PROTEIN SYNTHESIS

Proteins are built up from about 20 types of amino acids. These amino acids are linked up together by peptide bond forming a long chain known as Polypeptides. The sequence of amino acids are definite for a particular protein.

The basic mechanism of protein synthesis is that DNA makes RNA, which in turns makes protein.

The central dogma of protein synthesis is as:

$$DNA \xrightarrow{\text{Replication}} DNA \xrightarrow{\text{Transcription}} RNA \xrightarrow{\text{Translation}} Protein.$$

1. Protein synthesis is broadly constitutes of two aspects

   I → Transcription.

   II → Translation.

I → Transcription :- DNA strand unwinds.

One of the two strands form an mRNA.

The nucleotides of m-RNA are complementary to template DNA strand. Uracil(U) replaces Thymine (T) of DNA. Thus A-U, C-G. complementation is formed. After complete formation m-RNA passes to cytoplasm through nuclear pore.

Transcription needs → template (Normally a DNA).

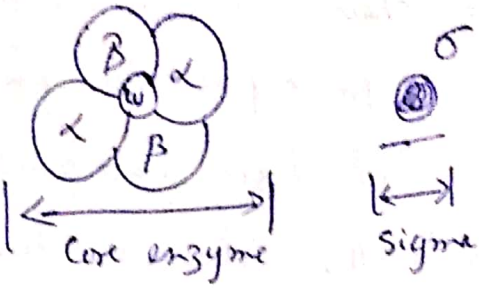
→ Ribonucleoside triphosphates (ATP, GTP, UTP & CTP).

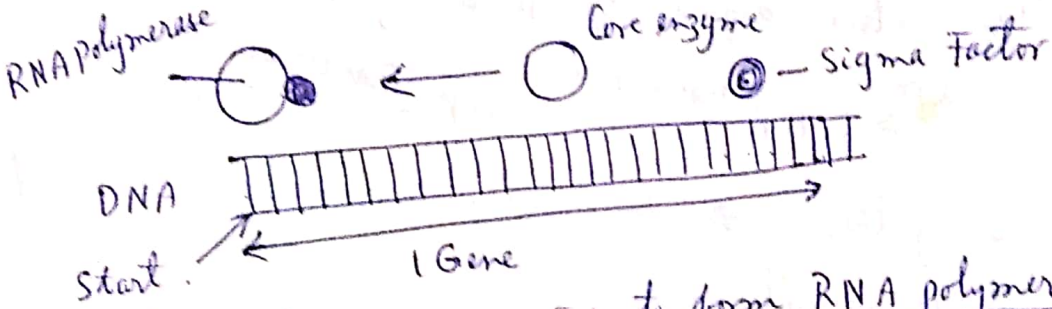
→ The enzyme RNA polymerase and

→ Divalent metal ions.

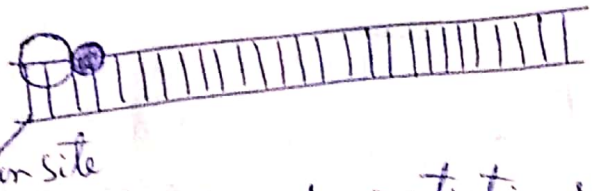
- RNA polymerase consists of a core enzyme, with sub-units $\alpha, \alpha, \beta, \beta, \omega$ and a sigma (σ) factor.
- This sigma (σ) factor initiates transcription of m-RNA on DNA template and the core enzyme consitute transcription.

→ All RNA chains which start with PPP G or PPP A
→ They are synthesized in 5'→3' direction.
→ Rho ρ(P) factor is required for termination of m-RNA synthesis.

