Messenger RNA

Messenger RNA is the single-stranded intermediate molecule that transfers the genetic information from DNA in the nucleus to the cytoplasm, where it serves as a template in the formation of polypeptides.

From: Endocrinology: Adult and Pediatric (Seventh Edition), 2016

Related terms:

Hippocampus, Eicosanoid Receptor, Enzymes, Brain-Derived Neurotrophic Factor, MicroRNA, Protein, Gene Expression, DNA, RNA

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DNA and Protein Synthesis

Joseph Feher, in Quantitative Human Physiology (Second Edition), 2017

Messenger RNA Carries the Instructions for Making Proteins

mRNA is "messenger" RNA. mRNA is synthesized in the nucleus using the nucleotide sequence of DNA as a template. This process requires nucleotide triphosphates as substrates and is catalyzed by the enzyme **RNA polymerase II**. The process of making mRNA from DNA is called **transcription**, and it occurs in the nucleus. The mRNA directs the synthesis of proteins, which occurs in the cytoplasm. mRNA formed in the nucleus is transported out of the nucleus and into the cytoplasm where it attaches to the **ribosomes**. Proteins are assembled on the ribosomes using the mRNA nucleotide sequence as a guide. Thus mRNA carries a "message" from the nucleus to the cytoplasm. The message is encoded in the nucleotide sequence of the mRNA, which is complementary to the nucleotide sequence of the DNA that served as a template for synthesizing the mRNA. Making proteins from mRNA is called **translation**.

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RNA Turnover in Eukaryotes: Analysis of Specialized and Quality Control RNA Decay Pathways

Meenakshi K. Doma, in Methods in Enzymology, 2008

2.3 Construction of reporter constructs to assess translational dependence of NGD

NGD is dependent on mRNA translation wherein mRNA cleavage requires that the ribosomes reach the encoded pause site. The translational dependence of NGD can be analyzed in two ways.

1. A first approach is to prevent the ribosome from reaching the stall site by blocking ribosome scanning. Such a block to scanning is achieved by introduction of a stem-loop structure within the 5′-UTR of the reporter mRNA; such a stem-loop has been shown to completely block translation initiation on the reporter mRNA (Muhlrad *et al.*, 1995).
2. A second approach involves translation termination of the reporter mRNA before the ribosome reaches the stall site by introduction of a PTC prior to the stall site (Muhlrad and Parker, 1994).

Reporter genes used to test the translation dependence of NGD were made by introducing the pause-inducing stem-loop into PGK1 genes that encode mRNA that are blocked in translation initiation or that harbor a PTC upstream from the pause site (Table 1.2). Both approaches have been shown to abolish the accumulation of NGD endonucleolytic cleavage fragments (Doma and Parker, 2006).

Table 1.2. List of plasmids with reporter mRNAs available for analysis of NGD in yeast

Reporter mRNA and pause sequence	Lab plasmid number	Description[a]
PGK1	pRP 469	*PGK1* reporter mRNA with no pause sequence[b]
PGK1-SL	Prp 1251	*PGK1* reporter mRNA with stem-loop in frame[c]
PGK1-PK	pRP 1285	*PGK1* reporter mRNA with pseudoknot in frame[c]
PGK1-RC	pRP1286	*PGK1* reporter mRNA with rare codon in frame[c]

PGK1-STOP	pRP 1287	*PGK1* reporter mRNA with premature termination codon (PTC) in frame[c]
PGK1-pro-pro-stop	pRP 1288	*PGK1* reporter mRNA with two praline and one stop codon in frame[c]
SL-PGK1-SL	pRP 1252	*PGK1* reporter mRNA with block to initiation and with stem-loop in frame[c]
PGK1-PTC-SL	pRP 1253	*PGK1* reporter mRNA with PTC and stem-loop in frame[c]
SL-PGK1	pRP 543	*PGK1* reporter mRNA with block to initiation due to small stem-loop in 5′-UTR[d]
PGK1-PTC	pRP 609	*PGK1* reporter mRNA with premature termination codon[e]
MFA2	pRP 485	*MFA2* reporter with no pause[f]
MFA2 with Xba1 site	pRP 1254	*MFA2* reporter mRNA with site directed mutagenesis generated *Xba*1site[c]
MFA2-SL	pRP 1255	*MFA2* reporter mRNA with stem-loop in frame[c]

a All reporter constructs are under the control of the *GAL1* upstream activator sequence (UAS) and have a short poly(G) in the 3′-UTR to inhibit exosome action.

b From Decker and Parker (1993).

c From Doma and Parker (2006).

d From Muhlrad *et al.* (1995).

e From Muhlrad and Parker (1994).

f From Decker and Parker (1993).

