

Transcription Control in Eukaryotes

Transcription control in eukaryotes is more complex than in prokaryotes, with more gene-gene interactions, presumably required to produce more different cell types in more complex organisms.

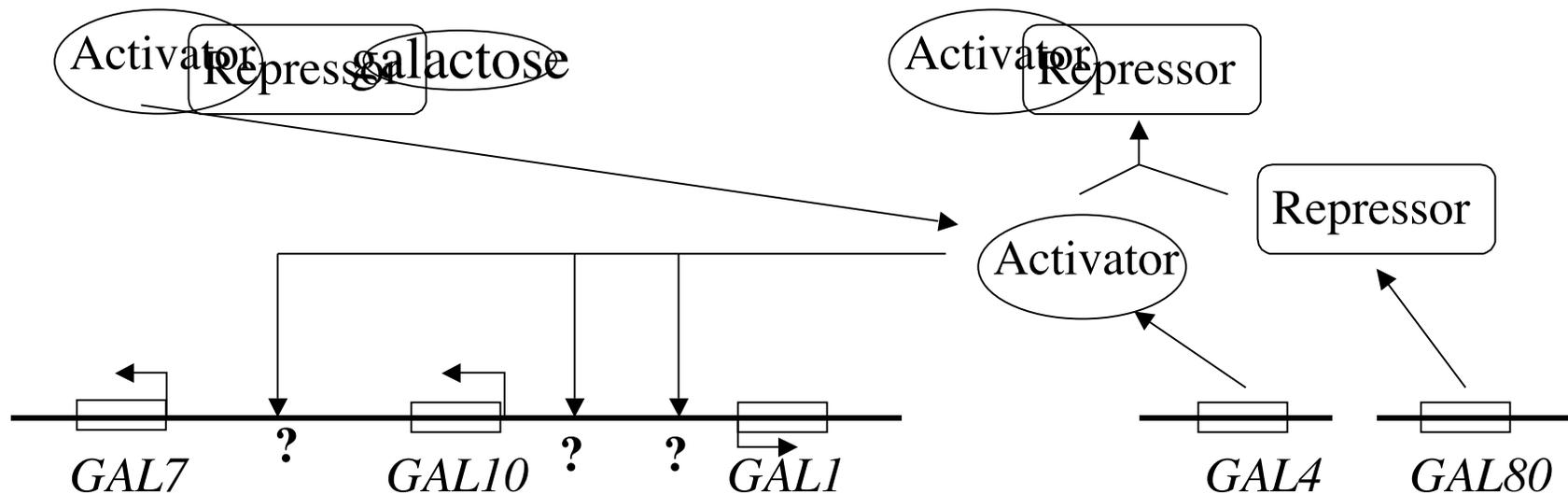
We will consider some examples and models to illustrate some general principles.

Example: Activation of *GAL* Genes in Yeast

Tightly linked genes *GAL1*, *GAL7*, and *GAL10* are coordinately activated or repressed by the activity of two genes on different chromosomes.

