MOLECULAR BIOLOGY II

Color index:
Red and orange: Important

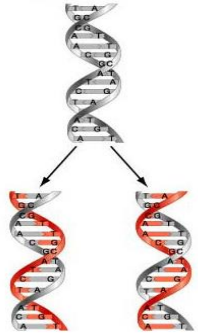
Dark Blue: Further explanation

*To understand DNA replication

*To know the transcription of genetic material into messenger RNA

*To get an idea about the translation of mRNA into a functional protein.

Features of DNA replication in Eukaryotes:



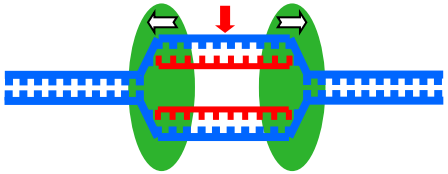
- DNA replication model:

Semiconservative model (one parental strand and newly replicated strand).

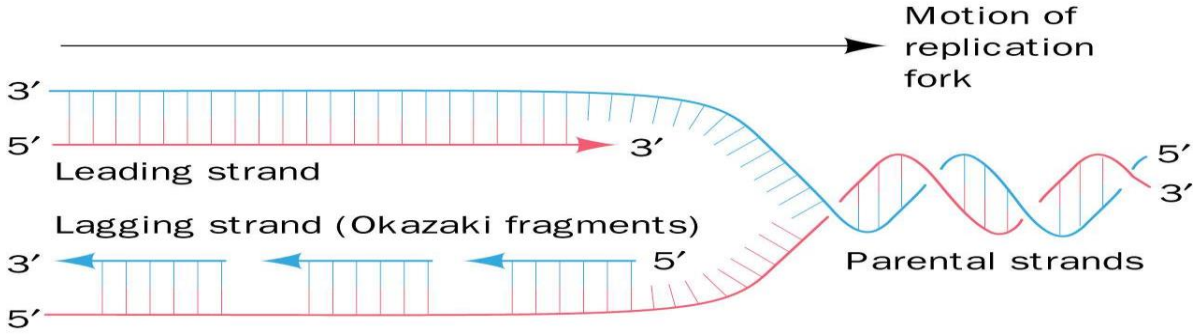
- The direction of DNA replication:

Bidirectional replication (in two directions) with multiple origin.

- Primed by short stretches of RNA.



- DNA replication is Semi-discontinuous :
- The leading strand is continuous (in the direction of the replication fork) the lagging strand is discontinuous (the opposite direction of the replication fork).



Proteins involved in DNA replication:

Enzyme name	Function
Helicase	Unwinds parental double helix
Single-strand Binding protein	Stabilizes separate strands
DNA Primase	Adds a short segment of **RNA primer** to template strand
DNA polymerases	Forms new strands and removes RNA primer and inserts the correct bases
DNA Ligase	Joins Okazaki fragments (in the lagging strand) and seals gaps in sugar-phosphate backbone

Other proteins:

*Topoisomerases:

Topoisomerase I.

