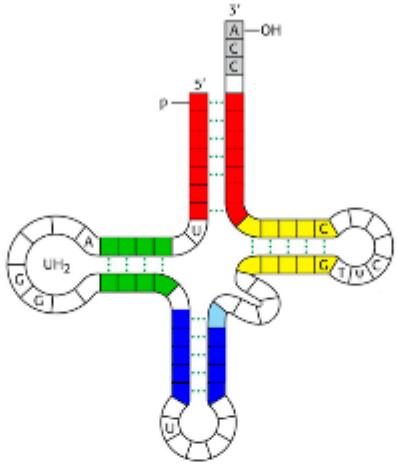


Transcription and Translation (AHL)

Protein Synthesis: Transcription and Translation

DNA (gene) —transcription (nucleus)→ mRNA (message) —translation (cytoplasm)→ polypeptide (product)

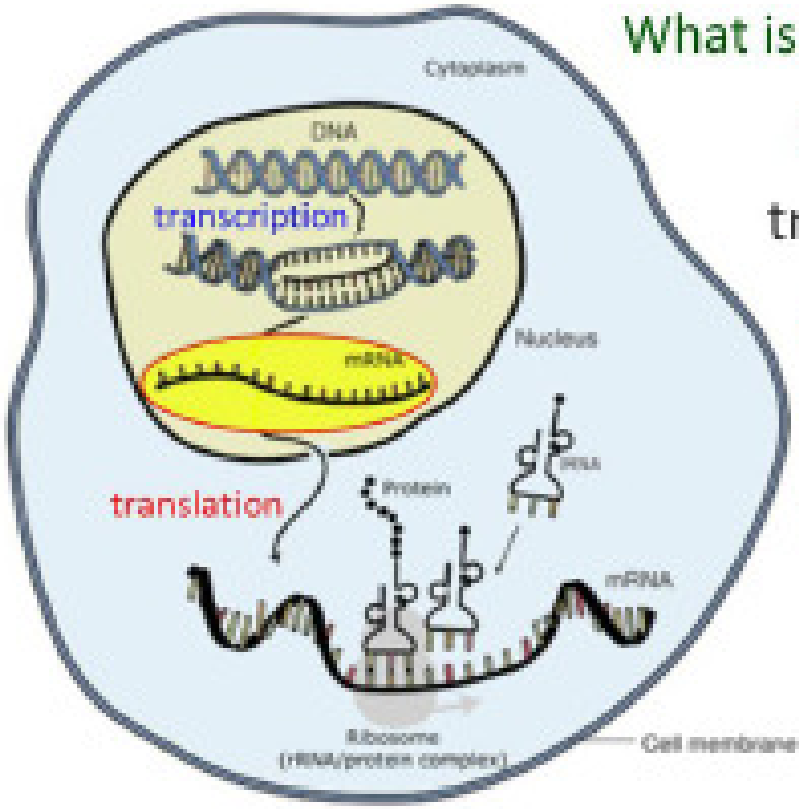


Image adapted from National Human Genome Research Institute

http://www2.geneticsolutions.com/PageReq?id=1530:1873&InPopUp=true

What is the significance of each of these terms?

sense antisense mRNA tRNA

triplet codon ribosome polysome

binding sites complementary base pairing

nucleoside triphosphates promoter regions

RNA polymerase terminator 5' - 3'

introns exons release factor

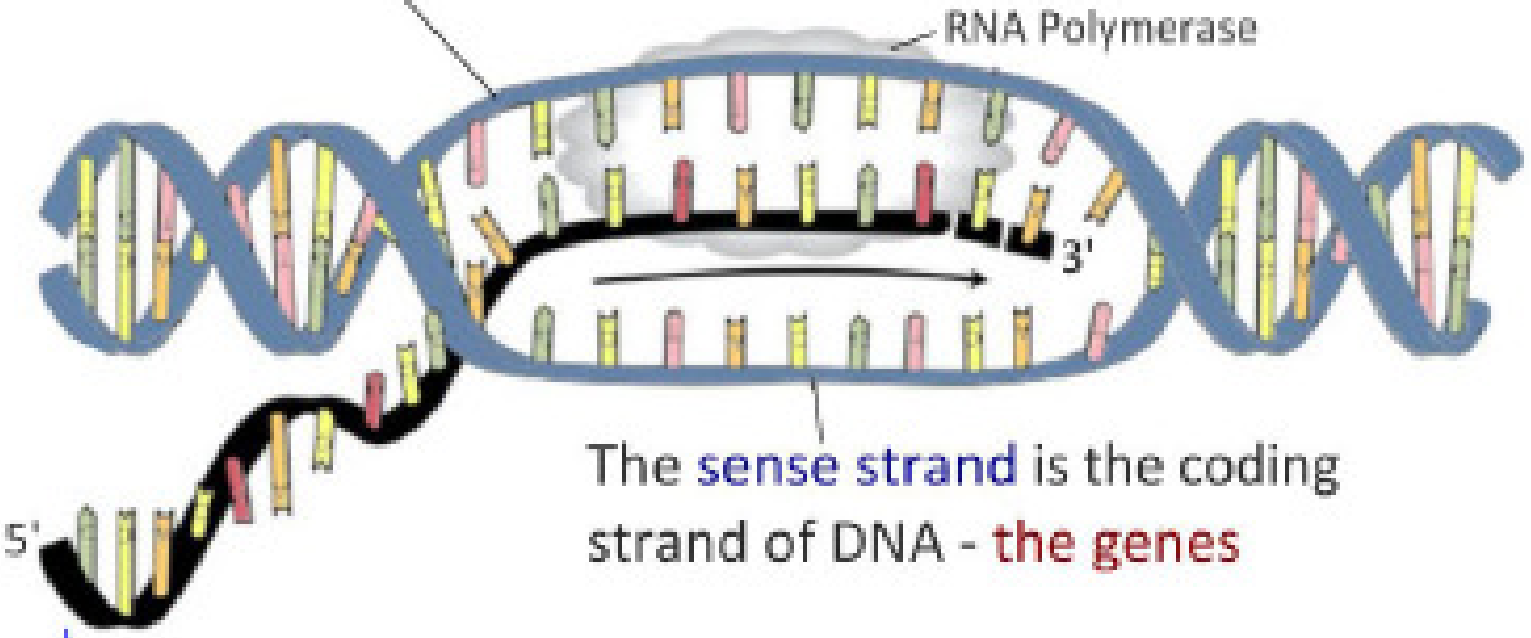
initiation elongation

translocation termination

DNA has a sense strand and an antisense strand

The antisense strand is complementary to the sense strand.

It is also known as the template strand, as this is the strand which is used for transcription - making mRNA.



The sense strand is the coding strand of DNA - the genes

By transcribing the antisense strand, the base sequence of the mRNA will be the same as the coding DNA - except U replaces T.

