TRANSCRIPTION, TRANSLATION & EFFECT OF MUTATION ON PROTEIN STRUCTURE & FUNCTION

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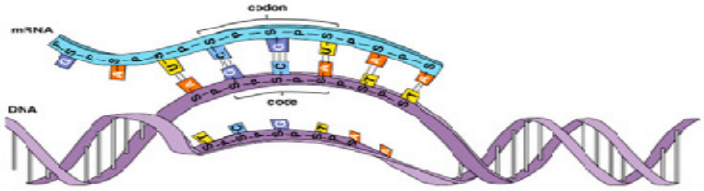
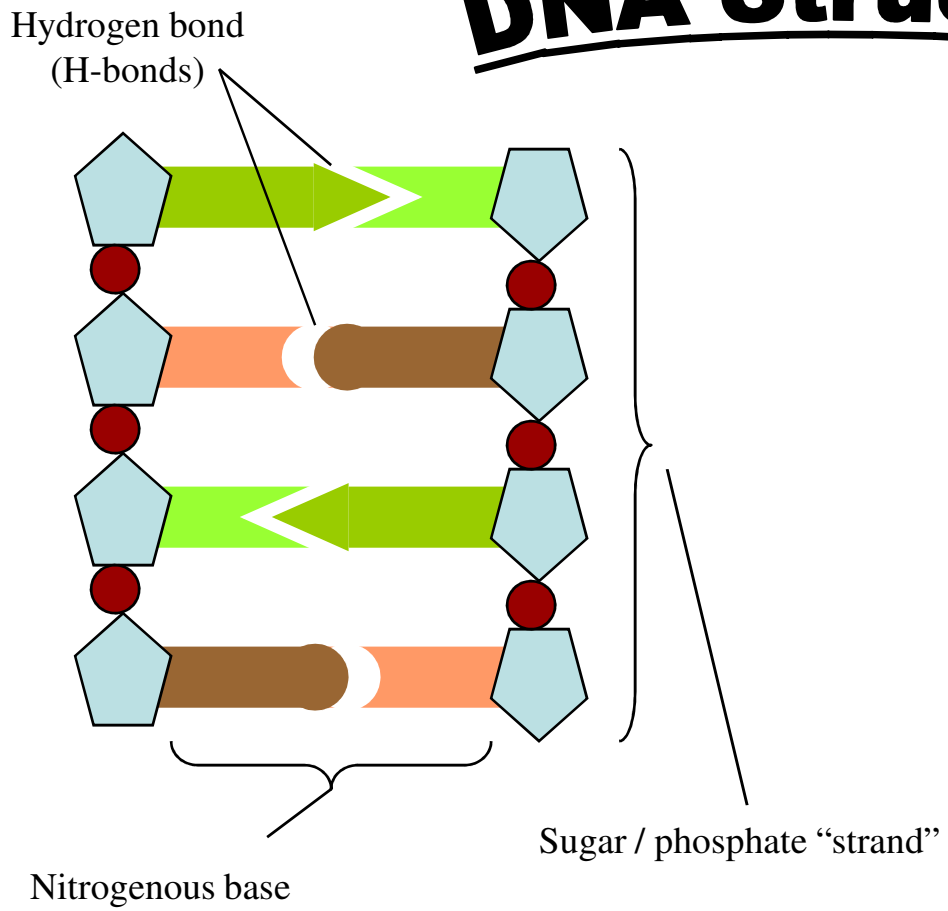
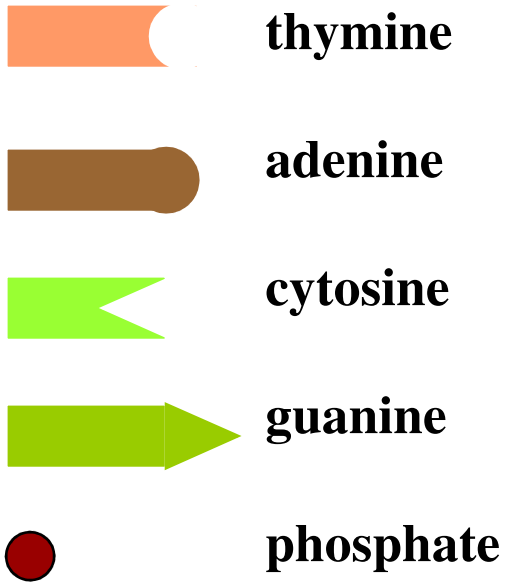
Transcription



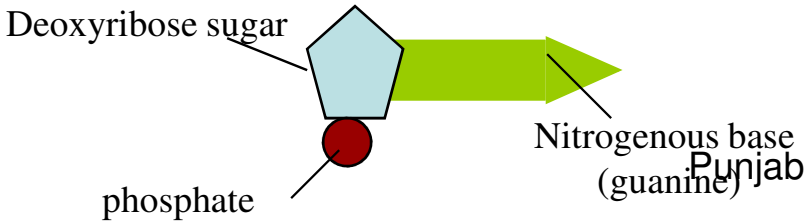
The process by which a molecule of DNA is copied into a complementary strand of RNA.

