14.4 TRANSLATION

tRNA – transfer RNA

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

each one ⇒ carry's 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 ⇒ how do they fit through pores ??

→ they are Re-usable !

family of enzymes

Aminoacyl-tRNA synthetases

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

↳ specific enzymes for each Amino Acid
i.e. ~~Trp~~ 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 61 possible codons

-explains why synonymous codons differ in 3rd base.

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

✡ rRNA most abundant type of cellular RNA

Bacteria - 3 ~~RNA~~ 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) - mRNA 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's added to the C-terminus

⇒ ELONGATION factors (proteins) are needed

3 phases:

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

Termination

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

UGA
UAA
UAG
} stop codons

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

WHAT?!

- causes an H_2O 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

↳ 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

~~Beta~~ 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 polypeptide is being discharged INTO the ER lumen

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

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

↳ 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 mRNA's from the same DNA

Bacteria - transcribe & translate the same gene simultaneously

Eukaryotes - SEGREGATE transcription & translation spatially, allowing for processing