

2nd Lecture: Introduction into Gene Regulation

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What is a gene?

Which of the following statements are true?

- ▶ Coding sequence is either intronic or exonic.
- ▶ Each nucleotide of an mRNA belongs to the coding sequence.
- ▶ Introns are non-coding.
- ▶ The 5' or 3' end of a pre-mRNA can be intronic.
- ▶ Untranslated regions are spliced out of the mRNA.
- ▶ Exons are at least partially covered with coding sequence.

Gene Regulation

is the **regulation of gene expression**. Gene expression is the processes of deriving a functional gene product from a gene sequence on the DNA. Subject of regulation are:

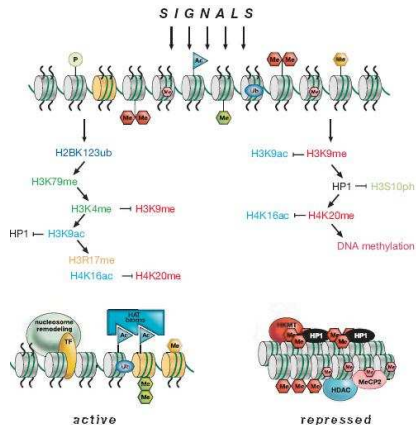
- ▶ the amount of gene product produced (expression level)
- ▶ the speed at which gene product is produced
- ▶ the place and time of expression during organismal development (expression pattern)
- ▶ the isoform of the gene product that is made from the gene locus
- ▶ the activity of the gene product

Major Levels of Regulation

- ▶ epigenetic or chromatin regulation
- ▶ transcriptional regulation
- ▶ post-transcriptional or translational regulation
- ▶ signalling or regulatory cascade

Epigenetic or Chromatin Regulation

Epigenetic marks index the genome, define active (**euchromatic**) and inactive (**heterochromatic**) regions that are in a loose chromatin conformation or tightly packed, respectively. Is said to **regulate accessibility** of gene regions to transcription factors.

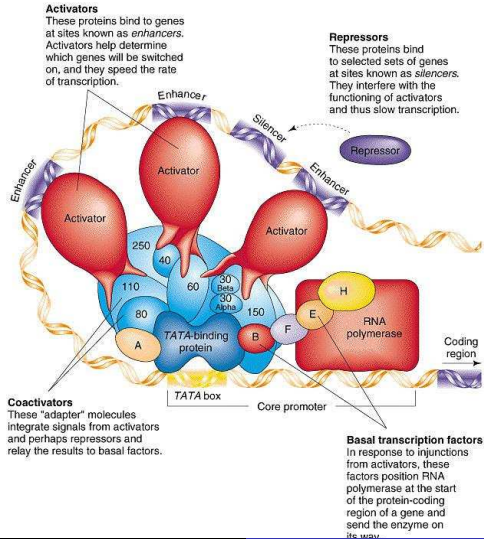


important terms

- ▶ chromatin
- ▶ nucleosome
- ▶ histone
- ▶ histone modification
- ▶ epigenetic mark
- ▶ chromatin remodelling

Transcriptional Regulation

Regulation of **recruitment of RNA polymerase** and initiation of transcription.

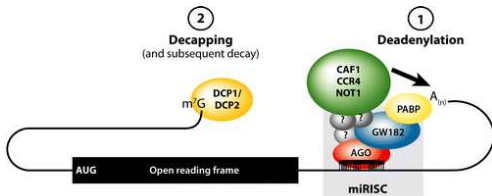
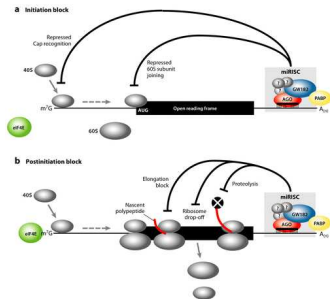


important terms


- ▶ transcript
- ▶ transcription start site (TSS)
- ▶ promoter
- ▶ enhancer
- ▶ silencer
- ▶ transcription factor (TF)
- ▶ transcription factor binding site (TFBS)
- ▶ repressor
- ▶ initiation (of transcription)
- ▶ elongation (of transcription)
- ▶ termination (of transcription)

Post-transcriptional or Translational Regulation

Regulation of processes that take place after transcription to prepare the mRNA for translation.



Fabian MR, et al. 2010.
Annu. Rev. Biochem. 79:351–79

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important terms

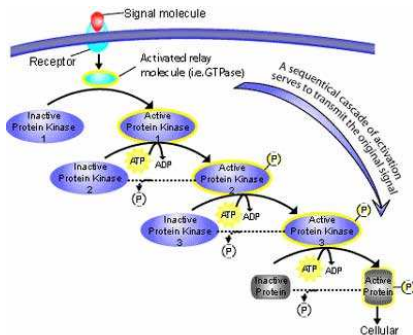
- ▶ alternative splicing
- ▶ internal ribosomal entry site (IRES)
- ▶ microRNA (miRNA)
- ▶ upstream ORF
- ▶ decapping
- ▶ deadenylation
- ▶ exonuclease
- ▶ endonuclease

Signaling or Regulatory Cascade

Initiates or alters the cellular response to an environmental signal.

1. a signaling molecule activates a certain receptor
2. the receptor activates a protein downstream in the cascade that again activates a downstream protein.

Activation is usually achieved by phosphorylation and/or induction of a change in conformation. The final goal is the regulation of target molecules to create a response to the signal.



important terms

- ▶ receptor
- ▶ signal transduction
- ▶ phosphorylation
- ▶ conformation change
- ▶ localization signal
- ▶ complex formation