DNA Structure

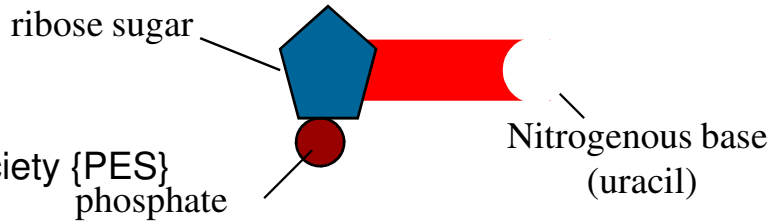




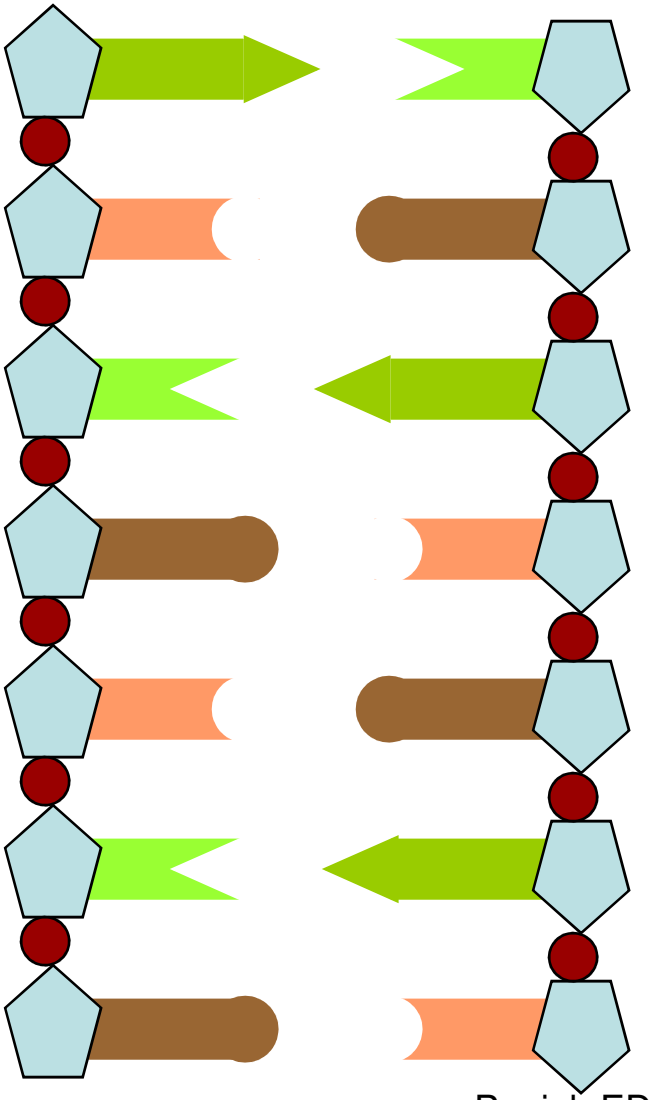
DNA nucleotide



RNA nucleotide



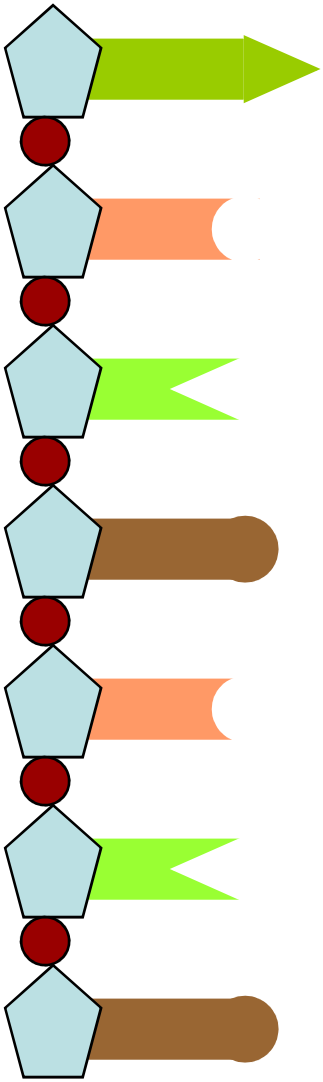
RNA Transcription



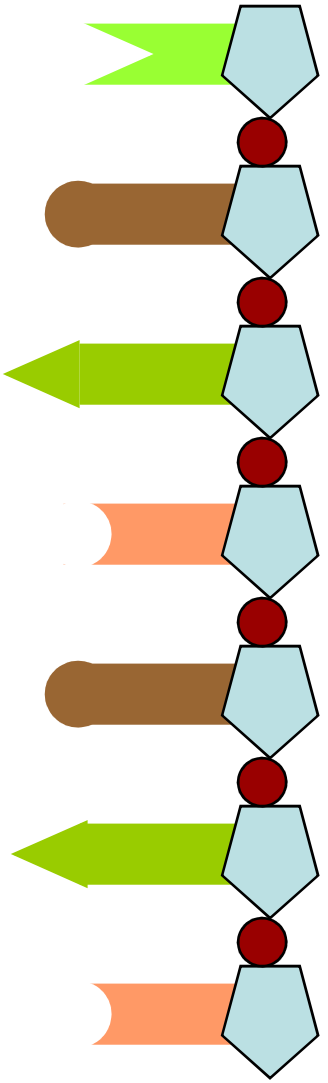
Step 1: Hydrogen bonds between complimentary bases break

DNA “unzips”

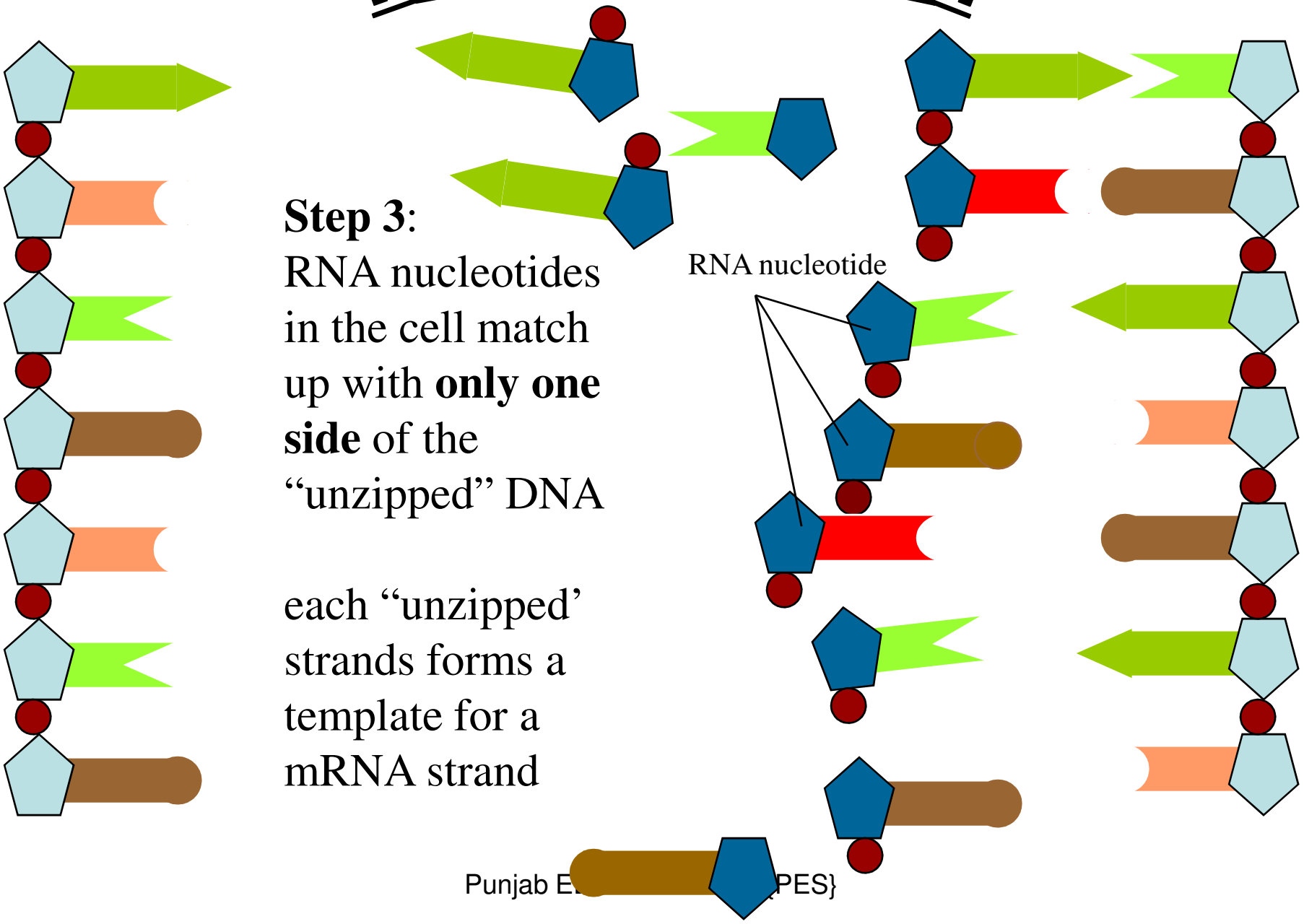
RNA Transcription



Step 2: DNA strands
pull apart from each other



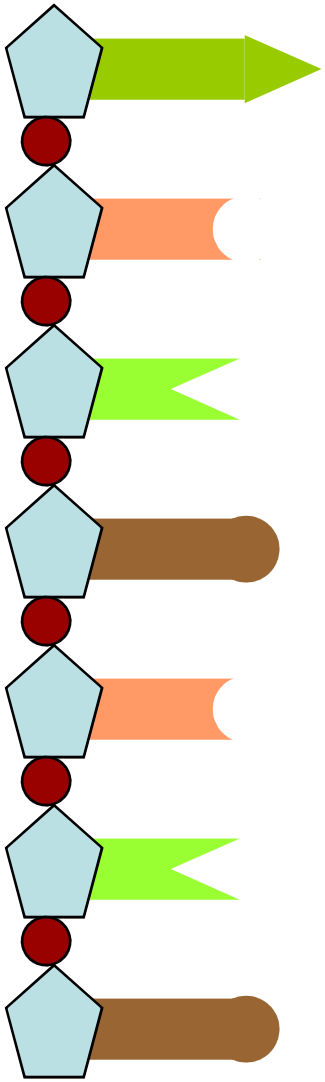
RNA Transcription



Step 3:
RNA nucleotides in the cell match up with **only one side** of the "unzipped" DNA