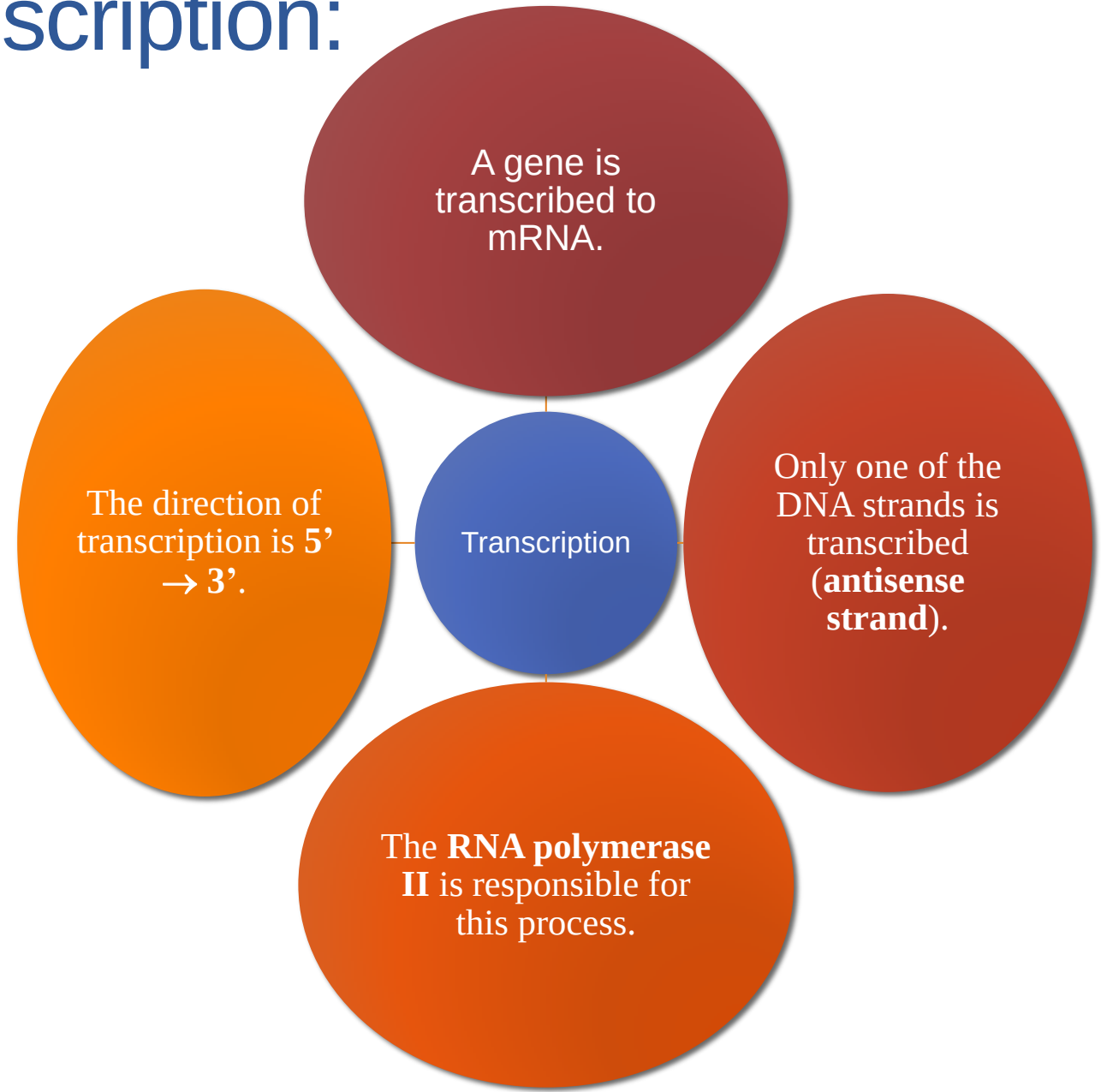
Topoisomerase II.

*Telomerases

1)Steps in DNA replication:

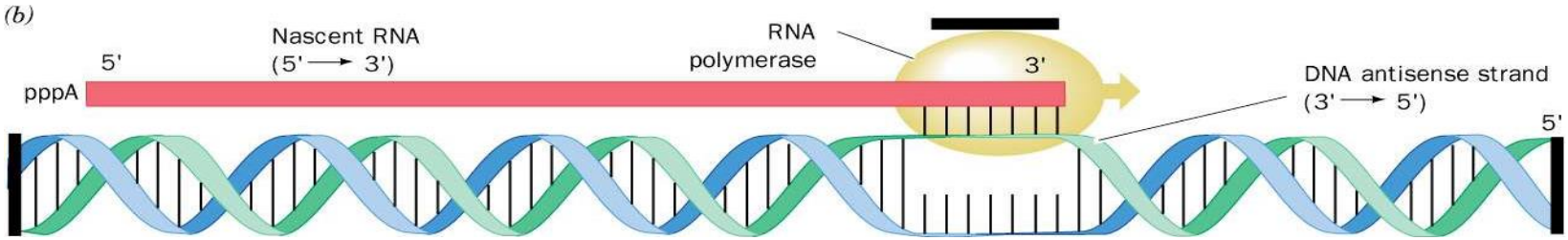
Helicase	• protein binds to DNA sequences called origins and unwinds DNA strands .
Single strand binding proteins	• binding proteins prevent single strands from rewinding
Primase	• makes a short segment of **RNA primer** complementary to the DNA.
DNA Polymerase	• enzyme adds DNA nucleotides to the RNA primer and proofreads(corrects) bases added and replaces incorrect nucleotides
Then	• *Leading strand synthesis continues in a 5' to 3' direction *Discontinuous synthesis produces 5'to3'DNA segments called Okazaki fragments
DNA Polymerase	• Exonuclease activity of DNA polymerase removes RNA primers then DNA polymerase fills the gaps
Ligase	• forms bonds between sugar-phosphate backbone