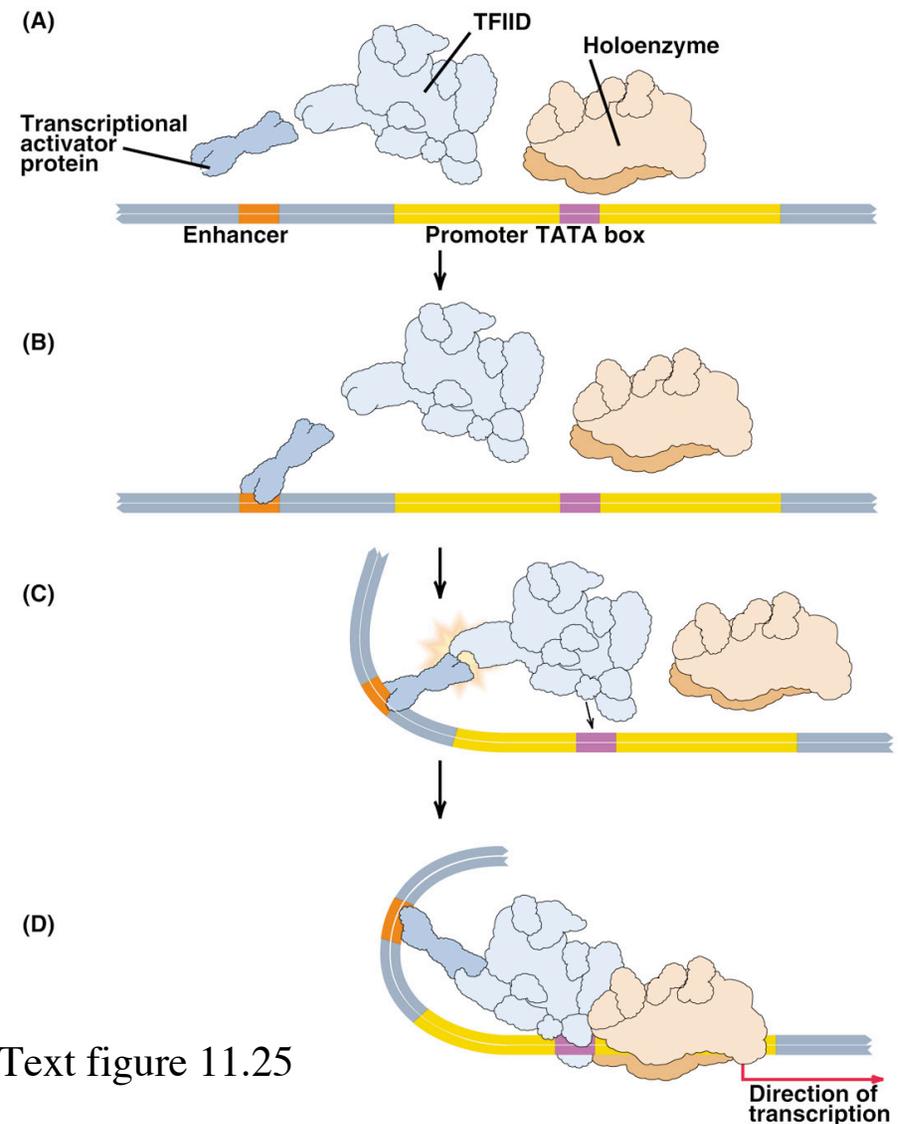
Their protein products are enzymes required for conversion of galactose to glucose-1-phosphate which enters the glycolysis pathway.

The activator binds to upstream enhancer sequences; the ? indicates that the position of these sites is unknown (to me).