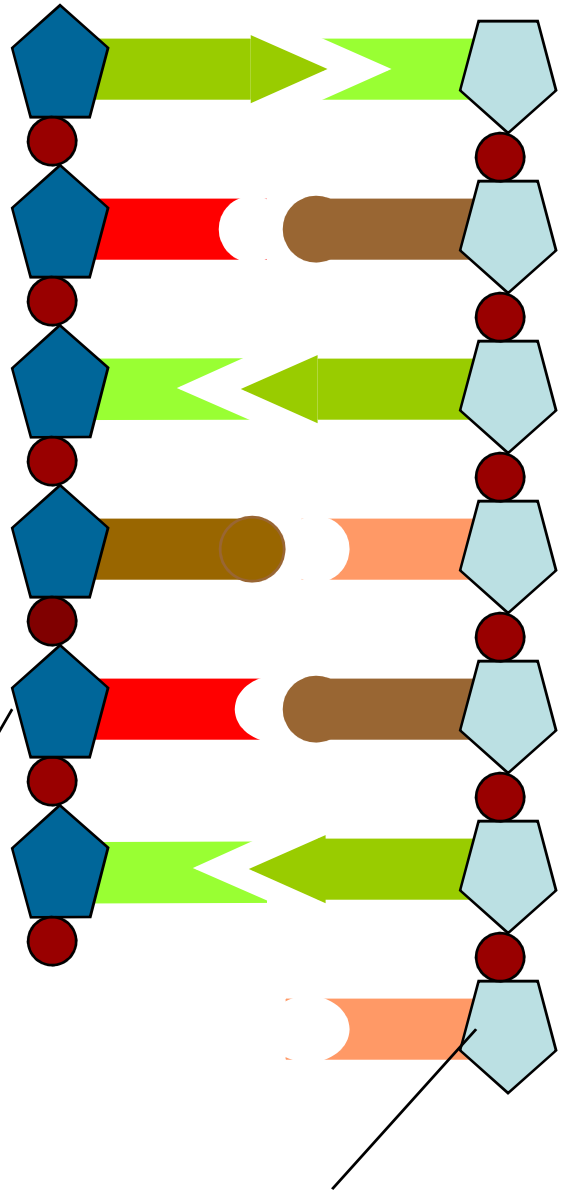
each "unzipped' strands forms a template for a mRNA strand

RNA Transcription



Step 4:
RNA nucleotides continue to match up with "unzipped" DNA

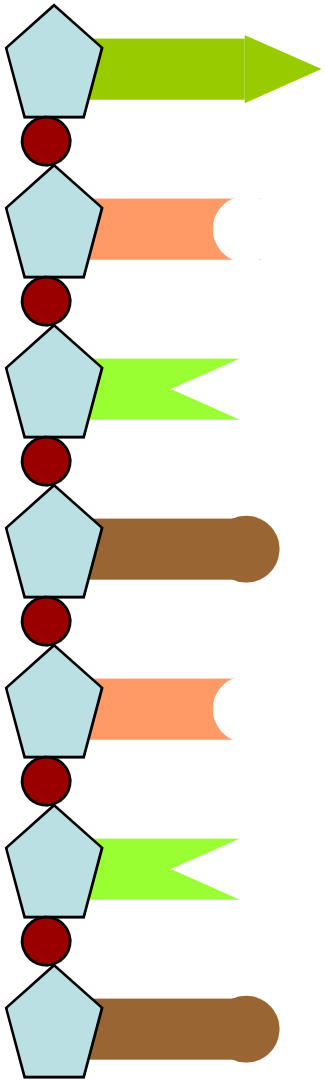
until the message is completely transcribed



