Translation

Amino Acid Activation (Before translation)

- **Aminoacyl-tRNA synthetase** catalyses the attachment of the specific amino acid to the 3' CCA stem of a tRNA molecule with a specific anticodon to form amino-acyl tRNA

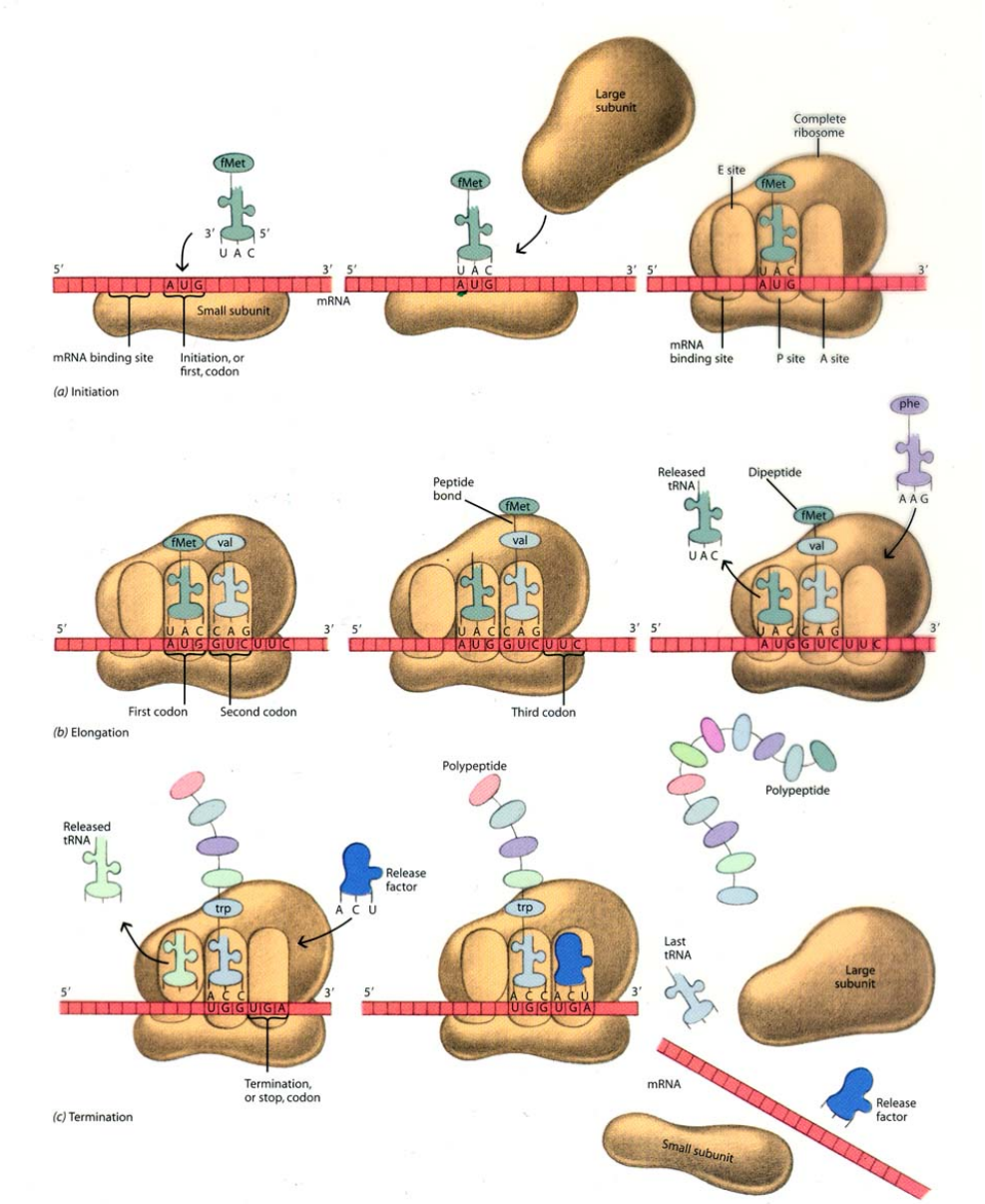
Initiation

- Prokaryotes
    - **Translation initiation factors** facilitate the binding of the small ribosomal subunit to the **Shine-Dalgarno** sequence (within 5' UTR)
    - AUG start codon correctly positioned in ribosome
    - Anticodon (UAC) of initiator tRNA (carrying formylmethionine) complementary base pairs with complementary codon on mRNA
- Eukaryotes
    - **Eukaryotic initiation factors** binds to small ribosomal subunit and correctly positions initiator tRNA (carrying methionine)
    - Small ribosomal subunit recognises and binds to 5' cap of mRNA molecule
    - Small ribosomal subunit moves in 5' to 3' direction in search of start codon AUG
- General
    - Initiation factors facilitate binding of the **small ribosomal subunit** and the **initiator tRNA** carrying methionine to the newly synthesised mRNA strand
    - **Anticodon** (UAC) of initiator tRNA will complementary base pair with start codon (AUG) of mRNA
    - **Large ribosomal subunit** binds, completing a ribosome and forming the **translation initiation complex**
    - Initiator aminoacyl-tRNA positioned in peptidyl-tRNA binding site (**P site**) leaving the aminoacyl-tRNA binding site (**A site**) vacant for incoming aminoacyl-tRNA molecules
    - GTP is required for initiation stage

Elongation and Translocation

- Second aminoacyl-tRNA binds to A site by forming hydrogen bonds with second codon on mRNA through **complementary base pairing**
- **Peptidyl transferase** in large ribosomal subunit catalyses formation of peptide bond between adjacent amino acids and methionine dissociates from initiator tRNA
- Translocation
    - Ribosome translocates in **5' to 3'** direction with 1st tRNA shifted to exit (E) site and released into cytosol, 2nd aminoacyl-tRNA (i.e. amino acid still attached to tRNA) moved to P site and A site now empty and ready to receive 3rd aminoacyl-tRNA

- Process repeated until **stop codon** (UAA/UAG/UGA) is reached at A site



Termination

- When stop codon reaches A site, **release factors** enter A site causing the hydrolysis of the bond between the polypeptide chain and the tRNA in the P site
- Polypeptide is released from ribosome and completes its folding into its necessary secondary and tertiary structures, and ribosome disassembles into its subunits

Post-translational modification

- Cleaving of proteins into smaller functional peptides
- Modification of proteins

Extra

- **GTP** required throughout translation process
- Active site of aminoacyl-tRNA synthetase complementary in shape and charge to specific amino acid and anticodon on tRNA
- Complementary base pairing between anticodon and codon confers specifity to ensure fidelity in information transfer
- Simultaneous transcription and translation (prokaryotes only)
    - mRNA can be translated while it is still being transcribed as it does not have membrane-bound nucleus
- Cluster of ribosomes simultaneously translating an mRNA molecule known as a polyribosome allows for faster protein synthesis