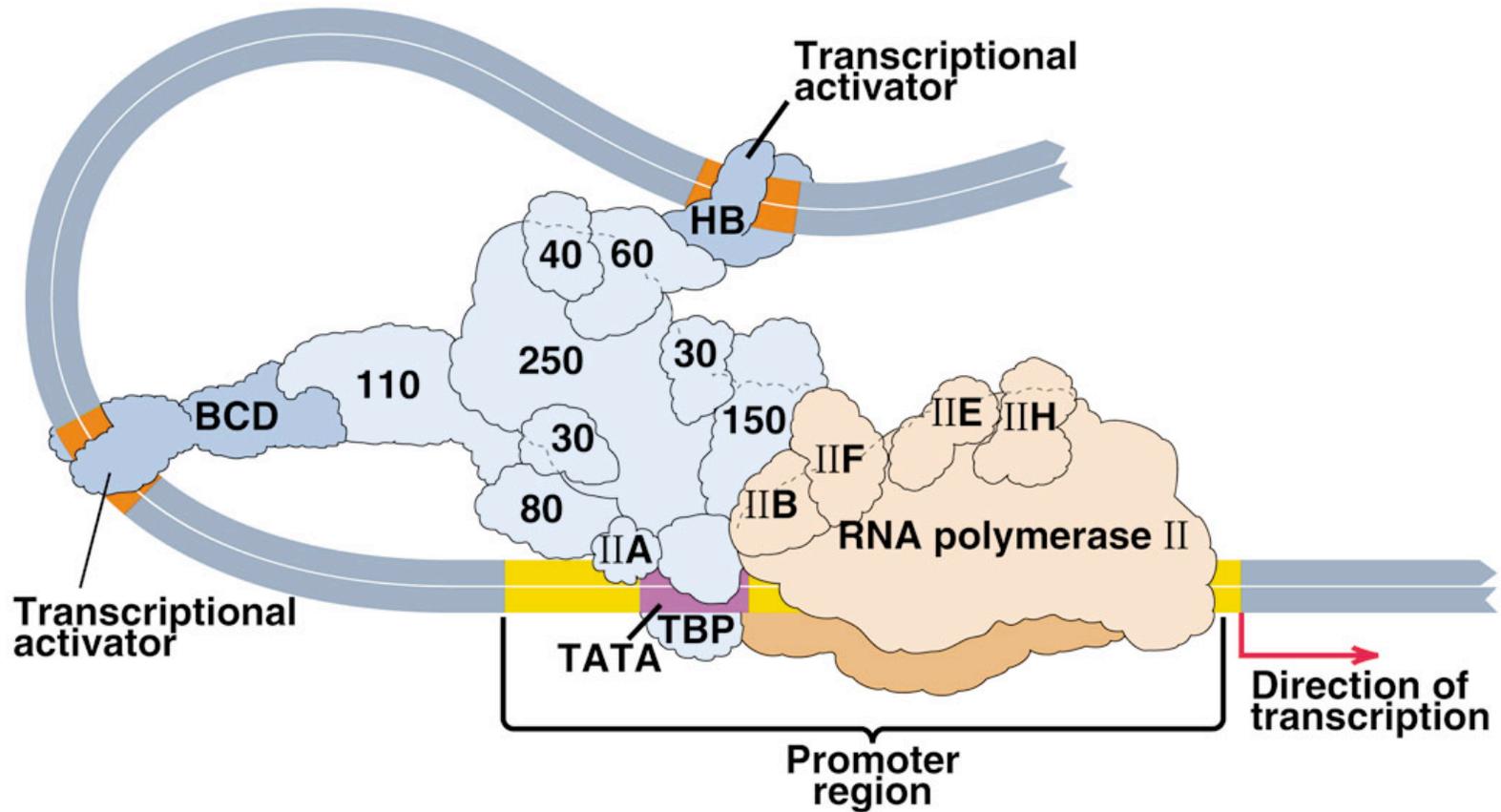
General Model of Transcription Control by Activator Proteins and Enhancer Sequences

1. A transcriptional activator protein binds to an enhancer sequence (maybe very far upstream or downstream from gene).
2. Activator protein binds Transcription Factor IID.
3. TATA-binding protein component of TFIID is recruited to the promoter and binds RNA polymerase holoenzyme (polymerase plus other proteins) .
4. RNA polymerase holoenzyme binds to promoter and begins transcription.



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More Detailed Model of Transcription Initiation