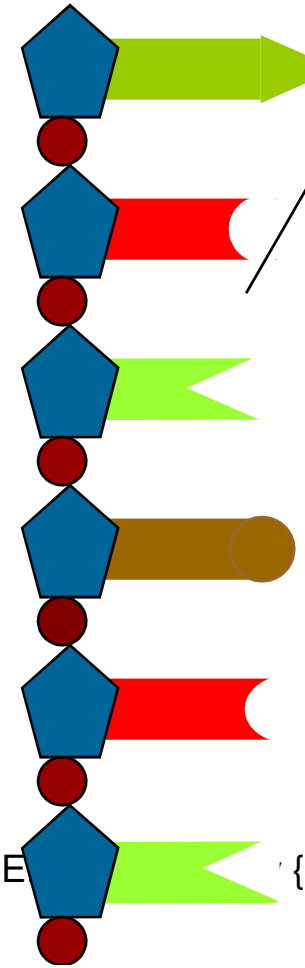
mRNA strand

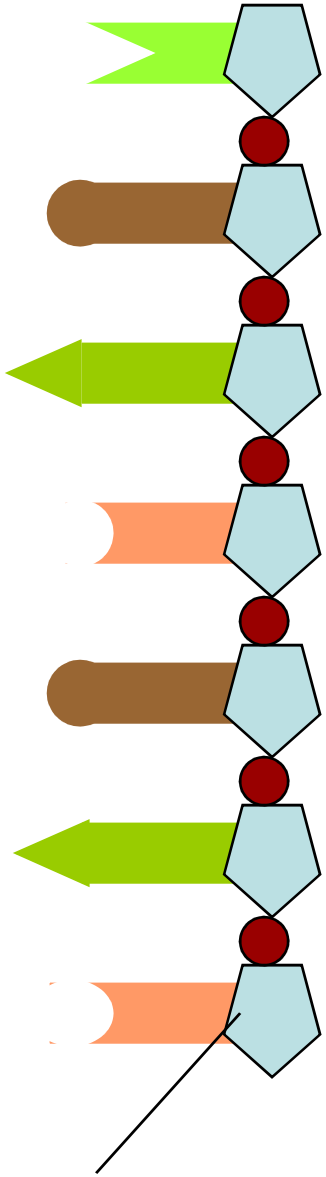
One side of DNA strand

RNA Transcription

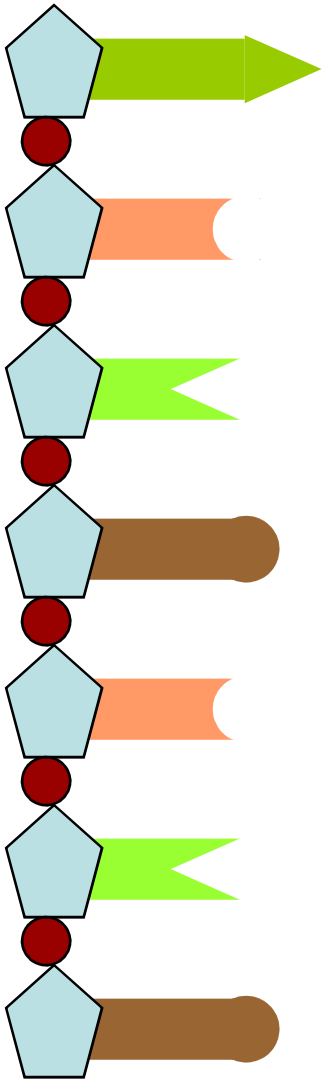


Step 4:
mRNA strand breaks off from the DNA strand

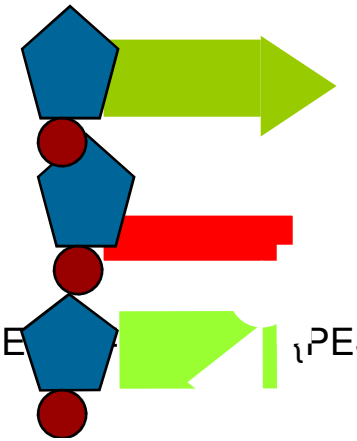


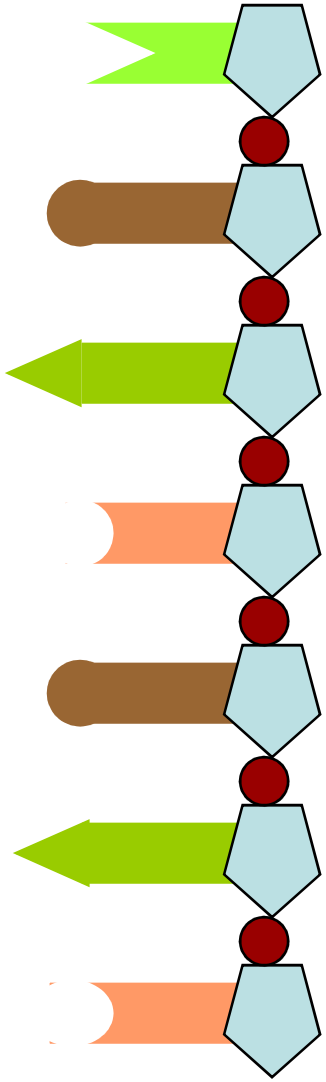


RNA Transcription

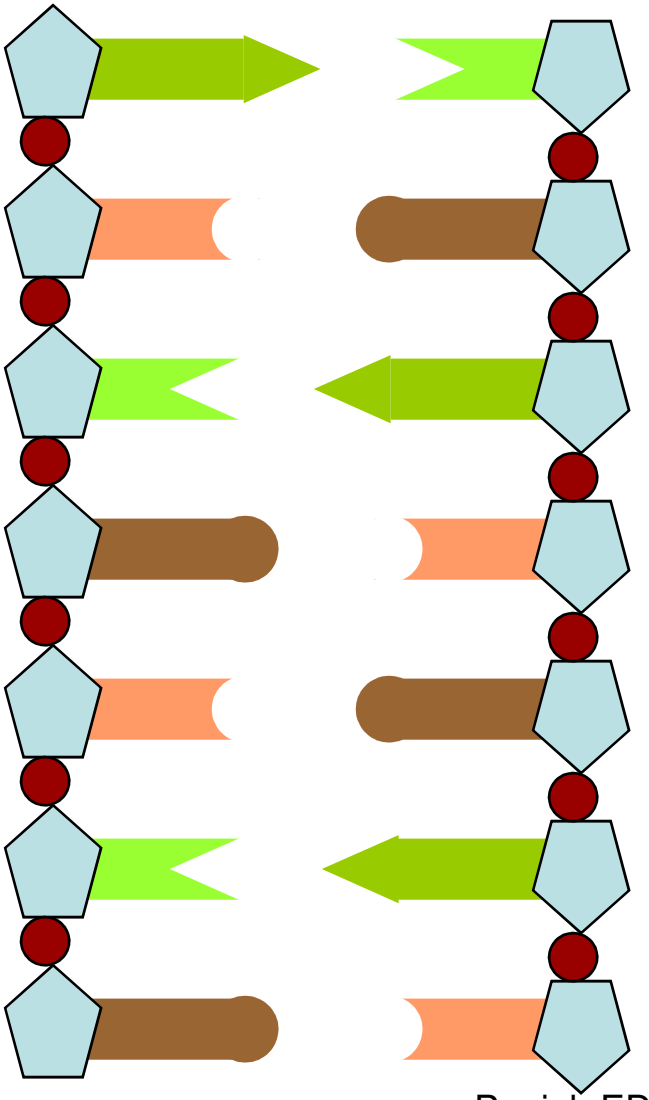


Step 5:
mRNA strand leaves the nucleus for the ribosome



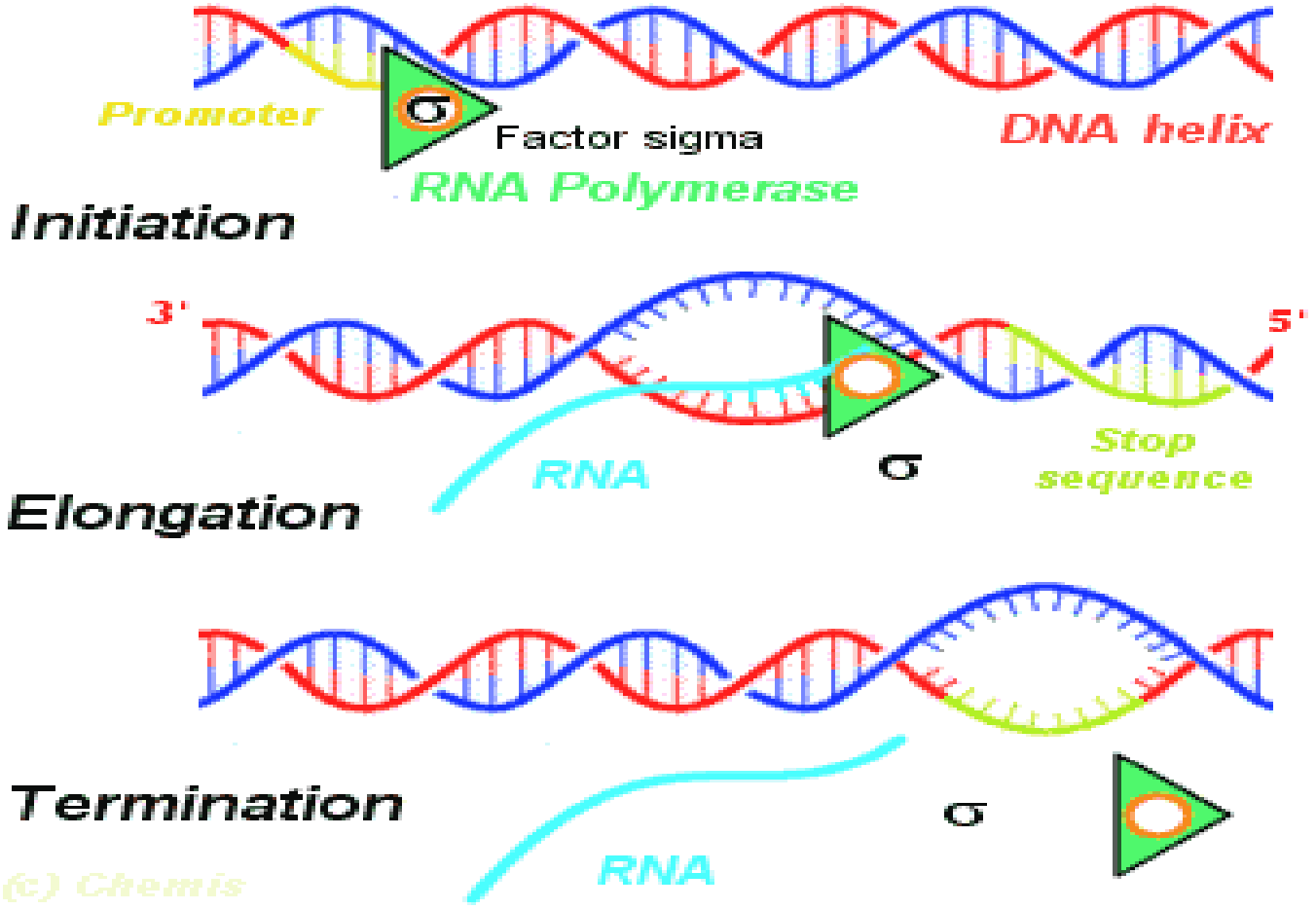


RNA Transcription



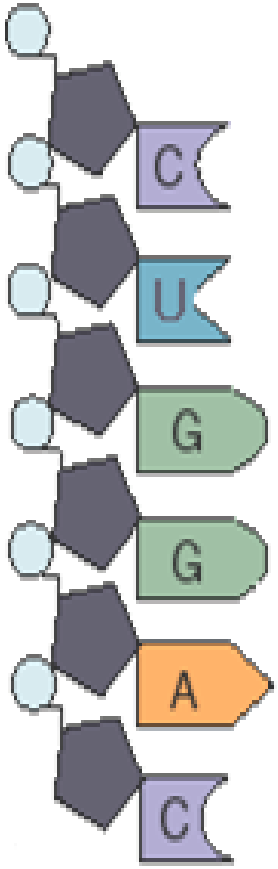