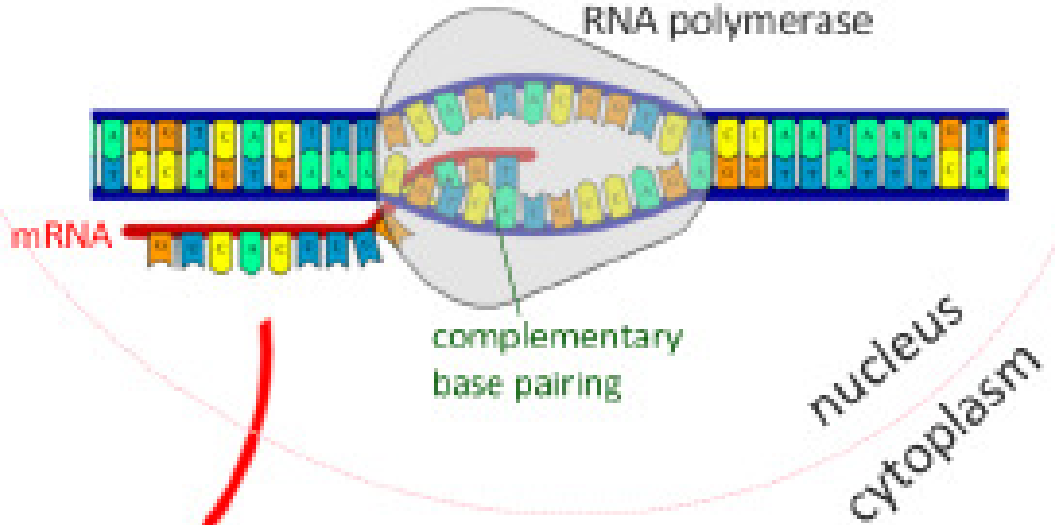
http://images1.clinicaltools.com/images/gene/antisense.jpg

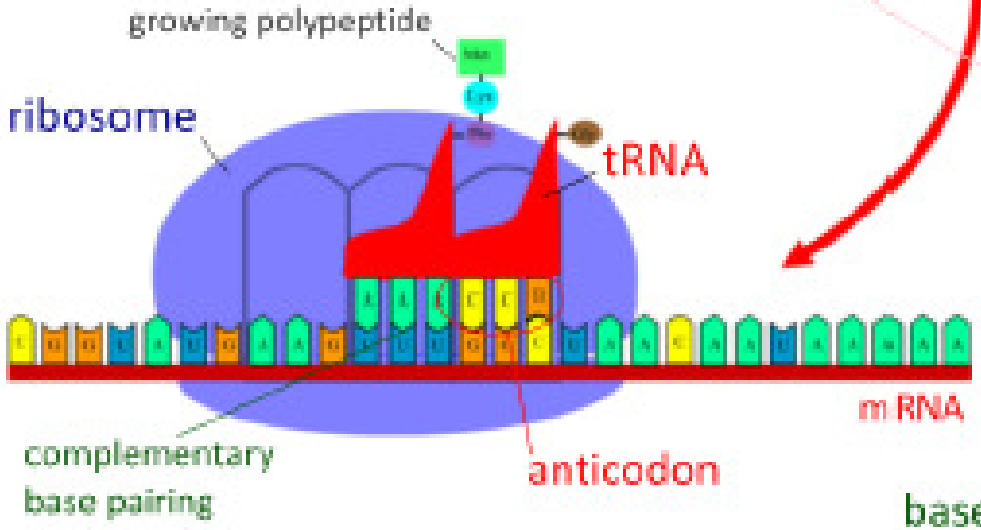
Protein Synthesis: Transcription and Translation

Transcription:

RNA polymerase makes a mRNA molecule that is complementary to the antisense strand of DNA.

(Corresponds with sense strand- although T has been replaced with U)





Translation:

mRNA is posted out of the nucleus and attaches to ribosomes.

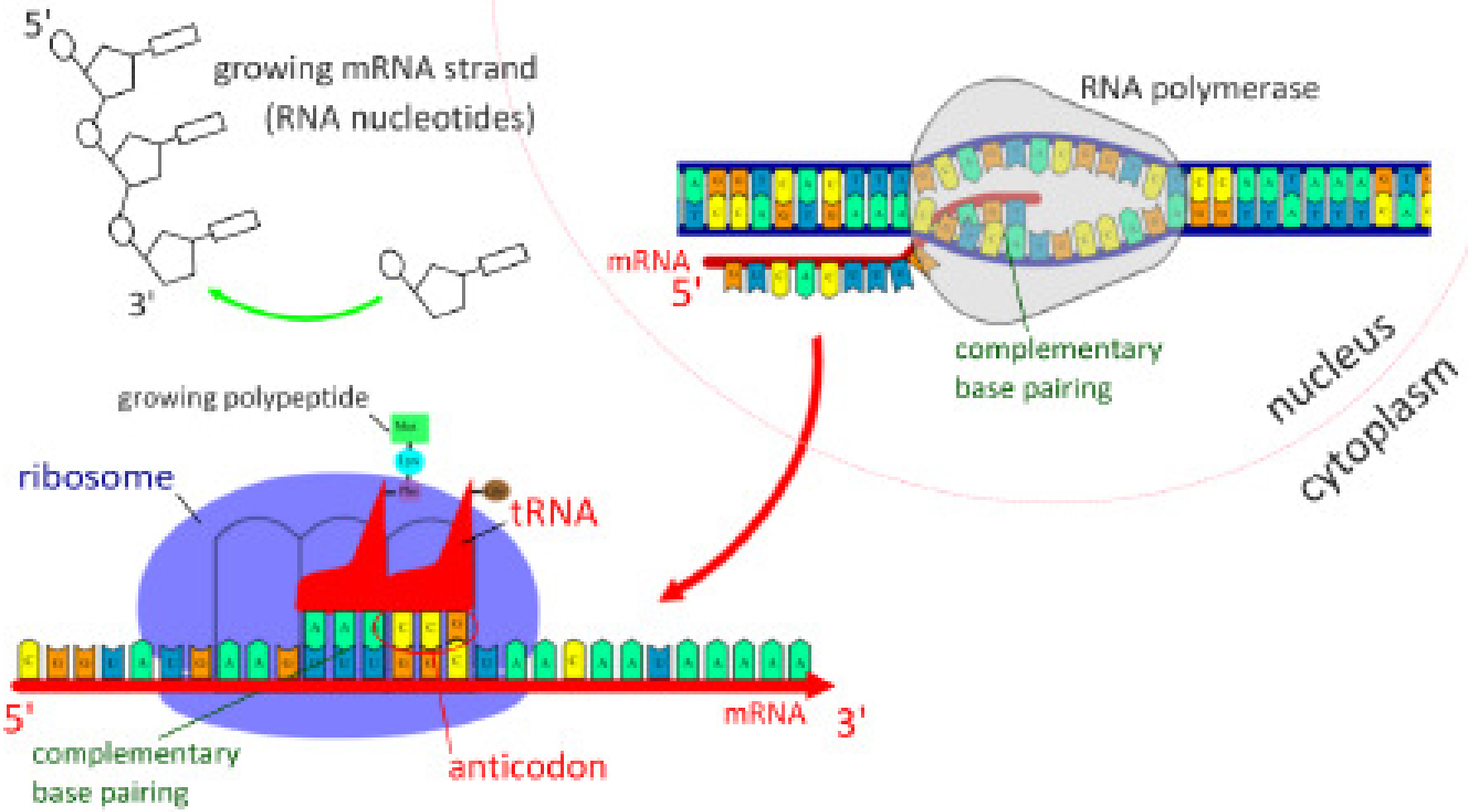
Ribosomes use complementary base-pairing to 'read' codons on the mRNA.

tRNA (transfer) molecules with corresponding anti-codons bring the correct amino acid.