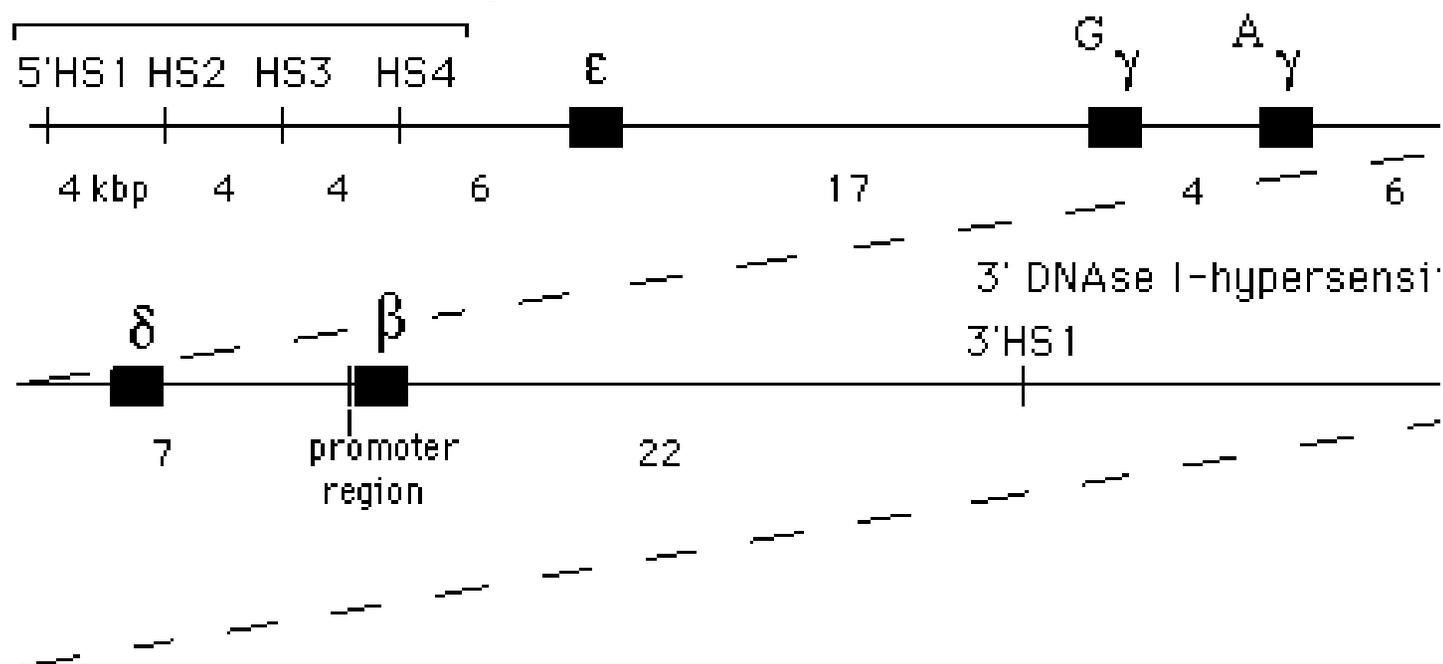
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Multiple Distant Transcription Control Sites

Locus Control Region of the globin genes in the β -globin cluster lies upstream from β -globin gene, consisting of four different sites. There are two more sites downstream which affect gene expression.