Step 6: Once the mRNA leaves, the DNA “zips” back together

Transcription Graphics



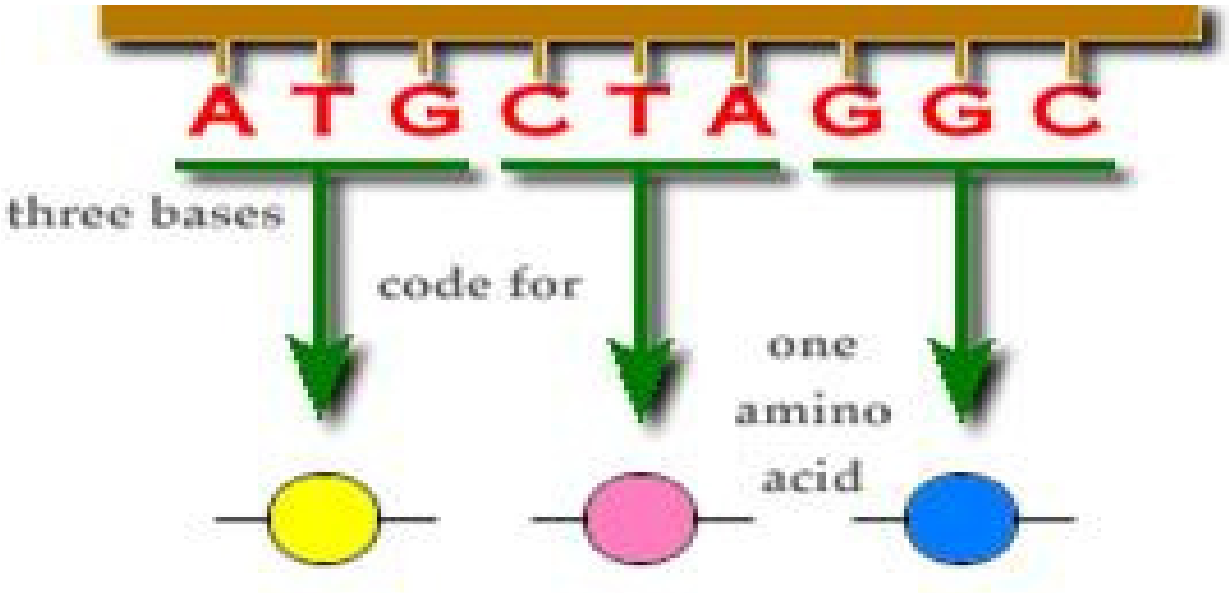
RNA and Protein Synthesis

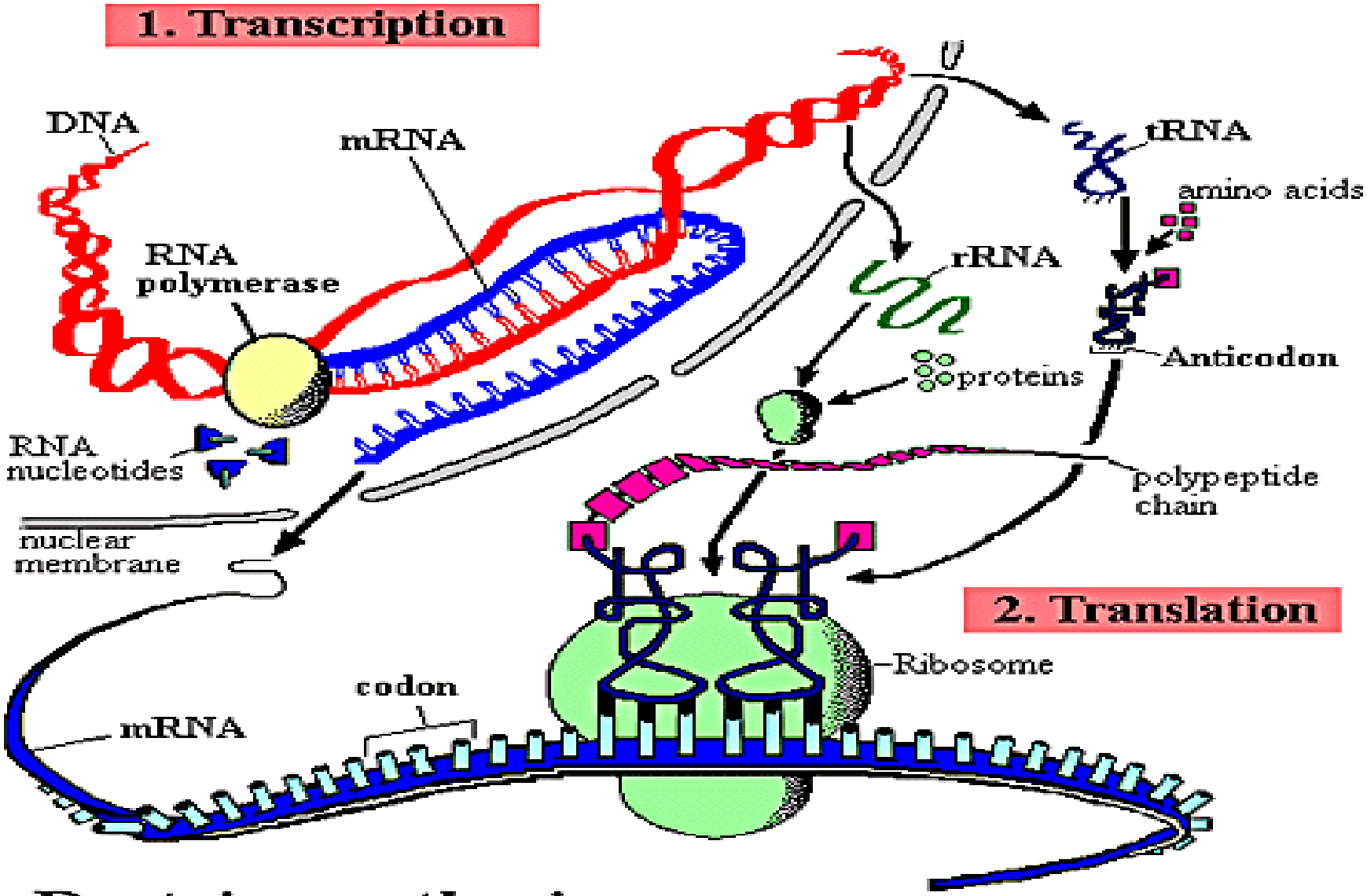
- RNA is a Single Stranded Nucleic Acid
- RNA Acts as a Messenger between DNA and Ribosomes
- Process Takes Amino Acids and Forms Proteins



TRANSLATION

Translation is the mechanism by which the triplet base sequence of an mRNA guides the linking of a specific sequence of amino acids to form a polypeptide (protein) on ribosomes.





