Translation in eukaryotes

Ribosome structure

Cytoplasmic ribosomes of nucleated cells are slightly larger than bacterial ones (80S). **The smaller subunit (40S)** contains 18S rRNA and around 30 proteins. The **larger subunit (60S)** houses 28S rRNA, 5.8S rRNA (sometimes referred to as 7S), which is analogous to bacterial 5S rRNA. Unlike the prokaryotic 50S subunit, the eukaryotic 60S subunit also contains a special 5S rRNA synthesized outside the nucleolus with the participation of RNA polymerase III. All rRNAs except 5S rRNA arise from the common precursor pre-45S rRNA, synthesized in the nucleolus by RNA polymerase I. Depending on the animal species, there are 40 or more proteins in the large subunit. Eukaryotic ribosomal proteins are synthesized in the cytoplasm, then transported to the nucleus, where they bind to the synthesized pre-rRNA.This is followed by maturation and transport of ribosomal subunits into the cytoplasm. Mitochondria of eukaryotic cells have their own proteosynthetic apparatus including ribosomes.

Initiation of eukaryotic translation

Initiation of protein synthesis on cytoplasmic ribosomes is somewhat more complex than in bacteria, requiring more regulatory factors. First, **CBP-protein** (cap binding protein) binds to the mRNA cap, which unfolds the initial section of the mRNA, thus making it accessible to the binding of the 40S subunit. The initiation factor eIF6 (e...eukaryotic) bound to the 60S subunit prevents the reassociation of ribosomal subunits. The initiating $Met.tRNA_i^{Met}$ is not formylated in nucleated cells. On the smaller subunit, already associated with the factors eIF3 and eIF4C, the initiating aa-tRNA arrives in a complex with GTP and eIF2. A **subunit complex** is formed. The eIF3 factor is important for the subsequent binding of this complex to the 5'-end of the mRNA. At the same time, ATP (not GTP) is hydrolyzed. The subunit complex then translocates down the mRNA to the initiation codon AUG. Another factor, eIF5, must release eIF2 and eIF3 from the initiation complex. Only then can the larger ribosomal subunit (60S) attach. This requires the aforementioned eIF4C. After the 80S ribosome is formed, all initiation factors are released and **translation** begins. The eIF2 protein has 3 subunits. The γ-subunit binds $Met\text{-}tRNA_i^{Met}$. The factor is active only when its α-subunit binds GTP, which is hydrolyzed during translation initiation. Regeneration requires eIF2B, also known as **guanyl nucleotide exchange factor (GEF)**. Importantly for the regulation of translation, the α-subunit can be phosphorylated under certain circumstances, thereby inactivating the factor.

Elongation of eukaryotic translation

This phase of translation proceeds analogously to prokaryotes. The EF-1 protein has an analogous function to the prokaryotic EF-Tu, helping to bind aa-tRNA to the A site, in its EF-1a.GTP form. After GTP hydrolysis on EF-1a.GDP, the factor is regenerated with the participation of EF-1b. This is followed by a peptidyl transferase reaction to form a peptide bond. The EF-2.GTP factor (prokaryotic EF-G analog) is needed to move the mRNA along the ribosome (translocation).

Termination of eukaryotic translation

Unlike prokaryotic termination, only one factor, **eRF**, is sufficient to recognize all three termination codons (UAA, UAG, UGA). Also in eukaryotic cells, proteosynthesis takes place on polysomes.

Inhibitors of eukaryotic translation

Cycloheximide is a toxic substance that blocks peptidyl transferase on the 60S subunit of the ribosome. It is used for research purposes. The causative agent of diphtheria, **Corynebacterium diphtheriae**, releases a protein toxin that is fatal in microgram amounts. The toxin catalyzes the transfer of ADP-ribose from NAD to one of the EF-2 amino acids (a covalent modification called ADP-ribosylation). EF-2 is thus inactivated. Other G-proteins are also modified by this mechanism.

Links

Related articles

- Translation
- Translation in prokaryotes
- Transcription
- RNA

Template:Brief biochemistry (Štípek)

Resources

- ŠTÍPEK, Stanislav. *Brief biochemistry : Storage and expression of genetic information.* 1. edition. Medprint, 1998. 92 pp. pp. 49–50. ISBN 80-902036-2-0.

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