Images from: http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/translation.swf

http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf

Transcription and Translation are both carried out in a 5'→3' direction



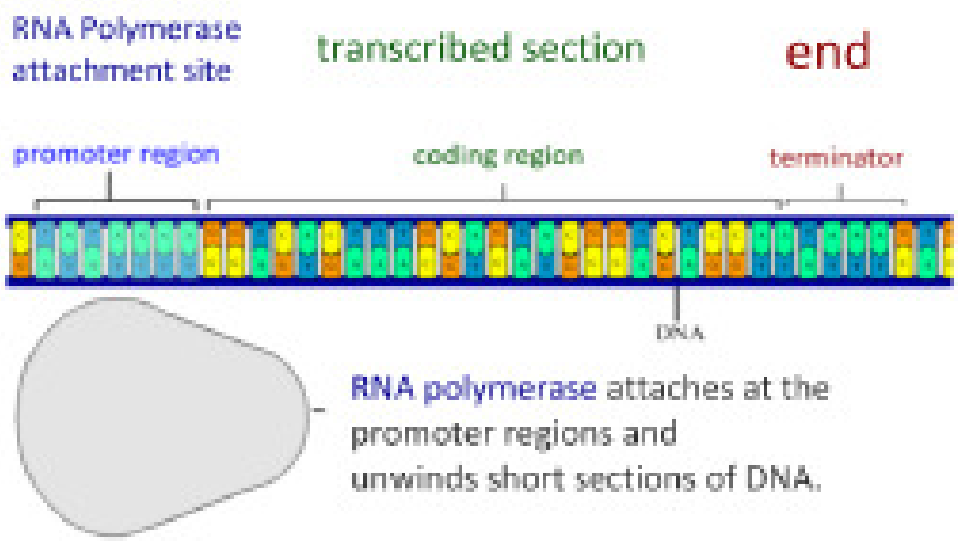
Images from:

http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/translation.swf

http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf

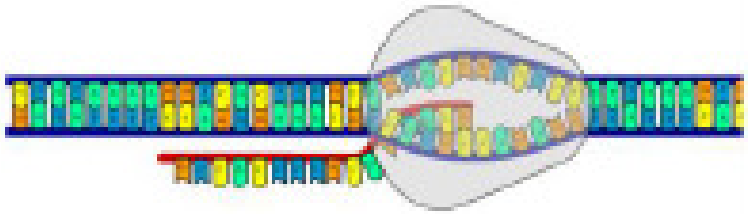
Transcription

Transcription of the gene results in an mRNA molecule which can be posted out of the nucleus. It is then translated into the polypeptide...



RNA polymerase attaches at the promoter regions and unwinds short sections of DNA.

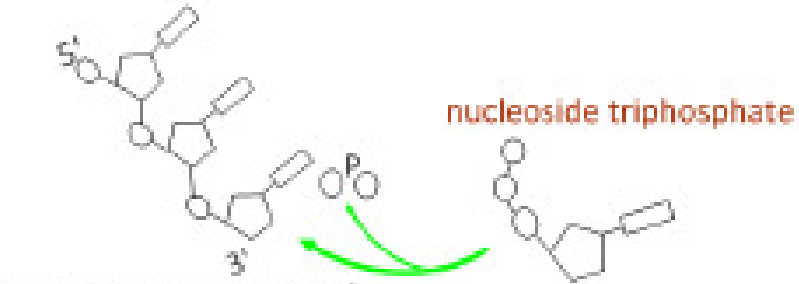
Full animation:



http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf

RNA polymerase moves along the antisense strand of DNA, using free nucleoside triphosphates to make a strand of mRNA.

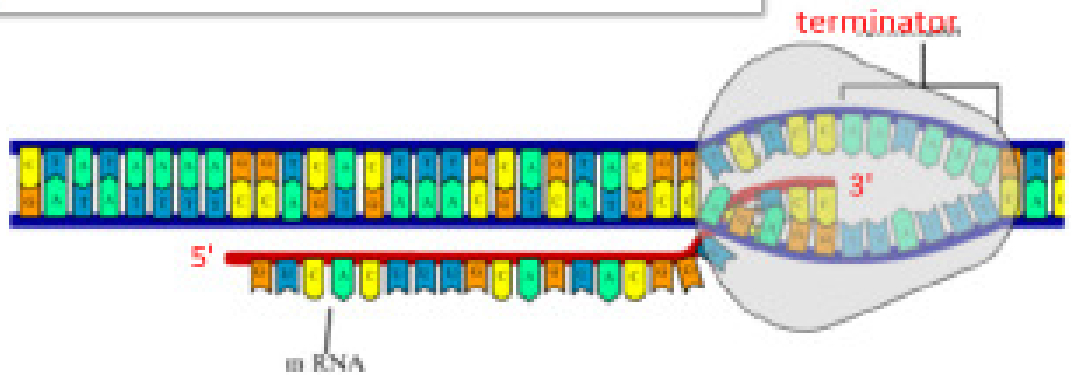
mRNA is elongated until the ribosome reaches the terminator region:



Free nucleoside triphosphates are found in the nucleus.

They are taken by the RNA polymerase and two phosphates are removed.

The resulting RNA nucleotides are added on to the 3' end of the growing mRNA strand.