5' DNase I-hypersensitive sites

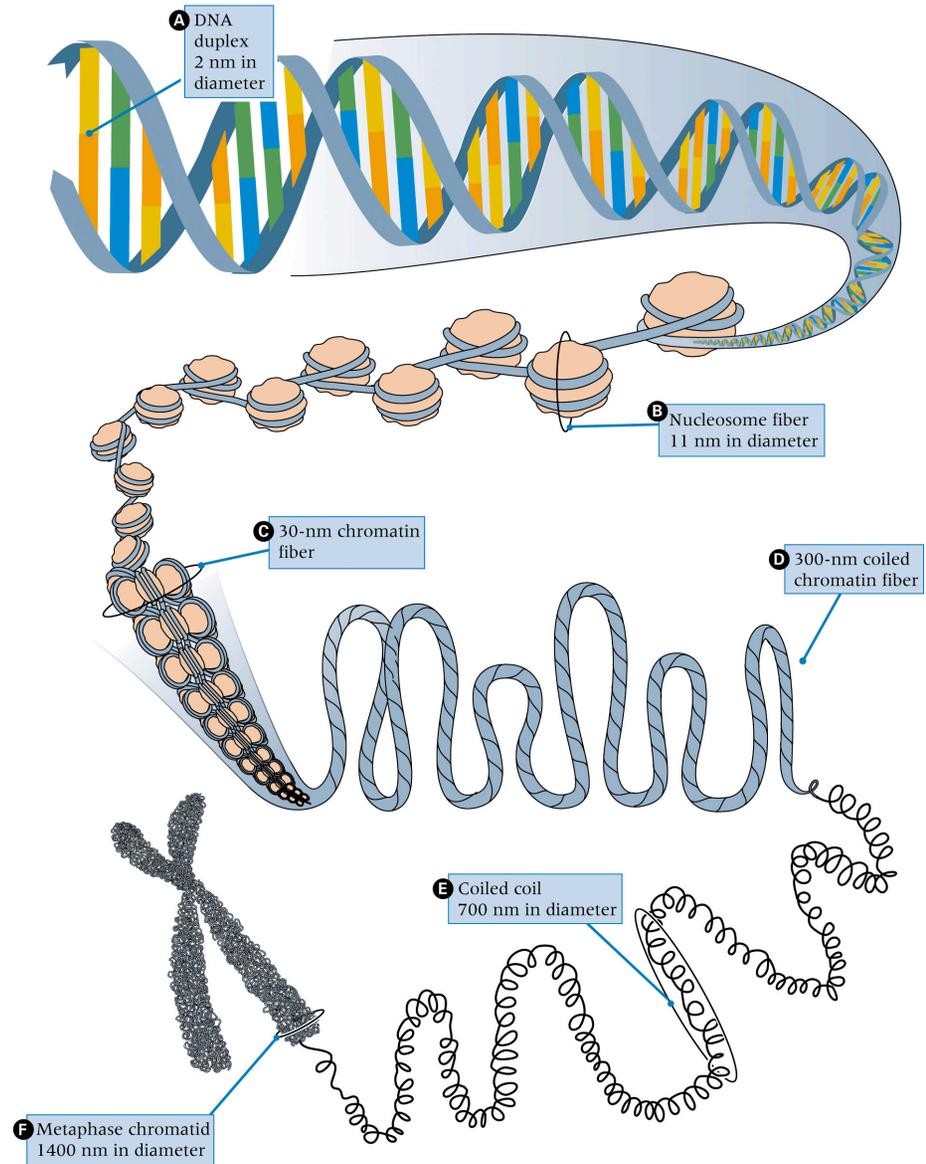
LCR = Locus Control Region



Gene Regulation by Chromosome Structure

DNA in chromosomes is highly folded and compacted, partly by being wound around structures called nucleosomes made of histone proteins.

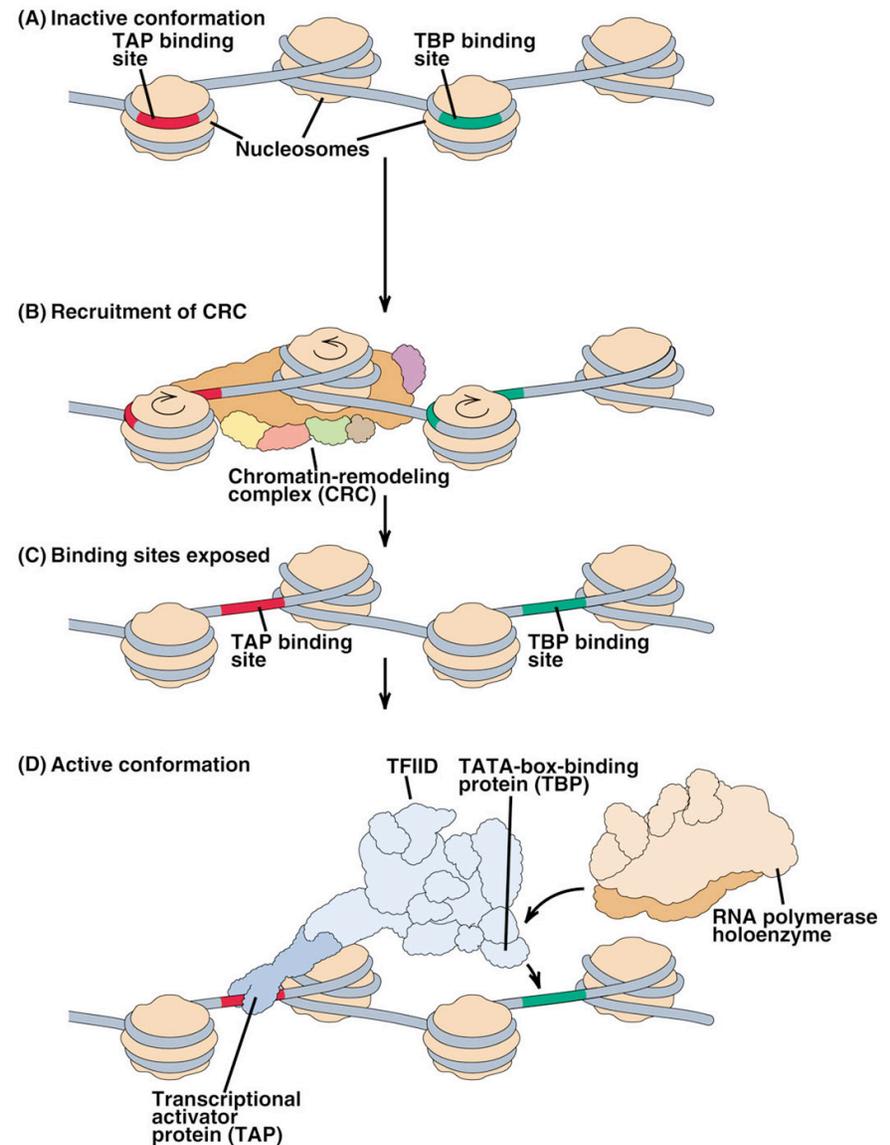
Chromatin = DNA plus associated proteins



