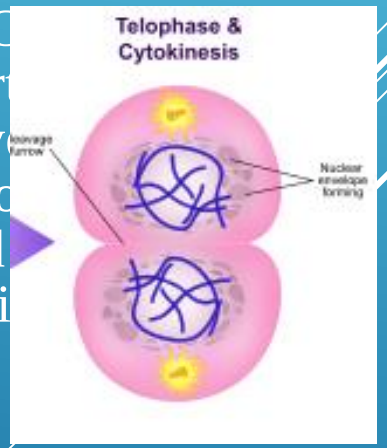
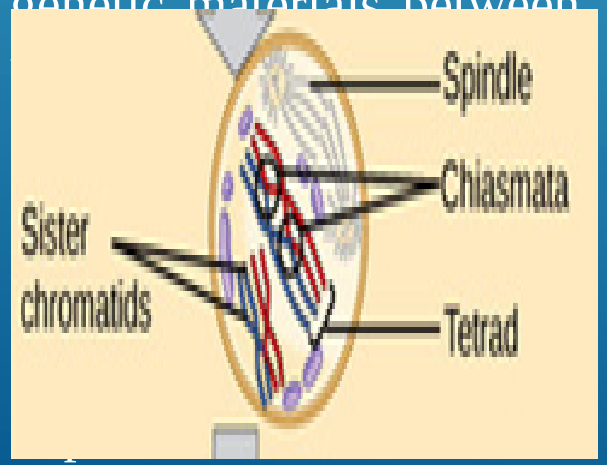


STEPS OF MEIOSIS I

Prophase I (4X)

1-Chromatin condensation
2- Unlike the mitotic prophase, the homologous chromosomes be visible, they attach together at various points called chiasmata to form a structure of 4 chromatids (Tetrads). The chiasmata allows for exchange of genetic materials between



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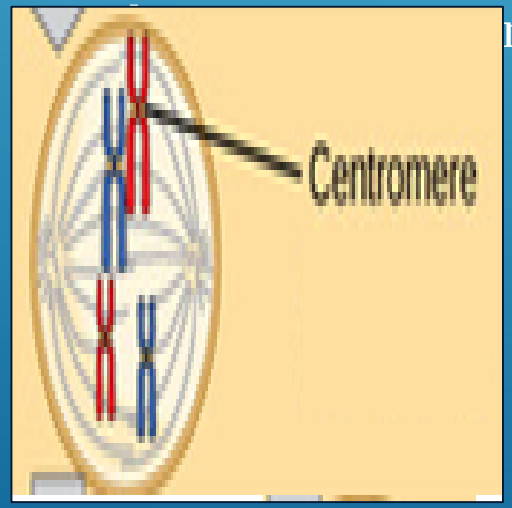
Prometaphase I (4X)

1-Complete spindle is formed.

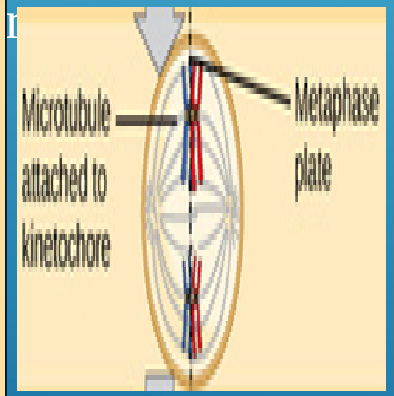
2-The tetrads attach to the spindle.

3- The nuclear



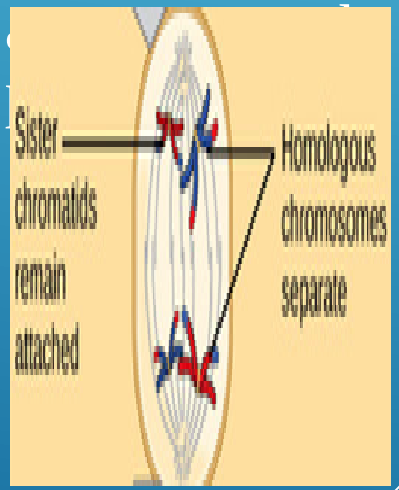
Metaphase I (4X)

1-The tetrads align within the metaphase plate.
2- The tetrads start splitting into homologous



Anaphase I (4X)

