

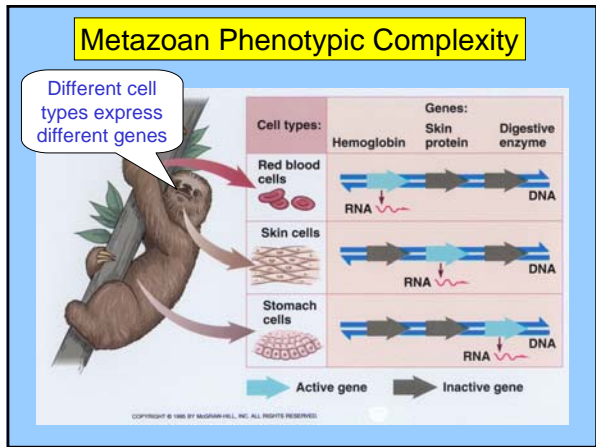
# Chapter 19: Eukaryote Genomes

## Organization, Regulation, and Evolution

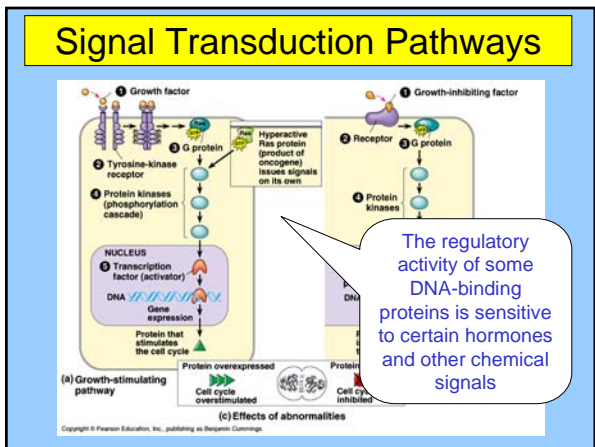
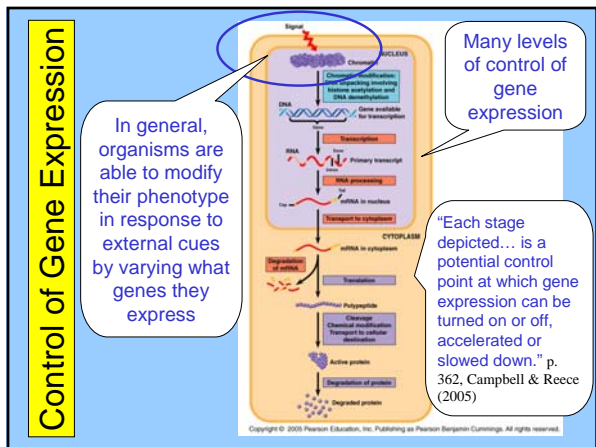
(through section 19.2 only)

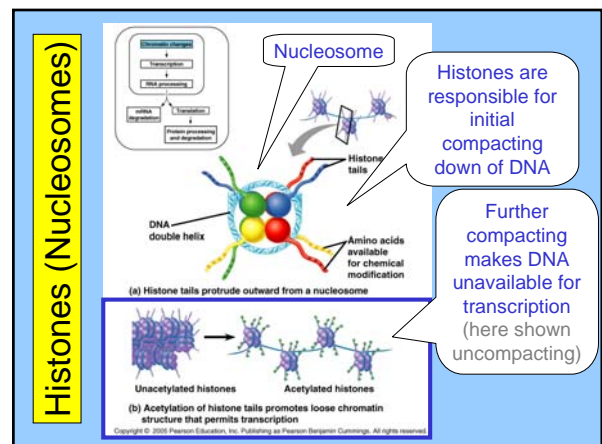
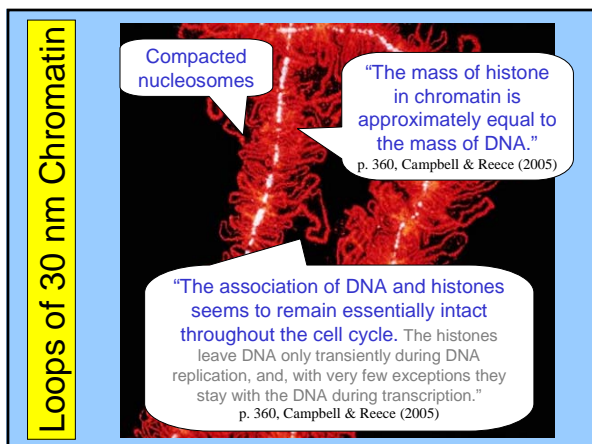
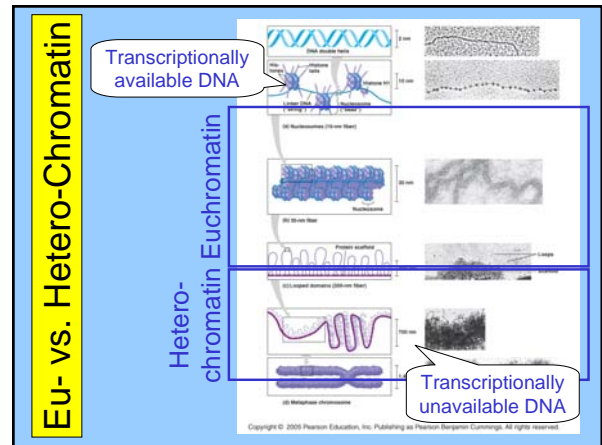
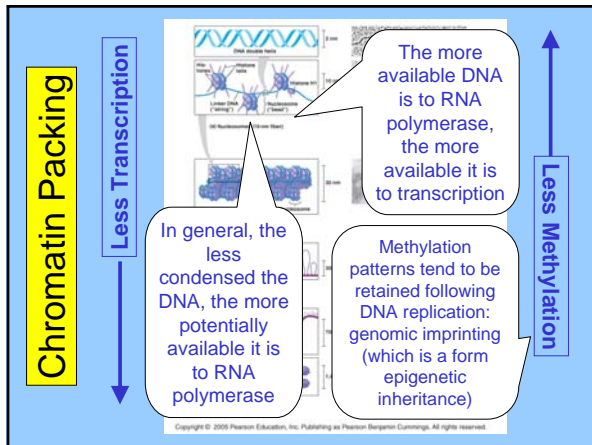
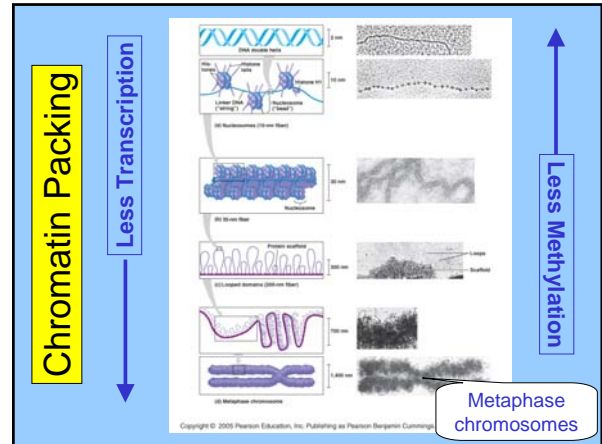
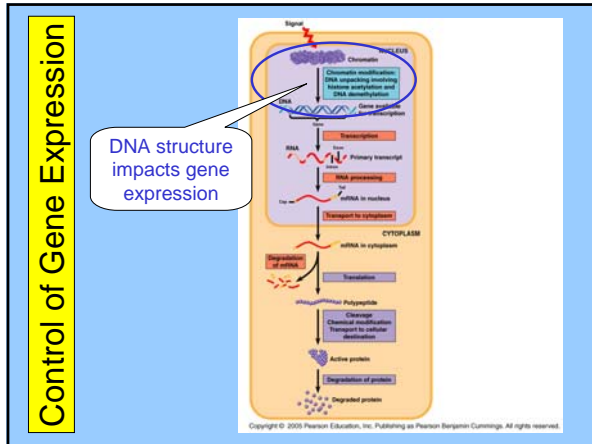
**Important Point:**