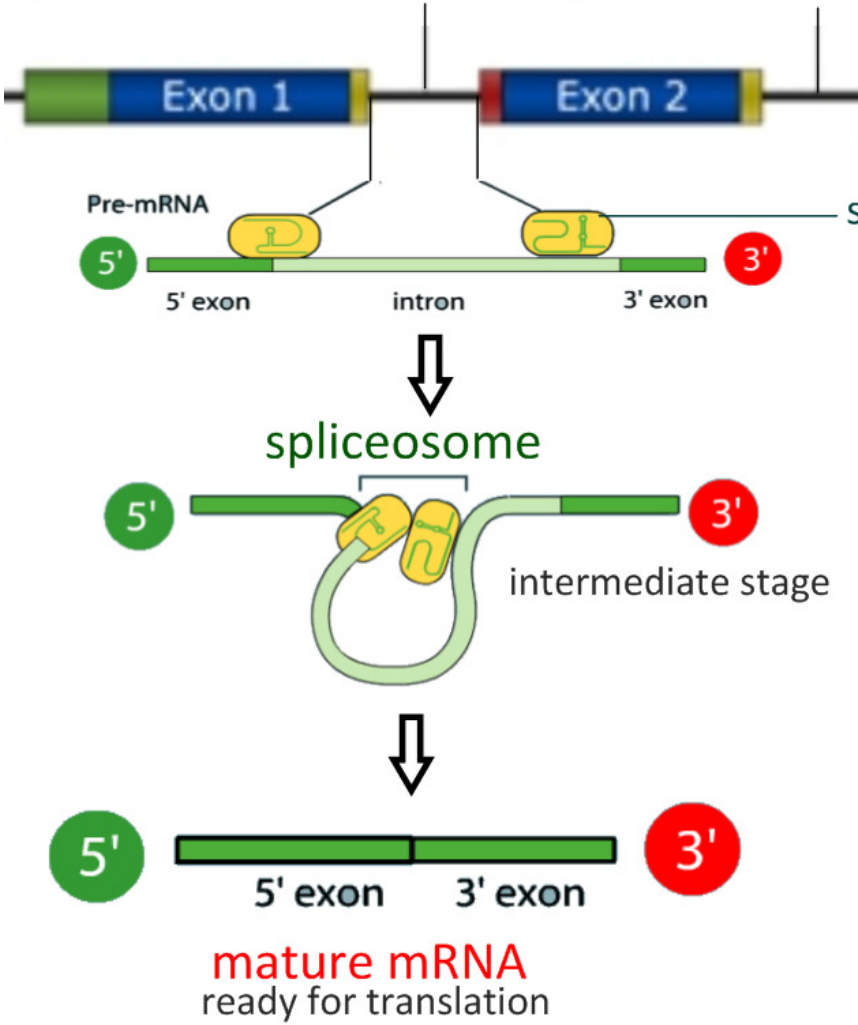


RNA polymerase detaches and releases mRNA

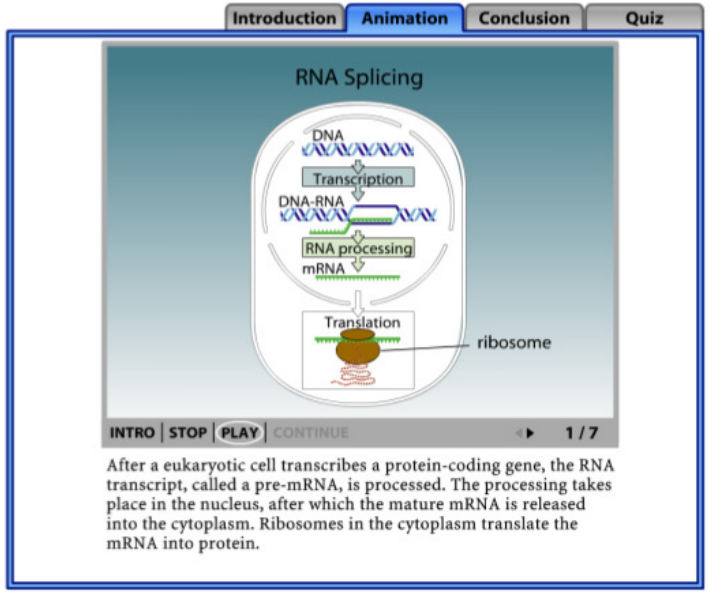
- http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf

Eukaryote pre-mRNA contains exons and introns

Introns are non-coding regions that need to be removed before translation



Find out more:



http://bcs.whfreeman.com/thelifewire/content/chp14/1401s.swf

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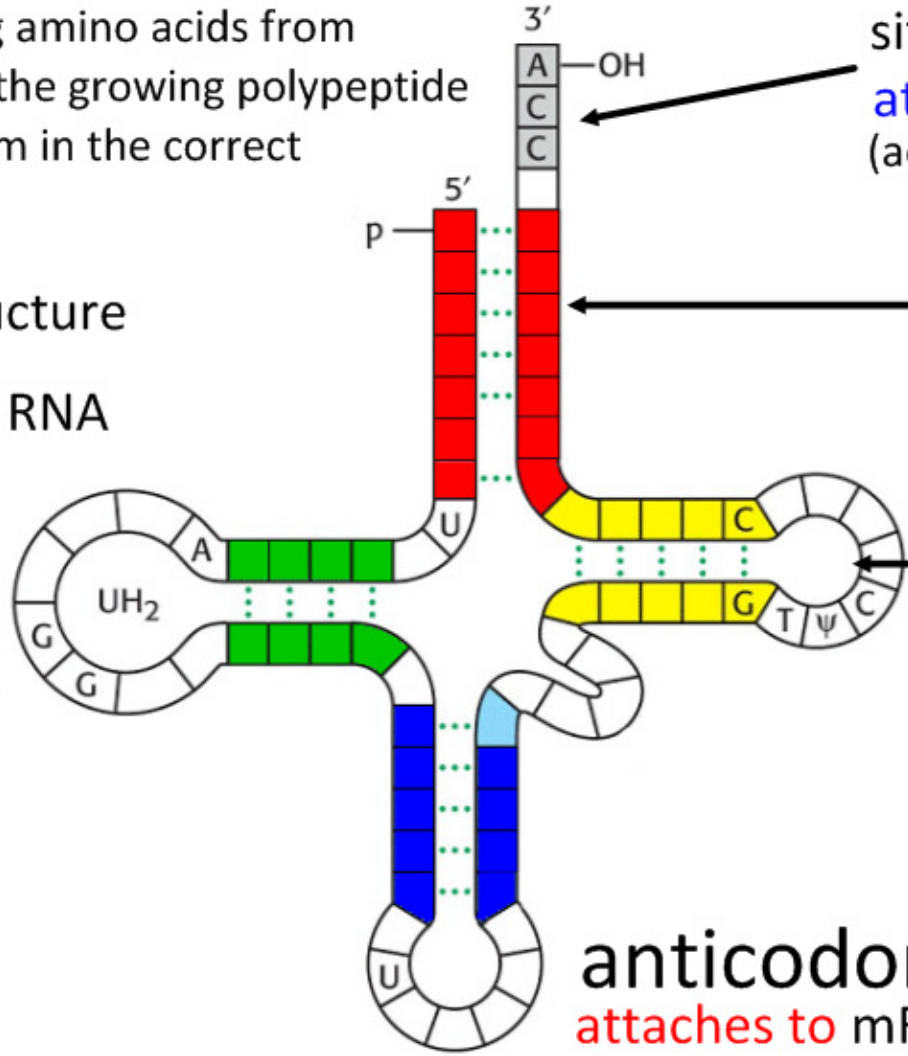
The structure of tRNA matches its function.

Function: to bring amino acids from the cytoplasm to the growing polypeptide and to attach them in the correct location.

Clover-leaf structure

single chain of RNA



site attaches to amino acid at 3' terminal end (acceptor loop)

double stranded sections are base paired (H-bonds)