2)Transcription:



Steps of mRNA synthesis:

Steps	Details
1)Chain initiation	RNA polymerase binds to promoter region of DNA to start transcription.
2)Chain elongation	a) A portion of DNA template unwinds (opens) at the point of RNA synthesis. b) This forms a short length of RNA-DNA hybrid.
3)Chain termination	DNA contains specific sites which stop transcription (at a sequence of 4-10 AT base pairs).



Post-transcriptional modification:

Type	Definition	Function
Capping	Addition of a methylated guanine nucleotide at 5' end of mRNA.	1. To prevent mRNA degradation by exonucleases. 2. It helps the transcript bind to the ribosome during protein synthesis.
Polyadenylation	Addition of a poly(A) tail (a highly conserved AAUAA sequence) at 3' end of mRNA.	1. To protect the mRNA from degradation. 2. For ribosomal RNA recognition.

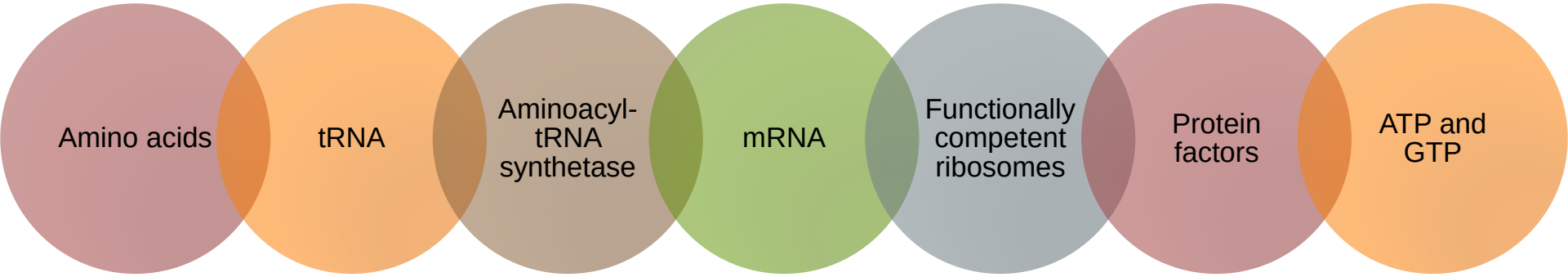
3)Translation:

- It is a process of protein synthesis from mRNA.
- mRNA has genetic codes for amino acids present in proteins.
- The genetic code is a dictionary that identifies the correspondence between a sequence of nucleotide bases and a sequence of amino acids.
- Each individual word in the code is composed of three nucleotide bases (codons).

- There are 64 possible codons:
  - 61 codons specify 20 amino acids
  - One start codon (AUG)
  - 3 stop codons