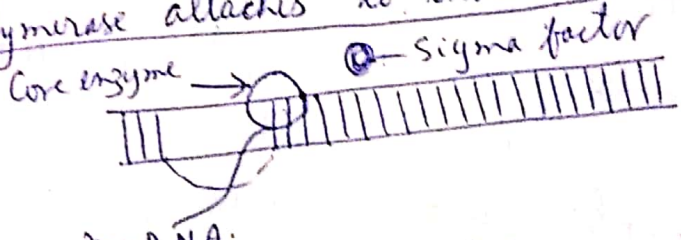




[A] Sigma factor and core enzyme join to form RNA polymerase

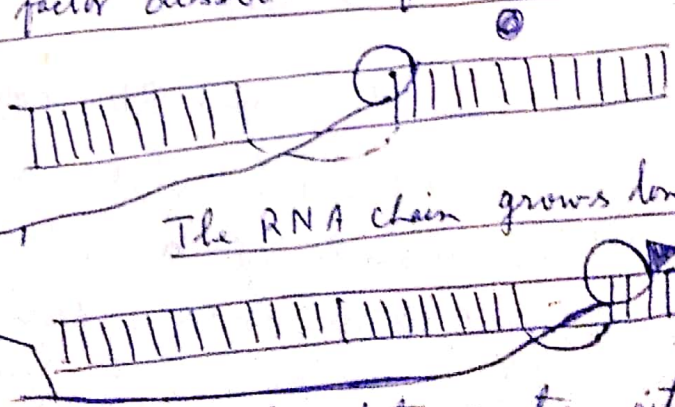


[B] RNA polymerase attaches to initiation site.



[C] DNA unwinds and core enzyme catalyses synthesis of m-RNA.
Sigma factor dissociates from core enzyme.

[D]



[E] Termination of chain growth at termination site by rho factor.

II TRANSLATION:

The m-RNA has a series of triplet bases, known as codons, which pair with triplets of anticodons on t-RNA. Triplets of m-RNA are according to a series of bases on DNA. Triplets of tRNA ~~arranged~~ come in contact ~~with~~ in accordance with triplets of m-RNA. Hence series of amino acids are according to m-RNA and DNA in turn. So it may be said that proteins are according to amino acid chains or m-RNA or DNA. ~~The genetic information present on m-RNA~~

The process of translation involves:-

(a) Activation of amino acids.
(b) Transfer of activated amino acid to t-RNA.
(c) Initiation of polypeptide chain synthesis.
(d) Chain elongation
(e) Chain termination.

(a) Activation of amino acids:- The amino acids (aa) used in protein synthesis are activated by ATP. ~~forming~~ Aminoacyl adenylates (aaa) or aminoacyl AMP is formed. In this reaction pyrophosphates (PPi) are released. ~~The enzyme mediate this~~ Amino acyl synthetase (E) ~~acti~~ is the specific activating enzyme which mediate this reaction.

$$aa + ATP + E \longrightarrow E.aa\text{-}AMP + PPi.$$

(b) Transfer of activated amino acids to t-RNA: The activated aminoacids is transfered to the specific t-RNA. The activating enzyme and AMP are released.

$$E.aa\text{-}AMP + t\text{-}RNA \longrightarrow aa\text{-}t\text{-}RNA + AMP + E.$$

(c) Initiation of Chain Synthesis:- This process require:

i) sub-units of ribosomes.
ii) m-RNA.
iii) ~~an~~ a source of energy GTP.
iv) activated aminoacids attached to t-RNA.
v) Initiation factor (IF).

→ In prokaryotes these initiation factors are— IF-1; IF-2 and IF-3.

→ In eukaryotes these initiation factors are — eIF-2; eIF-2'; eIF-2a; eIF-2a$_2$ eIF-2a$_3$ and eIF-3.

This process goes on as follows:

→ The 30S sub unit of ribosome attaches to m-RNA to form an m-RNA-30S complex, with the help of IF-3 and Mg^{++}.

→ Initiation codon is generally AUG. which attaches to anticodon UAC on t-RNA forming 30-S initiation complex, with the help of initiation factors IF-2; IF-3 and GTP as source of energy.

— The first amino acid is N-formyl methionine (f-met) in prokaryotes and methionine in eukaryotes.

→ The 50-S sub unit of ribosomes joins to 30-S initiation complex to form the complete initiation complex (70-S).

→ The larger sub-unit of ribosomes has two binding sites for t-RNA — x) A-site or Acceptor site and
x) P-Site or Peptidyl site

f-met-t RNA binds to the P site.