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RNA helicases

Angela Hilliker, in Methods in Enzymology, 2012

Abstract

Cytoplasmic mRNA protein complexes (mRNPs) can assemble in granules, such as processing bodies (P-bodies) and stress granules (SGs). Both P-bodies and SGs contain repressed messenger RNAs (mRNAs) and proteins that regulate the fate of the mRNA. P-bodies contain factors involved in translation repression and mRNA decay; SGs contain a subset of translation initiation factors and mRNA-binding proteins. mRNAs cycle in and out of granules and can return to translation. RNA helicases are found in both P-bodies and SGs. These enzymes are prime candidates for facilitating the changes in mRNP structure and composition that may determine whether an mRNA is translated, stored, or degraded. This chapter focuses on the RNA helicases that localize to cytoplasmic granules. I outline approaches to define how the helicases affect the granules and the mRNAs within them, and I explain how analysis of cytoplasmic granules provides insight into physiological function and targets of RNA helicases.

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Molecular Genetics; Lung and Breast Carcinomas

Shui Qing Ye, in Handbook of Immunohistochemistry and in Situ Hybridization of Human Carcinomas, 2002

1. mRNA Isolation and cDNA Synthesis.

mRNA isolation and cDNA synthesis are not unique to the SAGE procedure. Various reagents and kits can be used for these purpose at the investigator's choice. For example, total RNA from tissues or cells of interest can be isolated using the Total RNA Isolation Kit (Promega, Cat. No. Z5110) followed by the MessageMaker mRNA Kit (Invitrogen, Cat. No. 10298–016) to isolate mRNA per supplier's instruction. The mRNA can also be isolated directly from tissues or cells of interest. Superscript choice System cDNA Synthesis Kit (Invitrogen, Cat. No. 18090-019) or other equivalent reagents can be used for cDNA synthesis. The standard SAGE protocol requires 5 μg mRNA as a starting material.

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Thyroid Hormone Receptor Isoforms

Paul M. Yen, in Encyclopedia of Hormones, 2003

III Hormonal regulation of TR isoforms

TR mRNA regulation varies among the different isoforms. In the intact rat anterior pituitary, T3 decreases TR□-2 mRNA, modestly decreases TR□-1 mRNA, and slightly increases rat TR□-1 mRNA. Despite these countervailing effects, the total T3 binding decreases by 30% in the T3-treated rat pituitary. In other tissues, T3 slightly decreases TR□-1 and c-erbA□-2 mRNA, with the exception of the brain, where c-erbA□-2 levels are not changed. TR□-1 mRNA is minimally affected in nonpituitary tissues. The hypothalamic tripeptide, thyrotropin-releasing hormone (TRH), also regulates TR mRNA expression because it decreases TR□-2 mRNA, slightly decreases TR□-1 mRNA, and minimally affects TR□-1 mRNA in cultured rat pituitary cells. Retinoic acid blunts the negative regulation by T3 in these cells. Additionally, in patients with nonthyroidal illness who have decreased circulating serum free T3 and tetraiodothyronine (T4) levels, TR□ and TR□ mRNAs are increased in peripheral mononuclear cells and liver biopsy specimens. Thus, increased TR expression may potentially compensate for decreased circulating thyroid hormone levels in these patients.

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Subcellular RNA Localization☆

M. Holcik, in Reference Module in Life Sciences, 2017

Localized Protection From Degradation

Protection of mRNA from degradation plays a critical role in restricting mRNA to the germ plasm in Drosophila and zebrafish embryos. This type of localization mechanism is exemplified by Hsp83 mRNA in *Drosophila* embryos. In young embryos, maternally loaded Hsp83 mRNA is distributed uniformly. However, following egg activation there is degradation of the mRNA throughout the cytoplasm, except at the posterior pole, where it is protected. This selective degradation yields an embryo with posteriorly localized Hsp83 mRNA. An alternative mechanism was described in sensory neurons (SN) of the sea slug Aplysia in which sensorin mRNA is selectively stabilized at the axon hillock and neurites of the SN upon interaction with their synaptic target.

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Laboratory Methods in Enzymology: RNA

Wenqian Hu, Jeff Coller, in Methods in Enzymology, 2013

Abstract

Eukaryotic mRNA degradation is an essential aspect of gene regulation. Properly turning off transcript generation ensures that protein synthesis does not occur indefinitely. By ensuring that all mRNAs are destroyed, cells can adapt quickly to changing physiological and environmental conditions. Eukaryotic cytoplasmic mRNA degradation is predominately initiated by removal of the poly(A) tail at the 3′ end (deadenylation). Following deadenylation, either the mRNA is degraded in a 3′–5′ manner or the cap is removed and the mRNA is degraded 5′–3′ (reviewed in Coller and Parker, 2004). Determining mRNA decay rates, as indicated by mRNA half-life, is vital to understand how mRNA stability is modulated under various physiological conditions.

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RNA Turnover

T. Dunckley, R. Parker, in Encyclopedia of Genetics, 2001

Biological Role of mRNA Degradation

Messenger RNA stability is an important control point in modulating gene expression for several reasons. First, the steady-state level of a given mRNA is determined by a balance between its rates of synthesis and degradation. Second, the stability of individual mRNAs can be altered in response to numerous environmental stimuli including carbon source, viral infection, and developmental transitions, allowing for rapid alterations in gene expression. Third, a specialized system of mRNA degradation functions to eliminate potentially deleterious errors in mRNA synthesis (see below). Finally, efficient mRNA degradation is required for cell growth in both prokaryotes and eukaryotes, emphasizing the importance of this process.

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