Homologous chromosomes are pulled

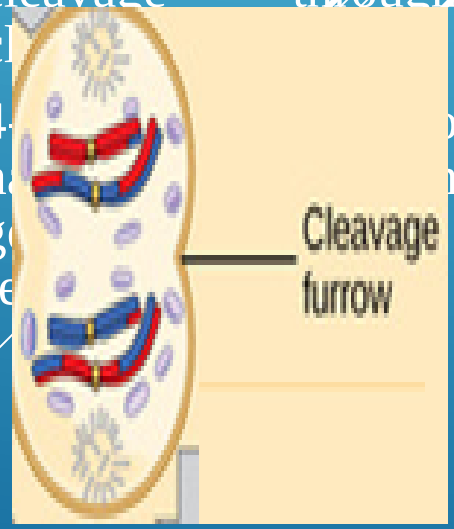


Telophase I and cytokinesis (2X)

1- De-condensation of the homologous chromosomes (sister chromatid) into chromatin fibers.

2- Nuclear membrane develop.

3- Cytoplasmic cleavage through



Steps of meiosis II

Prophase II (2X)

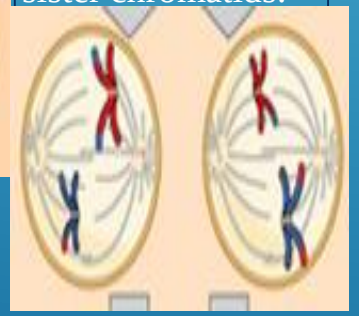
1-The sister chromatids form Telpohase I condense.
2-The centrosomes duplicate and each



Prometaphase II (2X)

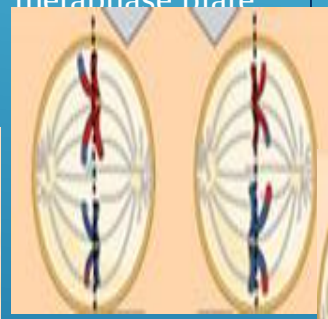
1-Complete spindle is formed.

2-The spindle starts engage with the sister chromatids.



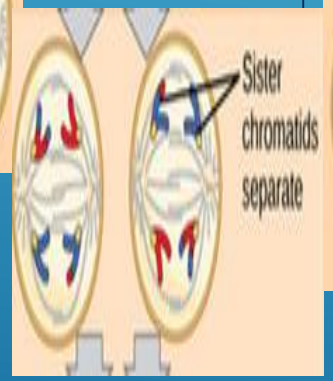
Metaphase II (2X)

1-The sister chromatids align within the metaphase plate



Anaphase II (2X)

The sister chromatids separate and move apart to each pole



Telophase II and cytokinesis II (1X)

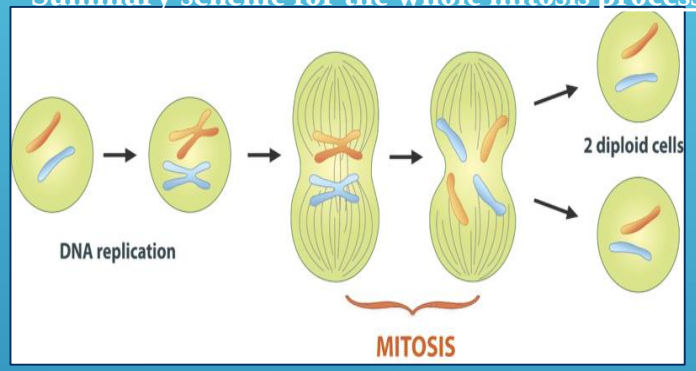
1- Each chromatid (haploid chromosomes) start de-condensation

2- Nuclear membrane develop.

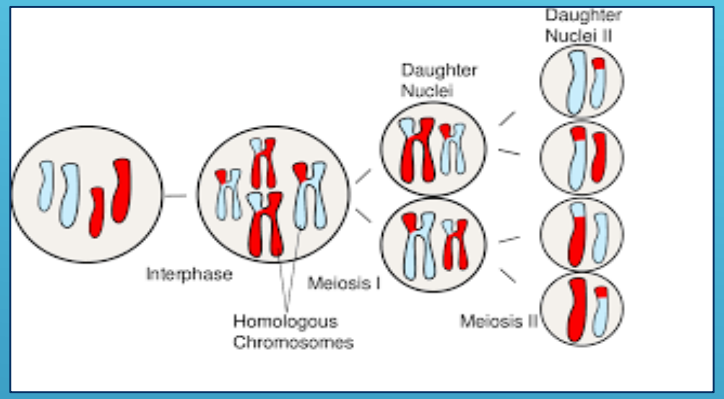
3- Cytoplasmic cleavage through



Summary scheme for the whole mitosis process



Summary scheme for the whole meiosis process



General difference between mitosis and meiosis

