Regulation of gene expression in eukaryotes

Eukaryotic cells have a far more complex structure than prokaryotic cells. The membrane system separates the nucleus from the cytoplasm, the substance transformation takes place in functionally specialized organelles (mitochondria, ER). This division also requires a *different regulation* of the individual steps of proteosynthesis and formation of cellular structures.

The *regulation of gene expression* in eukaryotes is considerably more complex and multifaceted than in prokaryotes. Transcription and translation take place at **other places in the cell'** and in a time sequence. **Synthesis of polypeptides** is differentiated depending on whether they will be used inside the cell or exported.

In a multicellular organism, the expression of genes is regulated indirectly by a *system of signaling molecules* that ensure the transmission of information between cells (and thus also information about the state of the external and internal environment). For the ``transmission *of these signals, cells are equipped with specific membrane and cytoplasmic ``receptors.*

The expression of human genes is comprehensively regulated **according to the needs of the cell''*, which depend, among other things, on the*** *type and developmental stage* of the cell.

After the fusion of egg and sperm, a **totipotent zygote'** ***is created - these cells are able to divide and produce any*** **differentiated cells** ***of the organism. After several divisions, they begin to*** *specialize.'* ***about*** *15% of your genes.*

Some genes are expressed in ""all cells of the organism"" (housekeeping genes) - their products (histones, ribosomal proteins) are vital for the cells

regulation of gene expression occurs at several levels:

1. **at the level of chromosomeu**
   - structure change
   - **position effect** = transfer of genes from euchromatin to heterochromatin = change of function
   - **amplification** = increase in the number of transcribed genes
   - **translocation** = displacement of gene structures into the regulatory sphere of a strong **promoter**
   - **advertisement of promoters** = will increase gene expression
   - also reconstructions at the DNA level (deletion, insertion); affecting editing
2. **regulation of transcription**
   - **RNA polymerase – I**
     - in the nucleolus – transcribes rRNA precursor (15 proteins)
   - **RNA-polymerase – II**
     - transcribes all pre-mRNA (14 proteins)
   - **RNA-polymerase – III**
     - transcribes all pre-tRNAs (17 proteins)
   - regulation of transcription by cis-elements
   - **enhancers** / **silencers** (attenuators)
     - enhancer creates a DNA loop and approaches the promoter, to which specific proteins - activators - bind
     - this bond prevents RNA polymerase from binding to the promoter
     - only after changing the conformation of the complex due to the action of signaling molecules or the binding of coactivators, the promoter is released for the polymerase and transcription begins
   - **Transcription factors**
     - **Zinc-fingers** = proteins whose chains form short loops where the Zn^{2+} atom is bound to 2 cysteines and 2 histamines; regulation of 5S rRNA transcription
     - **Leucine zippers** = connect 2 α-helices by bonds between leucine molecules
     - **HLH** (helix – loop – helix)
     - **HTH** (helix – turn – helix)
   - **Homedomains**
   - regulation of transcription by mediators = signaling molecules
     - coordinating activity:
       - paracrine
       - autocrine
       - endocrine (hormones)
3. **regulatory gene cascade**
   - primarily regulated genes can subsequently regulate the expression of other genes via their own product
   - the entire regulatory cascade can have a number of intermediate stages
   - at the end of the regulatory cascade, such factors (products) can also arise that, on the contrary, suppress the activity of primarily regulated genes
4. **regulation by pre-mRNA editing**
   - after pre-mRNA transcription and binding of the 5' cap during transcription
   - pre-mRNA editing:
     1. by cleaving the 3' end and attaching poly(A)
     2. intron splicing and exon splicing
   - Other influencing options[1]

        - alternative edit
        - mRNA editing (change of pre-mRNA structure)
        - mRNA stability in the cytoplasm
5. **regulation at the level of translation**
    - ex. mRNA translation for ferritin formation
6. **targeting**
    - genetic determination of protein orientation

Links

Related Articles

- Transcription factors
- Transcription
- Translation
- Regulation of gene expression in prokaryotes

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1. ŠTEFÁNEK, Jiří. *Medicíne, diseases, 1. LF UK* [online]. [cit. 2009]. <https://www.stefajir.cz/>.