    UAA, UAG and UGA

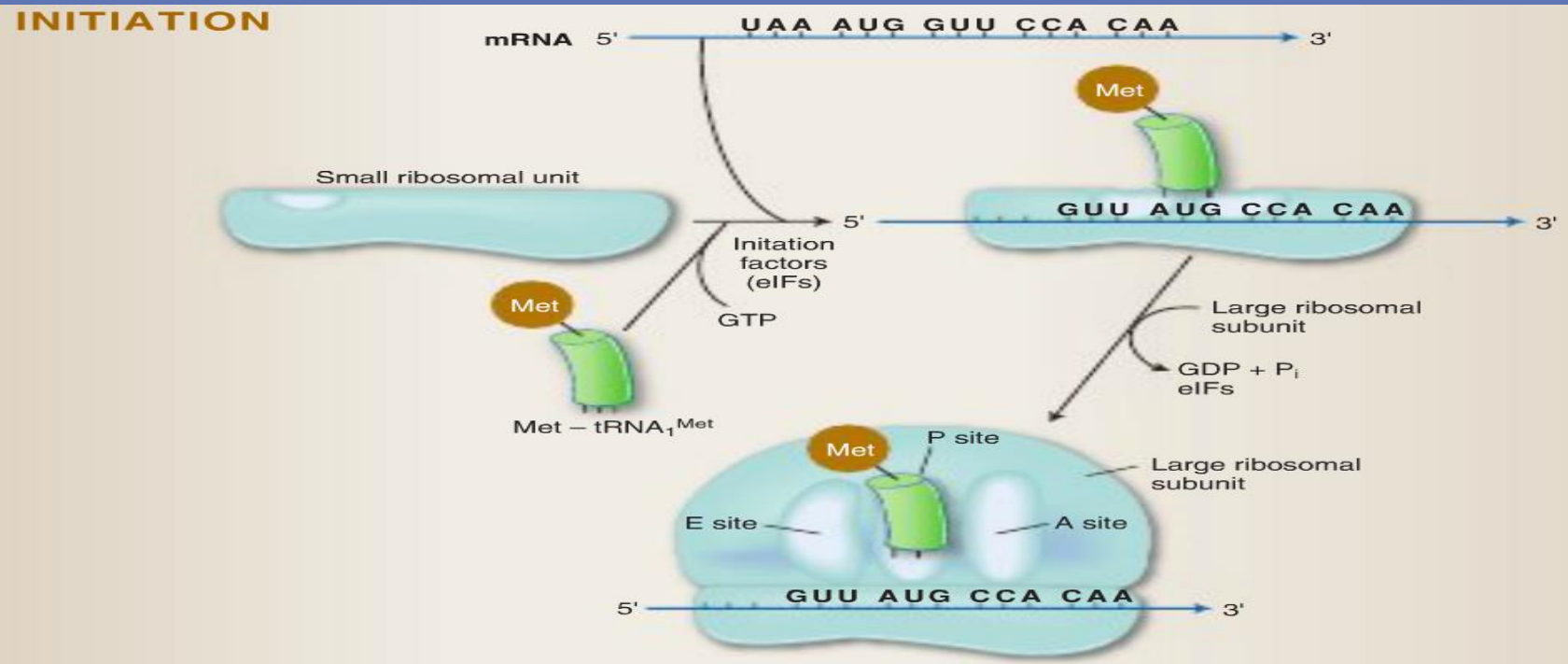
Components required for Translation:

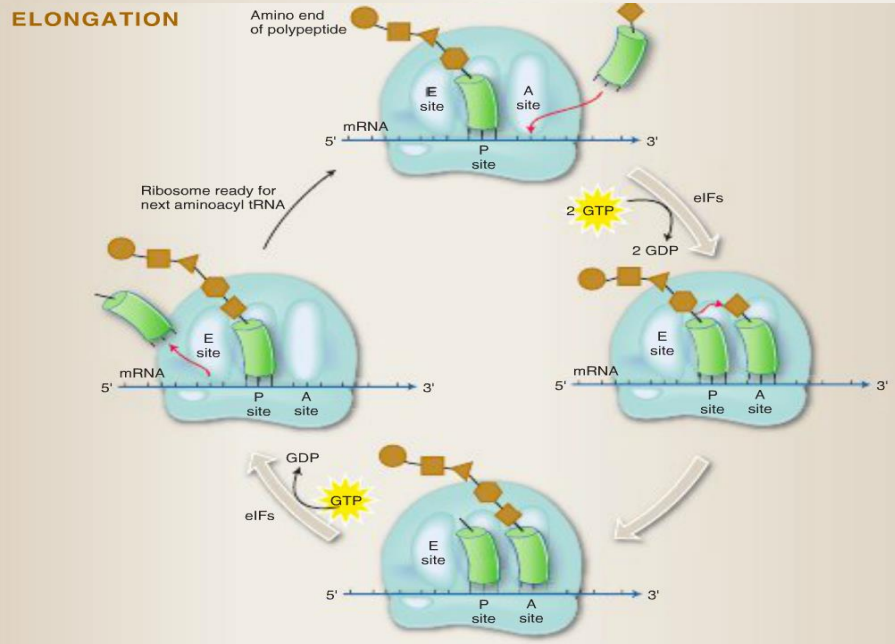


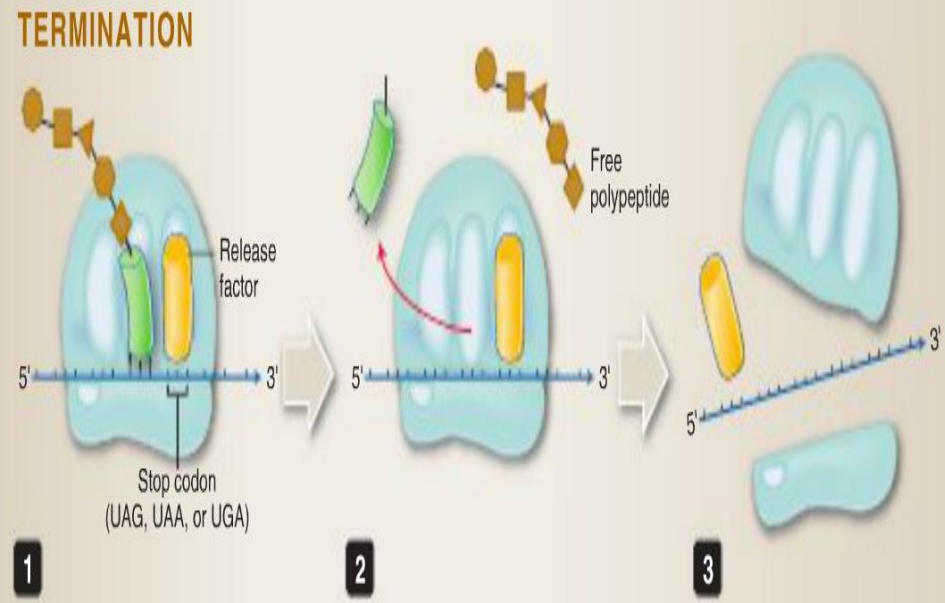
Steps protein synthesis:

- Synthesizing protein by Ribosomal RNA from mRNA. mRNA has codes present protein.

Steps	Details
1)Chain initiation	• Combination of Ribosomes, mRNA and tRNA together • The first tRNA binds to AUG (start codon)
2)Chain elongation	The second tRNA bind to A-site of ribosome Peptide bond formation takes place between two amino acids P-site tRNA is empty and leaves the ribosome A-site tRNA carries the growing protein chain and moves to P-site (translocation)
3)Chain termination	mRNA contains stop codons (UAA,UAG,UGA) When ribosomes reads any stops codon the translation is terminated


INITIATION
mRNA 5'
UAA AUG GUU CCA CAA
3'
Met
Small ribosomal unit
5'
GUU AUG CCA CAA
3'
Initation factors (eIFs)
GTP
Met
Large ribosomal subunit
GDP + Pi
eIFs
Met – tRNA1Met
Met
P site
Large ribosomal subunit
E site
A site
5'
GUU AUG CCA CAA
3'


ELONGATION
Amino end of polypeptide
E site
A site
mRNA
5'
3'
P site
Ribosome ready for next aminoacyl tRNA
2 GTP
eIFs
2 GDP
GDP
GTP
eIFs


TERMINATION
Release factor
Free polypeptide
5'
3'
Stop codon (UAG, UAA, or UGA)
1
2
3

Videos

- 1) A nice video talking about the central dogma.. it has little detail but it is very good.
- http://www.youtube.com/watch?v=yqESR7E4b_8
- 2) DNA Replication animation
- http://www.youtube.com/watch?v=vNXFk_d6y80
- 3)DNA Transcription animation
- http://www.youtube.com/watch?v=WsofH466lqk
- 4)DNA Translation animation
- http://www.youtube.com/watch?v=Nm5yzrd28rs
- 5) Transcription and translation شرح
- http://www.youtube.com/watch?v=6YqPLgNjR4Q

- Quiz:
- https://www.examtime.com/en/p/1465062

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