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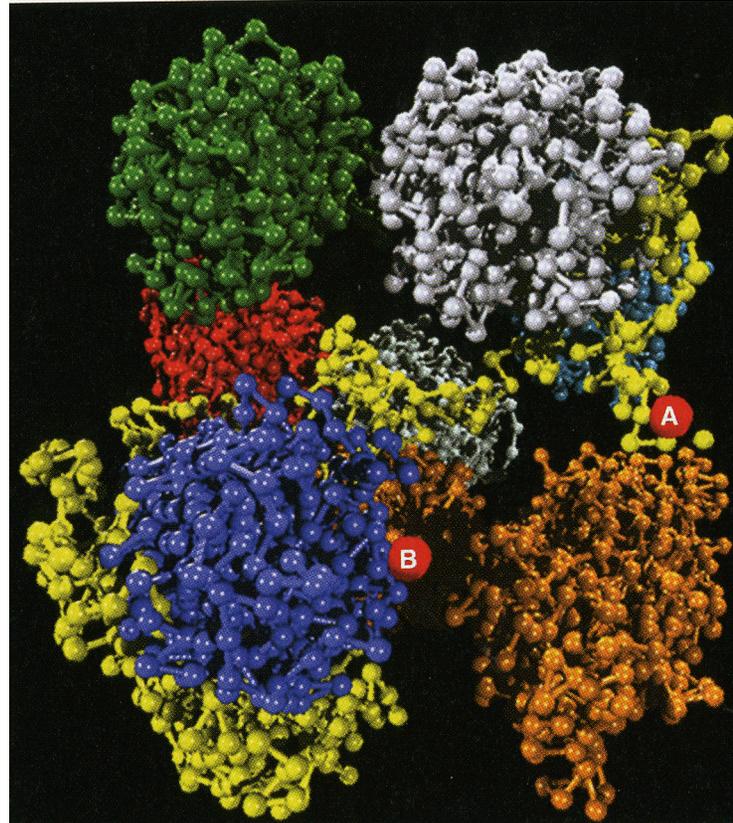
Gene Regulation by Chromosome Structure

Genes in nucleosomes are inaccessible to transcription complexes. Genes must be moved off of nucleosomes before they can be transcribed.



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Gene Regulation by Chromosome Structure



Text figure 7.10

Chromatin model. Sticks are DNA, colored spheres are nucleosomes. Red spheres labelled A and B are transcription complexes. Blue chromatin near B is too dense to allow transcription complex access to genes. Yellow chromatin near A is partially unfolded to allow access.

Coordination

- Many genes are involved in the transcription control of one gene.
- These genes are controlled by other genes (and sometimes by each other).
- Transcription control involves extremely complex networks of gene interactions that must be coordinated.
- Identifying these interactions requires ingenious genetic experiments.
- Understanding the interactions and their coordinations requires high-quality mathematical and computer analyses, part of the growing field of bioinformatics, looking for large-scale properties of networks and general rules.