Protein synthesis

Requirements for proteins synthesis

1. Amino acids as raw materials
2. DNA as specificity control.
3. RNAs as intermediaries.
4. Ribosomes as protein factories.

Mechanism of Protein synthesis

1. Activation of amino acids.
2. Charging of tRNA
3. Activation of ribosomes.
4. Assembly of amino acids (polypeptide formation).
   a) Initiation of polypeptide chain
   b) Elongation of polypeptide chain
   c) Termination and release of polypeptide chain
   d) Modification of released polypeptide chain

Activation of amino acids

Amino acids + ATP —(Activating enzyme, Mg^{2+})→

Amino acid-AMP-Enzyme complex+ PPi

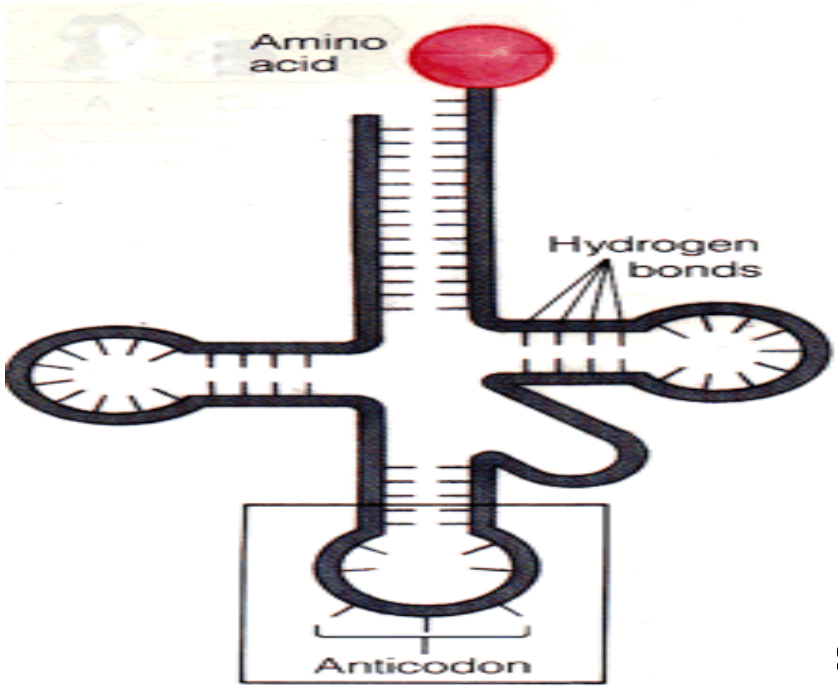
(Activated amino acid)

Charging of tRNA

Enzyme

Amino acid-AMP-Enzyme complex + tRNA ⟶

tRNA- Amino acid complex + ATP + Enzyme



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RNA Used in Protein Synthesis

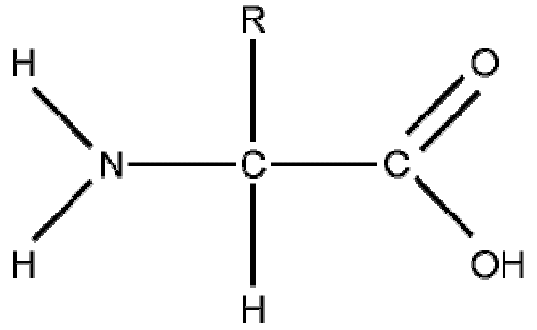
- Messenger RNA (mRNA).
- Ribosomal RNA (rRNA).
- Transfer RNA (tRNA).

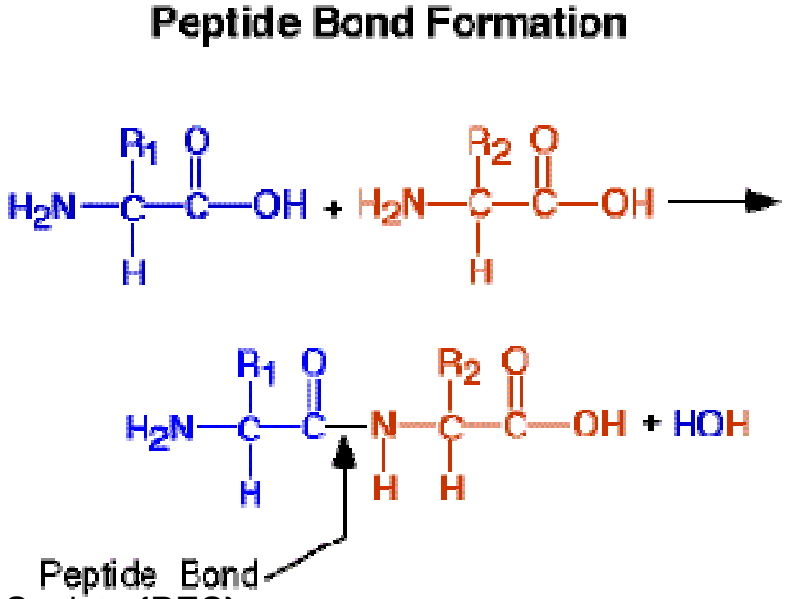
Proteins

- Proteins are composed of one or more polypeptides.
- Polypeptides are linear chains of amino acids.
- The sequence of amino acids in a polypeptide is known as its “primary structure”.

Amino Acids and Peptide Bonds

- There are 20 different amino acids coded in DNA.
- When polypeptides are synthesized, the acid group of one amino acid is attached to the amino group of the next amino acid, forming a peptide bond.





Translation

- Translation of mRNA into protein is accomplished by the ribosome, an RNA/protein hybrid. Ribosomes are composed of 2 subunits, large and small.
- Ribosomes bind to the translation initiation sequence on the mRNA, then move down the RNA in a 5' to 3' direction, creating a new polypeptide.
- Each group of 3 nucleotides in the mRNA is a "codon", which codes for 1 amino acids.