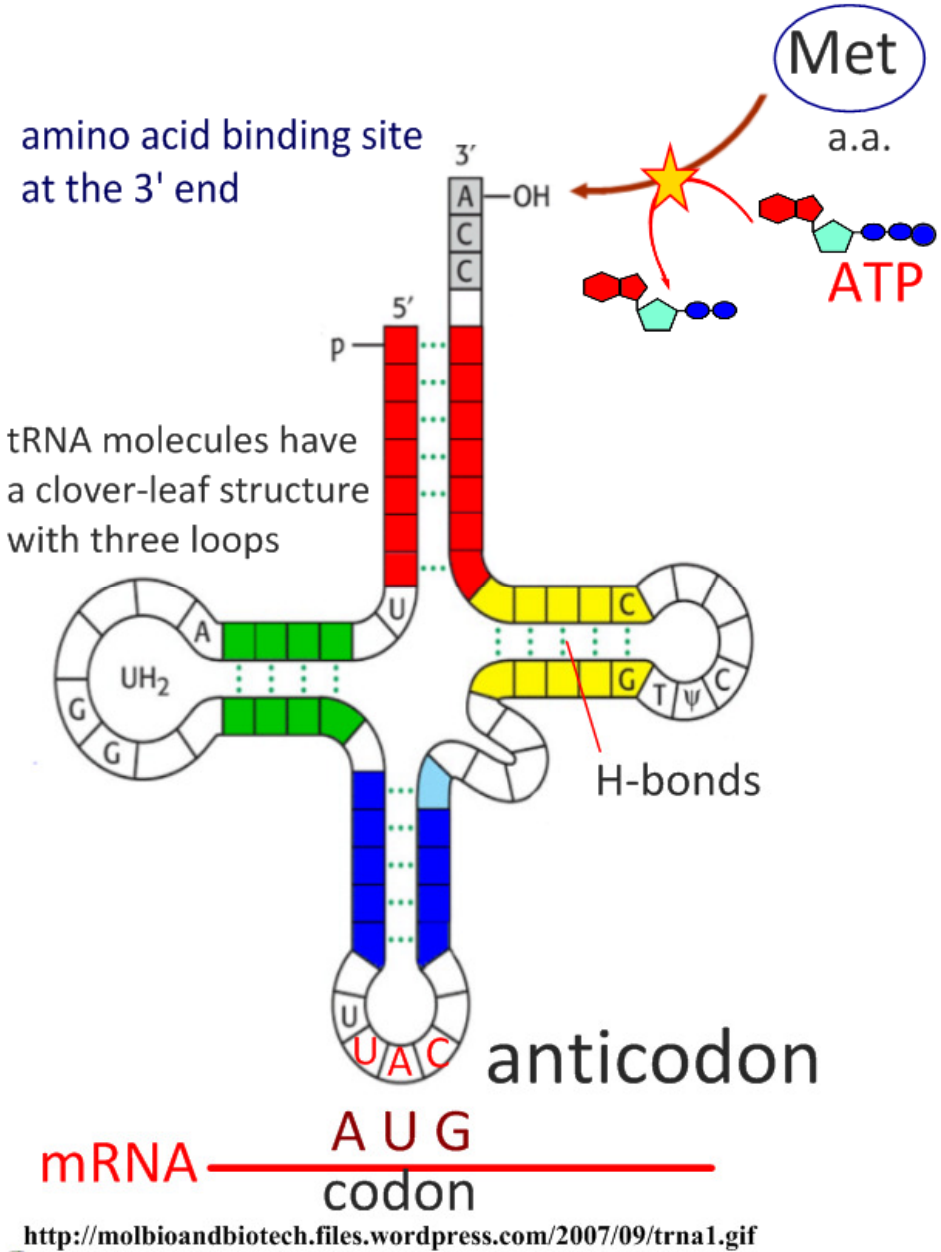
bases in these loops are not base paired

there are 3 loops

anticodon (3 bases)
attaches to mRNA codons

http://molbioandbiotech.files.wordpress.com/2007/09/trna1.gif

tRNA is activated by a tRNA activating enzyme



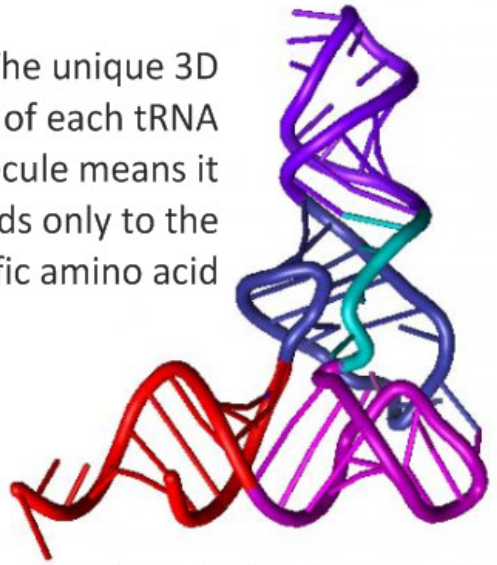
http://molbioandbiotech.files.wordpress.com/2007/09/trna1.gif

tRNA delivers amino acids to the growing polypeptide chain in translation.

It picks up new amino acids when activated by a specific tRNA activating enzyme. This uses ATP.

There are 20 of these enzymes, corresponding to the 20 amino acids, for which the tRNA molecule has the complementary anticodon.

The unique 3D structure of each tRNA molecule means it binds only to the specific amino acid



http://www.eurekalert.org/multimedia/pub/web/7027_web.jpg

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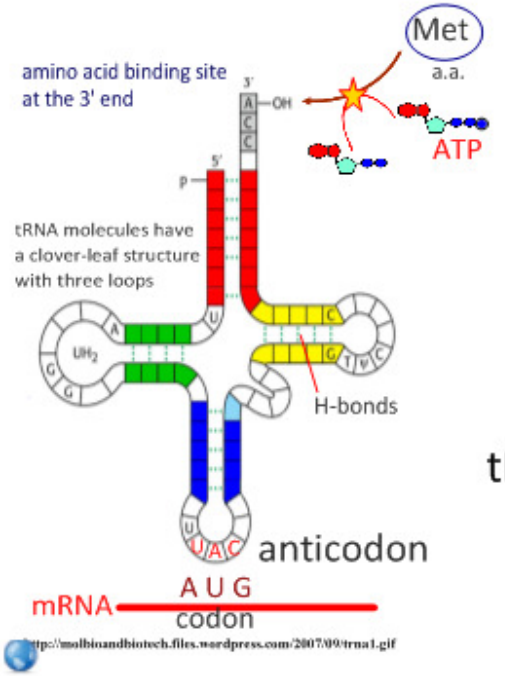

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tRNA-activating enzyme:

http://www.phschool.com/science/biology_place/biocoach/translation/addaa.html

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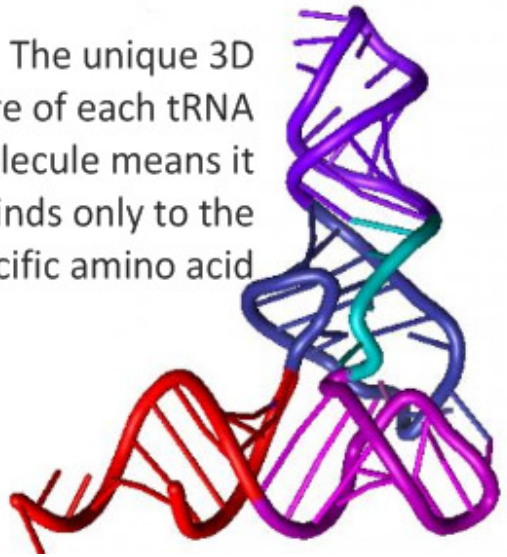
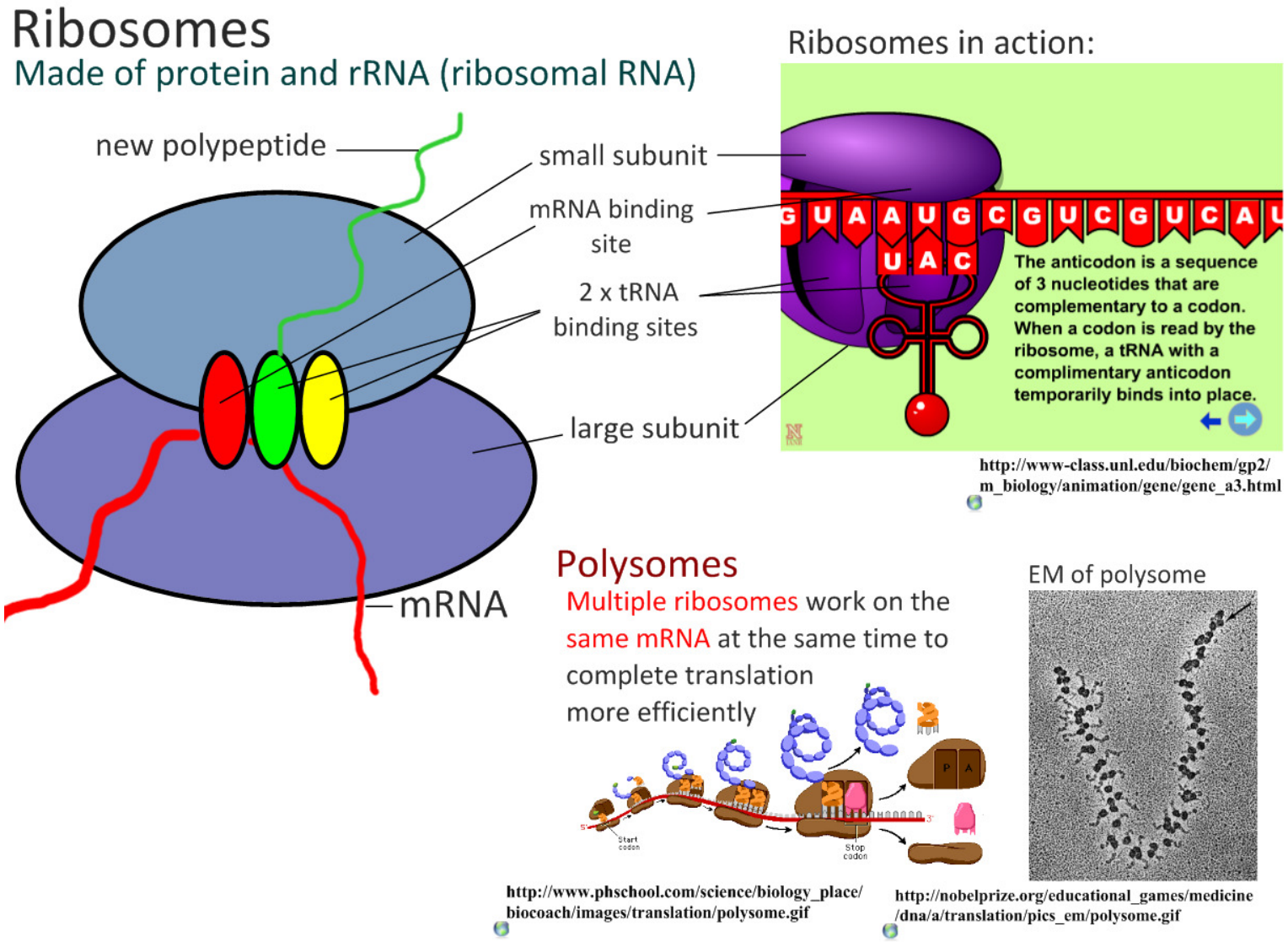


- http://www.phschool.com/science/biology_place/biocoach/translation/addaa.html



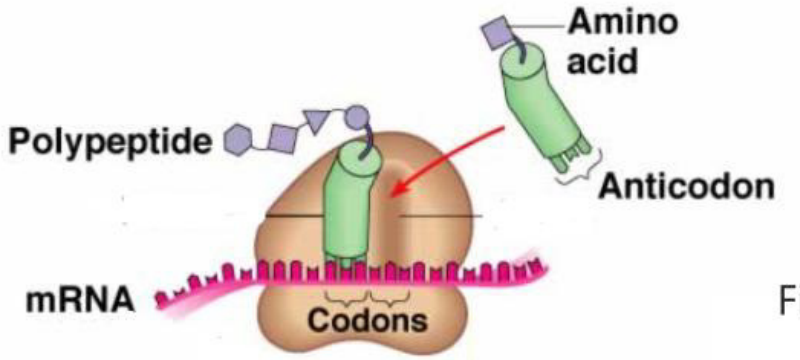
- http://www.phschool.com/science/biology_place/biocoach/translation/addaa.html

Translation

1. Initiation

Ribosome binds with mRNA at the 'Met' (AUG) codon (Start codon)

First tRNA molecules are brought in.

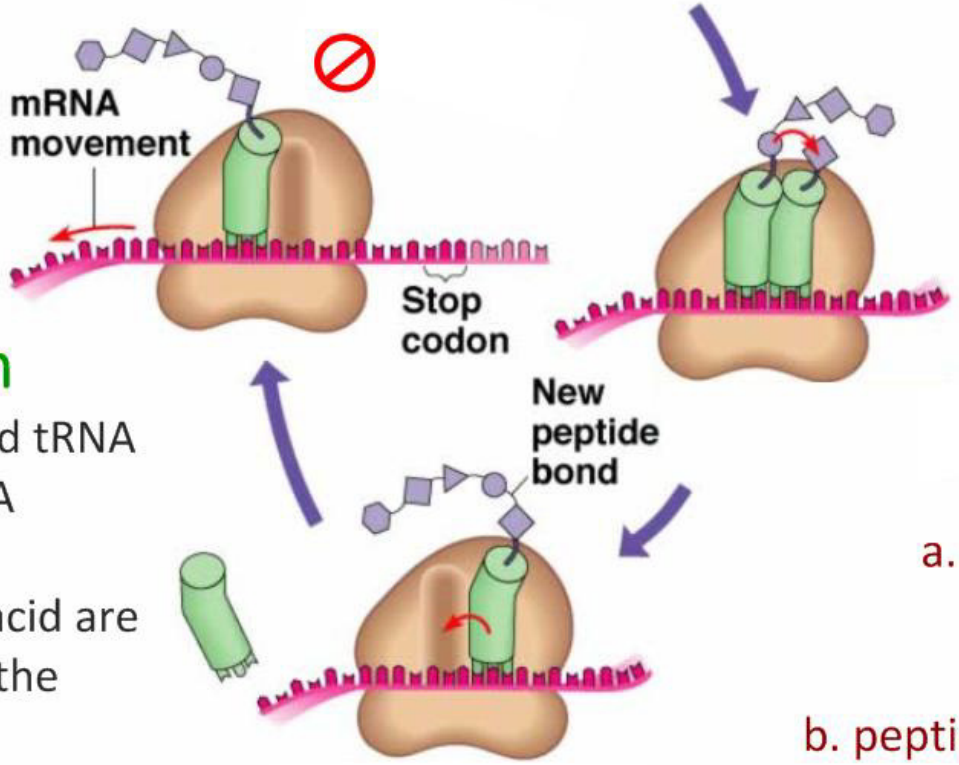


2. Elongation

Peptide bond is formed between the amino acids, making a polypeptide.

a. codon recognition
tRNA binds

b. peptide bond formation
amino acid added



3. Translocation

Ribosome releases used tRNA and moves along mRNA to the next codon.
Next tRNA and amino acid are brought in, elongating the polypeptide further.

4. Termination

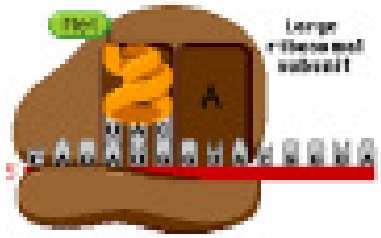
When a STOP codon is reached, the polypeptide is released.

