


# 14.4 TRANSLATION

(16)


## tRNA - transfer RNA

- transfer AA's from the cytoplasm to the growing polypeptide in a ribosome
- all 20 AA's present

each one  $\rightarrow$  carries a specific AA on one end and a nucleotide triplet (the anticodon) that base pairs with the complementary codon on mRNA

 single strand of RNA, 80 nucleotides long that HYDROGEN BONDS to itself to form 3-D shape

- loop on one end has the anticodon, and 3' end has the attachment site for AA.

 NOT everything is known about tRNA !!

- tRNA's are transcribed in the nucleus from DNA template before going to cytoplasm

Question  $\rightarrow$  how do they fit through pores??

→ they are Re-usable!

(17)

family of enzymes

### Aminoacyl-tRNA synthetases

→ provide specificity in joining amino acids to their tRNA's.

↳ specific enzymes for each amino acid  
i.e. ~~Tyr~~ Tyrosyl-tRNA for Tyrosine

↳ uses ATP to covalently bond the AA to the specific tRNA

→ creates a "CHARGED tRNA"

"Wobble" ⇒ flexible base pairing between the tRNA anti-codon and the mRNA codon in the third nucleotide position.

i.e. U could pair with either

A or G

Result → only 45 types of tRNA for 64 possible codons

-explains why synonymous codons differ in 3<sup>rd</sup> base.

(18)

# RIBOSOMES

- consists of LARGE SUBUNIT and SMALL SUBUNIT
- made from proteins and rRNA (ribosomal RNA)

★ facilitate the specific coupling of tRNA anticodons with RNA codons

- 1/3 of mass is proteins
- form a functional unit only when they clamp down on an mRNA

- transcribed, processed, and assembled with imported proteins in the NUCLEOLUS (in eukaryotes)

★ rRNA most abundant type of cellular RNA

Bacteria - 3 ~~rRNA~~ rRNA molecules

Eukaryotes - 4 rRNA molecules (larger & different)

⇒ because of differences, antibiotics can BLAST !! bacterial ribosomes without damaging the patient's (:) cool!!!

# Key Features

1) - m RNA binding site

2) EXIT Tunnel!

3) A SITE

↳ AMINOACYL-tRNA binding site  
↳ where the next amino to be added comes in

4) P SITE

↳ peptidyl-tRNA binding site  
↳ holds the tRNA carrying the growing polypeptide chain

5) E SITE

↳ holds the "uncharged" tRNA just before it leaves.

\* AA's added to the carboxyl end of the growing chain

⇒ the rRNA portions seem to be facilitating all of the enzymatic action, not the proteins!!

# STAGES

- ① INITIATION
- ② ELONGATION
- ③ TERMINATION

) Analogous to transcription.

## REQUIRED

- ① Protein "factors"
- ② ENERGY - in this case provided by GTP (Guanine Tri-phosphate)

TRANSCRIPTION INITIATION complex  
FIG 14.18



- ① mRNA
- ② initiator tRNA (UAC) → the anticodon to AUG
- ③ small ribosomal subunit
- then ...
- ④ large ribosomal subunit assisted by ...
- ⑤ INITIATION FACTORS (proteins) and ...
- ⑥ ENERGY from GTP

### Elongation

- AA<sup>n</sup> added to the C-terminus

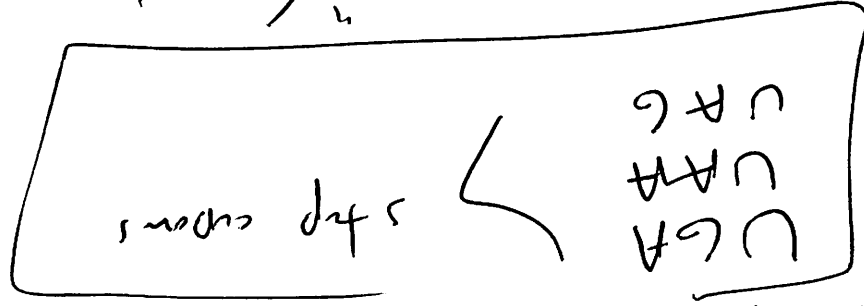
⇒ Elongation factors (proteins) are needed

3 phases:

- ① Codon recognition - catalyzed by riboflavin large subunit - needs GTP
- ② Peptide Bond Formation - needs GTP
- ③ Translocation - from A to P site.

### Termination

→ when a "STOP" codon reaches the A site, elongation stops



- A release factor (a protein, of course) shaped like aminoacyl-tRNA, binds directly to the stop codon in A site.



- causes an H<sub>2</sub>O molecule to be added to chain !! which ...

HYDROLYZES (breaks) the

polypeptide and the tRNA in the P site, shooting the chain

through the EXIT TUNNEL

W  
T  
A  
H  
E  
?  
!!

↳ 2 more GTP and protein factors are required to then break the whole complex apart.

MODIFICATIONS After Translation

Polypeptide chain (primary) → secondary → tertiary  
(this starts immediately)

⇓  
post-translational modifications  
may be necessary!

Such as:

- 1) attach things to AA's (sugar, lipid, phosphates)
- 2) remove leading AA
- 3) cleave in 2 or more pieces

## Locational Issues

(1) Free Ribosomes

(2) Bound Ribosomes - ER (cytosolic side)  
or to the nuclear envelope

↳ make proteins for EM system  
or for export

ribosomes are generic and can  
be used either way

How??

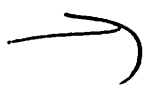
the growing polypeptide can cue  
the ribosome to attach to ER

↳ the "cue" is a SIGNAL PEPTIDE

### SIGNAL Peptide

~ 20 AA's near N-terminus of polypeptide

↳ gets recognized by a complex





called a ...

# SIGNAL-RECOGNITION PARTICLE (SRP)



SRP binds to the SIGNAL PEPTIDE, halts synthesis temporarily, AND

BRINGS !!! the

ribosome to a receptor-protein built into the ER membrane

wait, what?

↳ synthesis resumes, only NOW the poly peptide is being discharged into the ER lumen

↳ Another "SIGNAL-CLEAVING" ENZYME CUTS OFF the SIGNAL PEPTIDE and off it goes 😊

⇒ A similar process could bring ~~ribosomes~~ to other organelles  
polypeptides

↳ SIGNAL PEPTIDES play the key role.

### Multiple Polypeptides

— multiple ribosomes translate an mRNA at the same time

### ★ Polyribosomes (polysomes)

QUICK! — multiple ribosomes moving down the same strand of mRNA

↳ also, you could Transcribe multiple mRNAs from the same DNA

Bacteria — transcribe & translate the same gene simultaneously

Eukaryotes — SEGREGATE transcription & translation spatially, allowing for processing