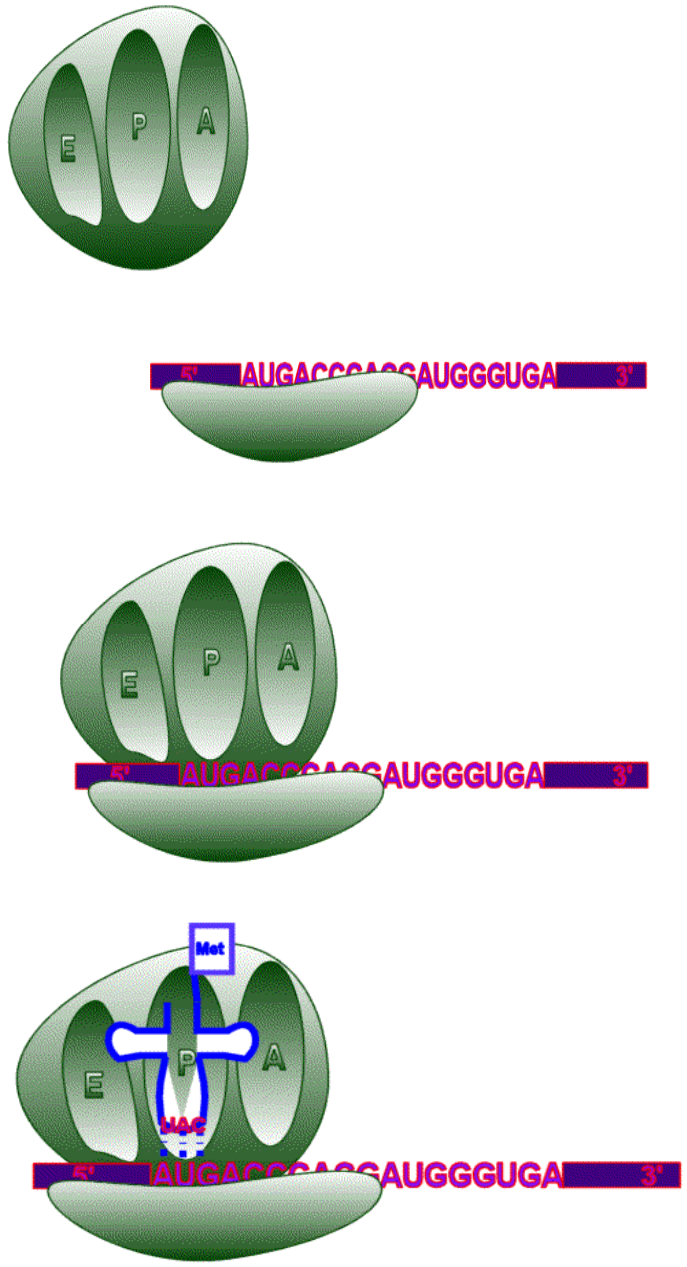
Initiation of Translation

- In prokaryotes, ribosomes bind to specific translation initiation sites. There can be several different initiation sites on a messenger RNA:

- In eukaryotes, ribosomes bind to the 5’ cap, then move down the mRNA until they reach the first AUG, the codon for methionine. Translation starts from this point. Eukaryotic mRNAs code for only a single gene.
- **Note that translation does not start at the first base of the mRNA.**

More Initiation

- The initiation process involves first joining the mRNA, the initiator methionine-tRNA, and the small ribosomal subunit. Several “initiation factors”--additional proteins--are also involved.
- The large ribosomal subunit then joins the complex.



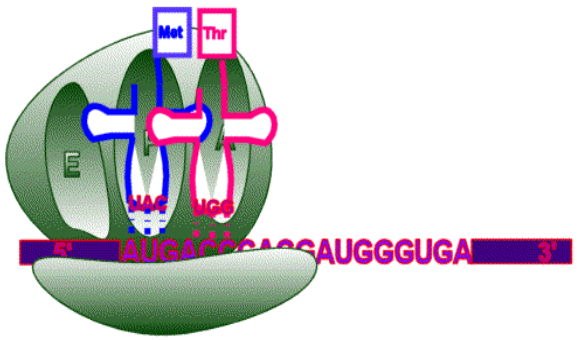
Elongation

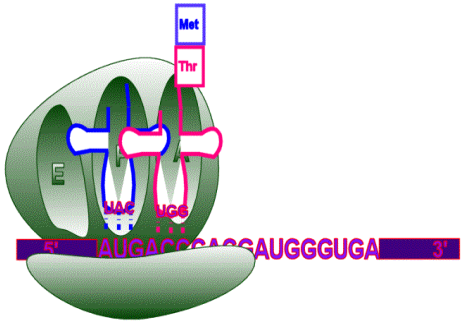
- The ribosome has 2 sites for tRNAs, called P and A.

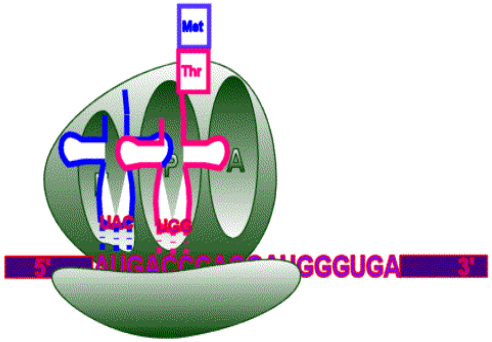
  The initial tRNA with attached amino acid is in the P site. A new tRNA, corresponding to the next codon on the mRNA, binds to the A site. The ribosome catalyzes a transfer of the amino acid from the P site onto the amino acid at the A site, forming a new peptide bond.

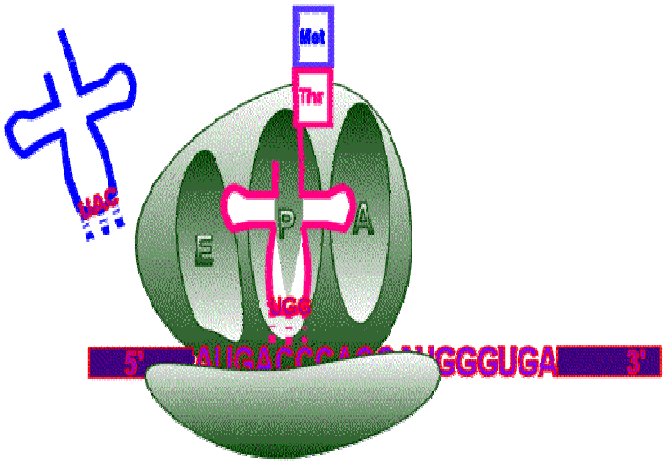
The process is then repeated:

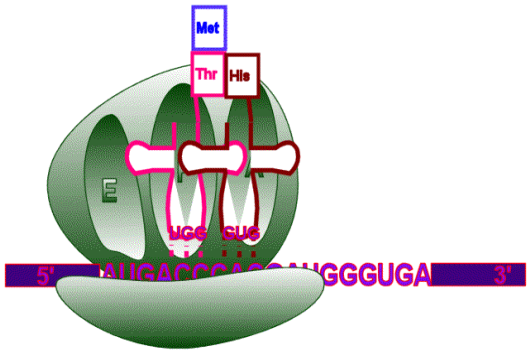
Elongation

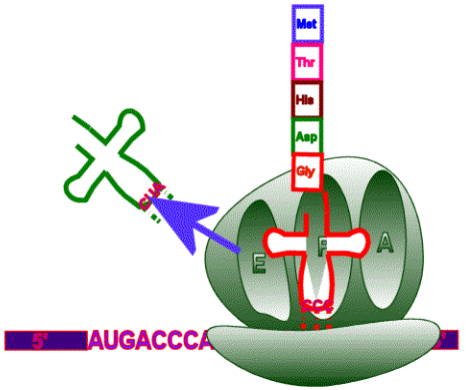

Met
Thr
E
P
A
UAC
UGG
AUGGGUGA
3'


Met
Thr
E
P
A
UAC
UGG
AUGGGUGA
3'


Met
Thr
P
A
UAC
UGG
GGGUGA
3'