Ribosome picks up a new strand of mRNA.

http://www.anselm.edu/homepage/jpitocch/genbio/translat.JPG

Translation

1. Initiation



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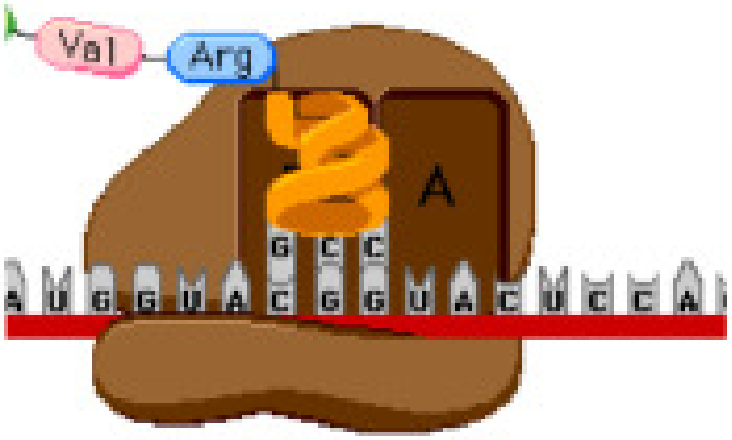

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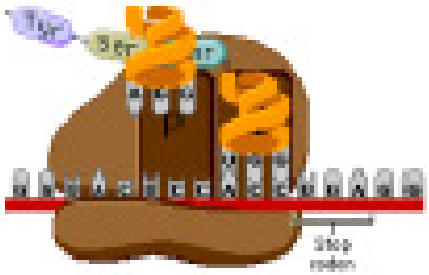
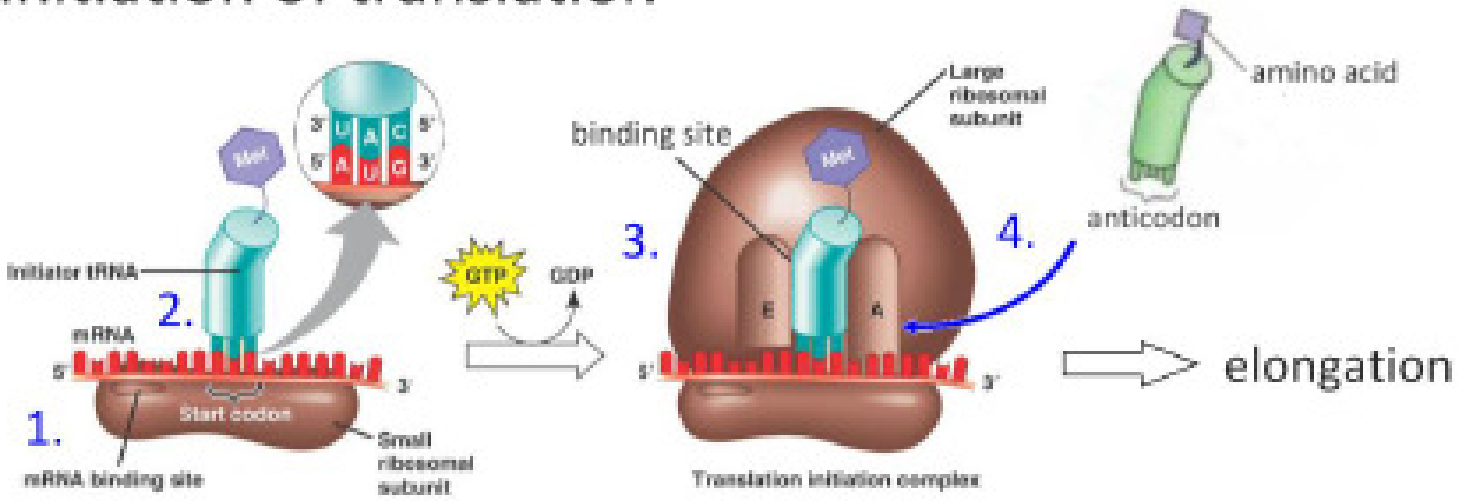


http://www.phschool.com/science/biology_place/biocoach/translation/intro.html

PEARSON

Click for animations

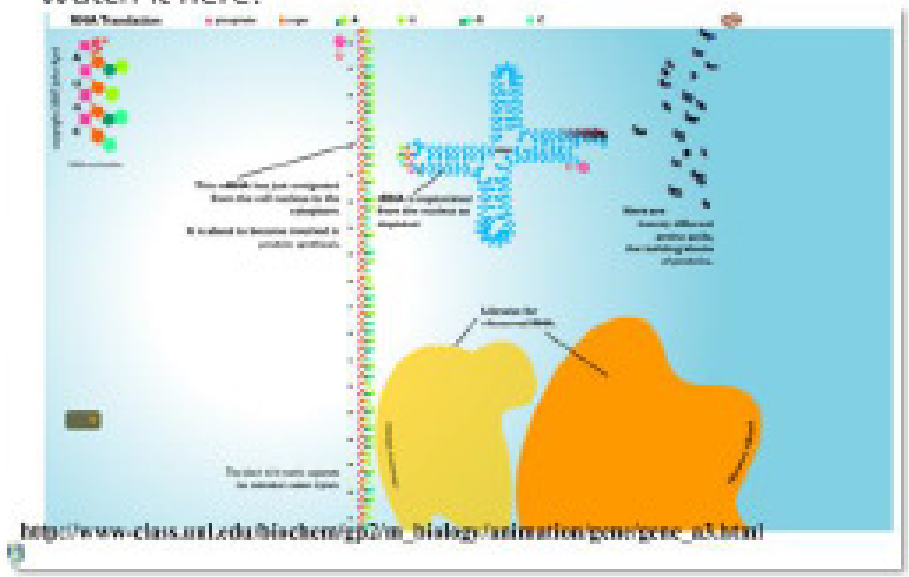
Initiation of translation



1. mRNA binds to small ribosomal subunit at binding site
2. tRNA carrying 'Met' binds to start codon
3. Large ribosomal subunit attaches
4. tRNA with anticodon corresponding to the next codon attaches
5. Peptide bond forms between amino acids
6. Elongation continues in a 5' - 3' direction along the mRNA

http://kvhs.nbed.nb.ca/gallant/biology/translation_initiation.jpg

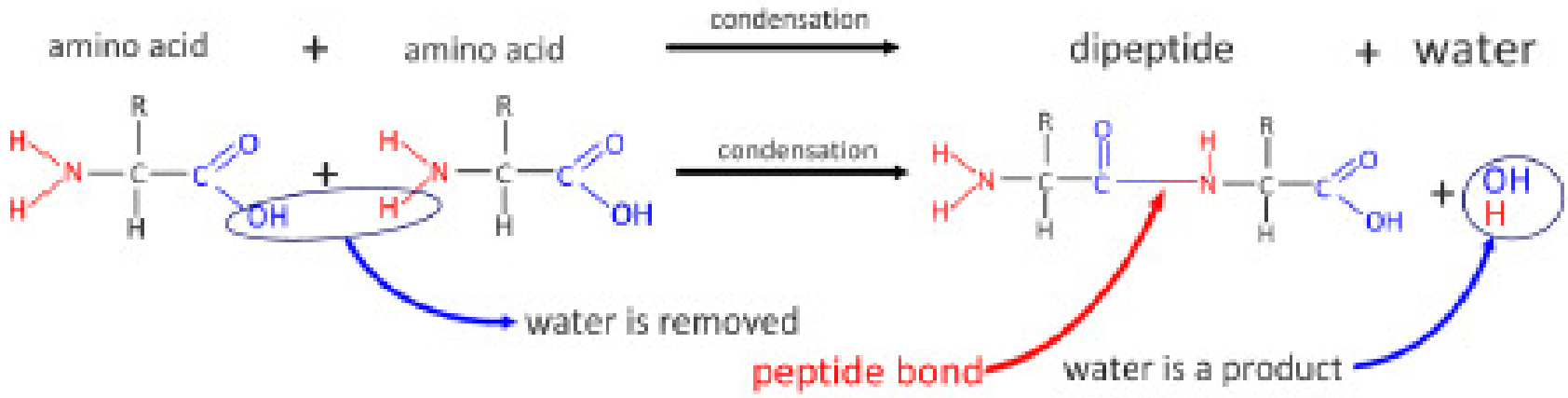
Watch it here:



http://www.class.unl.edu/biochem/gp2/m_biology/animation/gene/gene_a3.html

- http://www-class.unl.edu/biochem/gp2/m_biology/animation/gene/gene_a3.html

Peptide bonds are formed between amino acids:



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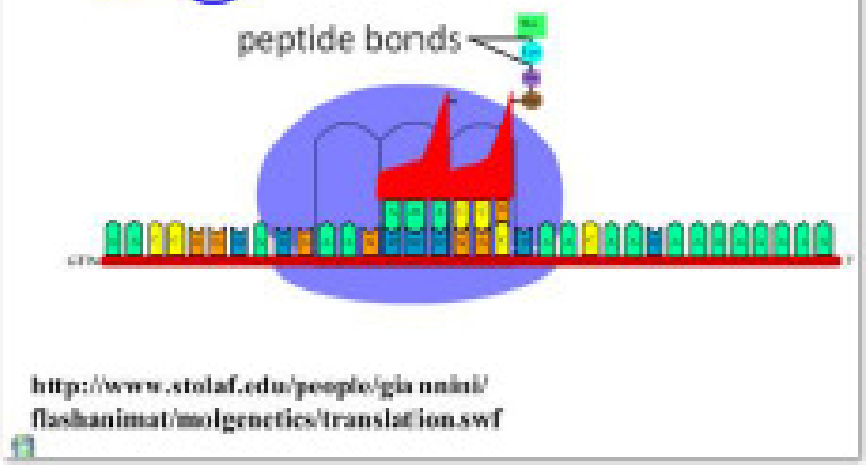
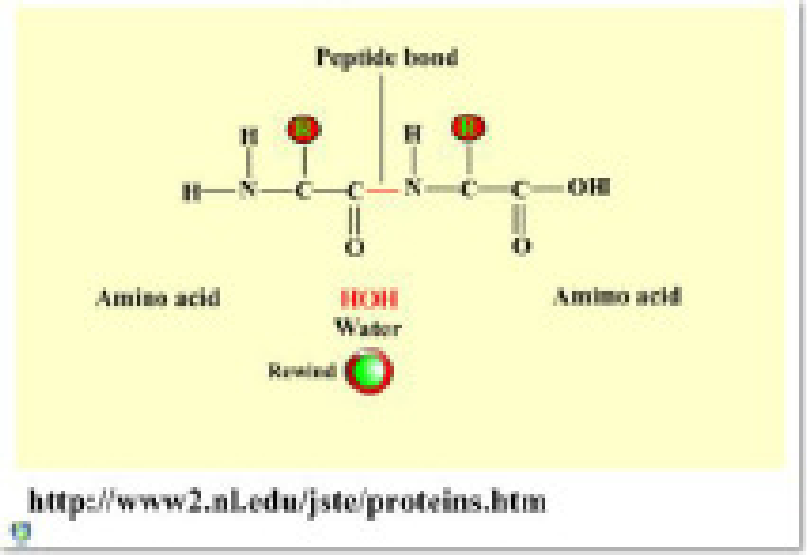
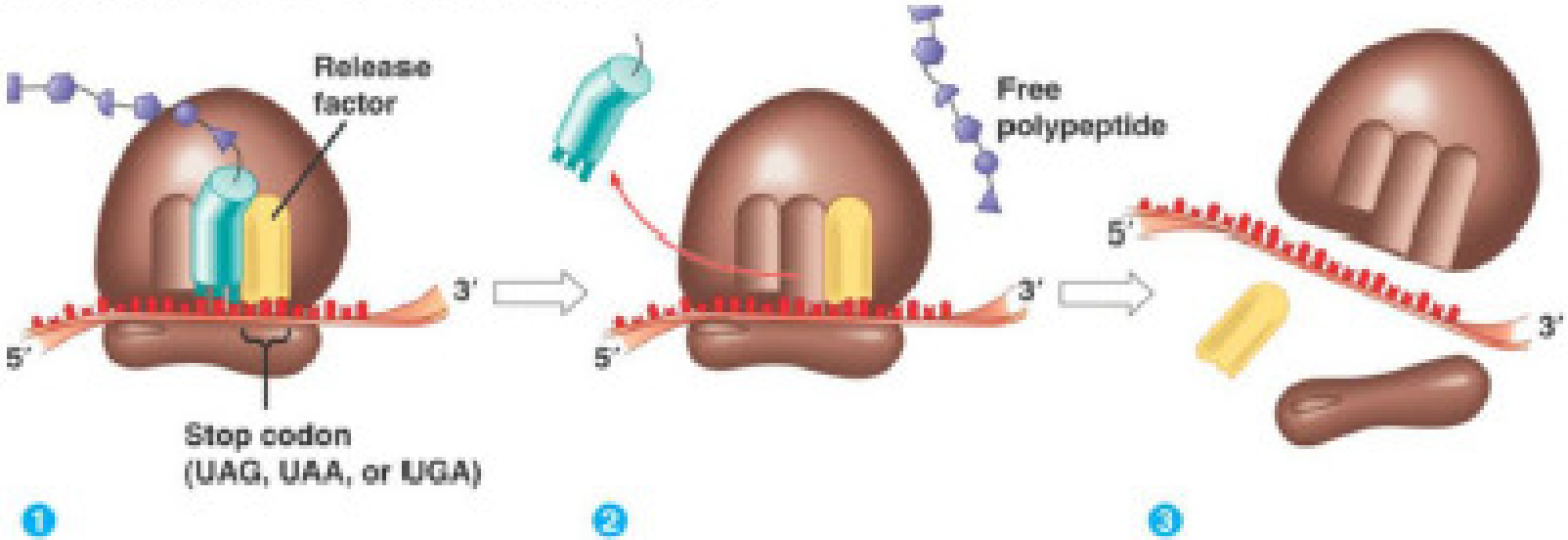


Condensation forms a peptide bond:



- http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/translation.swf

Termination of translation



Ribosome reaches the STOP codon

Release factor attaches

tRNA released to find another amino acid

polypeptide released

components of the ribosome break apart

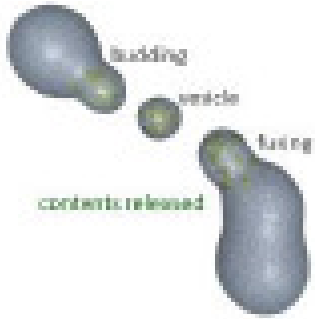
all are used again

http://kvhs.nbed.nb.ca/gallant/biology/translation_termination.jpg

Proteins produced in bound ribosomes (RER)
are for export out of the cell or lysosomes.

lysosomes contain enzymes

vesicle transport:



Proteins produced by
free ribosomes are for
use within the cell.