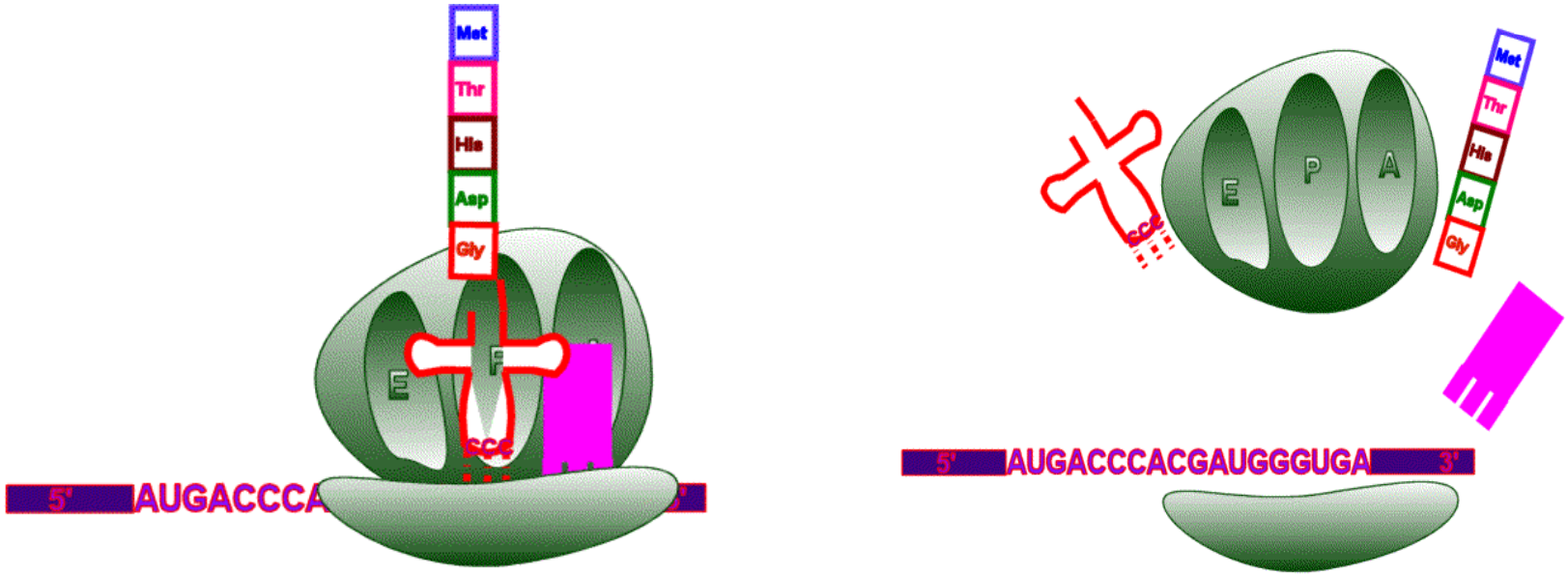

Met
Thr
UAC
E
P
A
UGG
GGGUGA
3'


Met
Thr
His
E
P
A
UGG
GUG
GGGUGA
3'


Met
Thr
His
Asp
Gly
E
P
A
GCA
AUGACCCA

Termination

- Three codons are called “stop codons”. **(UAA, UAG & UGA)** They code for no amino acid, and all protein-coding regions end in a stop codon.

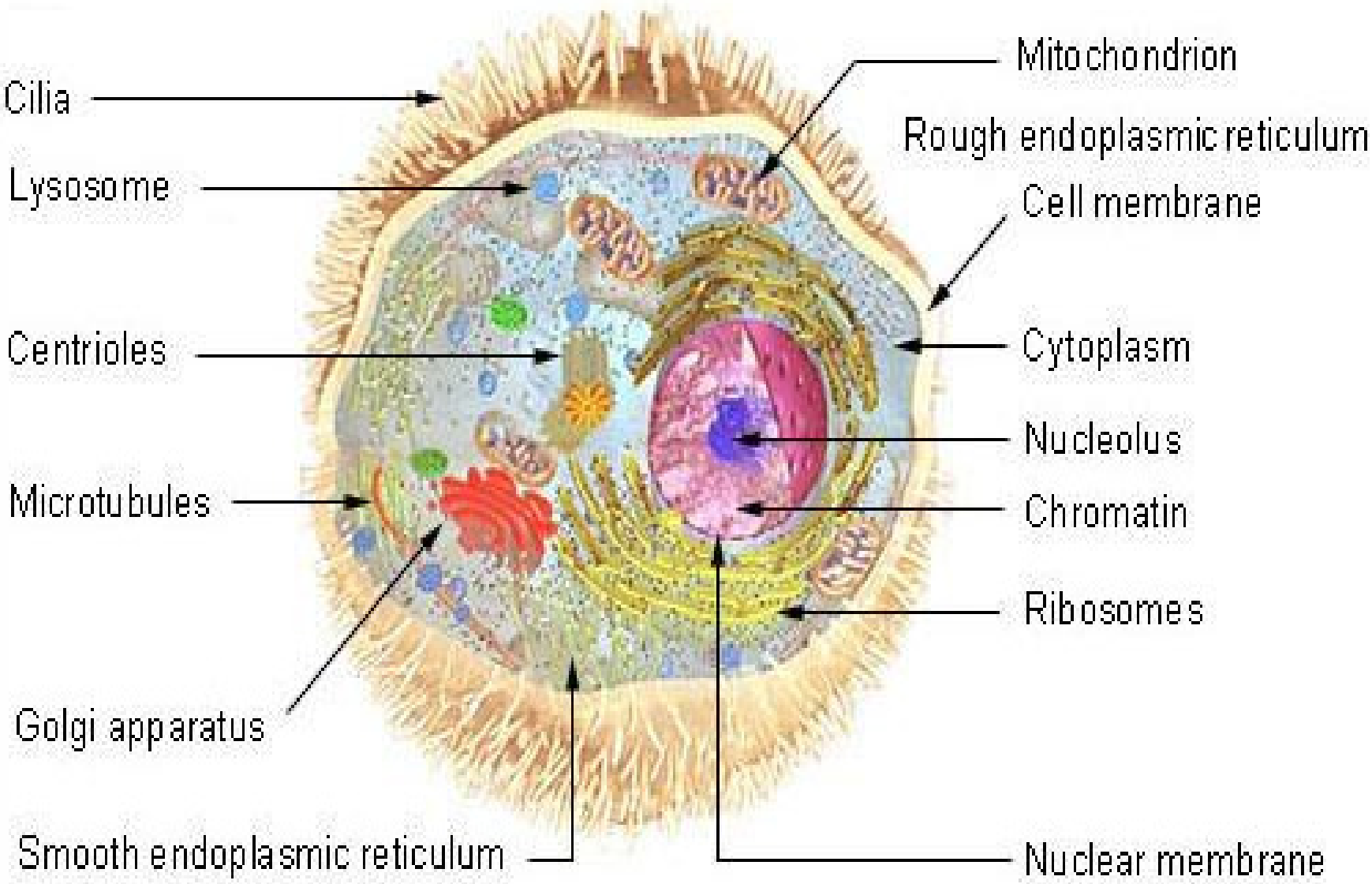


Post-Translational Modification

- New polypeptides usually fold themselves spontaneously into their active conformation.
- Many proteins have sugars, phosphate groups, fatty acids, and other molecules covalently attached to certain amino acids.
- Many proteins are targeted to specific organelles within the cell.

Why are DNA & Ribosomes located at different sites

Location of instruction centre (DNA) and manufacturing centre (ribosomes) at different sites in a cell is advantageous.


Cilia
Lysosome
Centrioles
Microtubules
Golgi apparatus
Smooth endoplasmic reticulum
Mitochondrion
Rough endoplasmic reticulum
Cell membrane
Cytoplasm
Nucleolus
Chromatin
Ribosomes
Nuclear membrane

thanks

Punjab EDUSAT Society {PES}