*If you are having trouble understanding lecture material:  
Try reading your text before attending lectures.  
And take the time to read it well!*

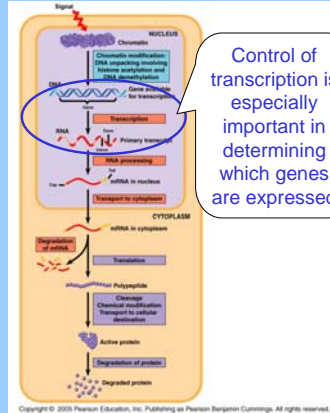


- ### Phenotypic "Plasticity"
- To survive, organisms must be able to adapt to changes in their environments
  - These adaptations can occur at many different levels:
    - Organisms can change their behaviors (ch. 51)
    - Organisms can modify the expression of their proteins post-translationally (ch. 6 & 11)
    - Organisms can change what genes are expressed (ch. 11, 18, & 19)
    - Organisms can display norms of reaction during development and/or can acclimatize (ch. 14, 21, 44)
    - Culture (learned behavior) can be modified (ch. 34)
    - Populations can genetically evolve (ch. 22 & 23)
  - These are listed in reverse-order of the speed with which they allow the organism (or species) to react





## Control of Gene Expression

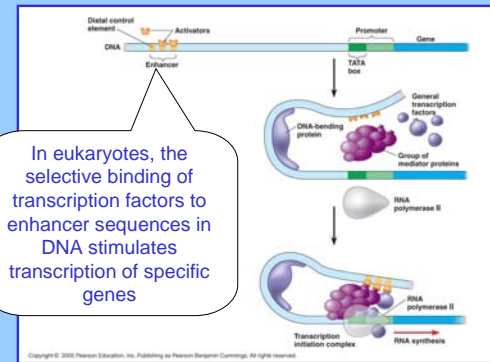


Control of transcription is especially important in determining which genes are expressed

## Enhancer Sequences

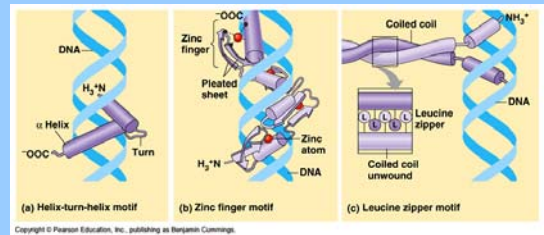
- Enhancers, like promoters, are DNA sequences (rather than the proteins that bind to DNA sequences)
- Enhancers are transcription control sequences analogous to transcription control sequences found in prokaryotes
- Unlike prokaryote transcription control sequences, enhancer sequences may be found thousands of bases away from the reading frame
- The great distance between reading frame and enhancer sequences as well as the distance between enhancers suggests that enhancer sequences are involved with changes of DNA structure that serve to enhance transcription

## Activation of Transcription



In eukaryotes, the selective binding of transcription factors to enhancer sequences in DNA stimulates transcription of specific genes

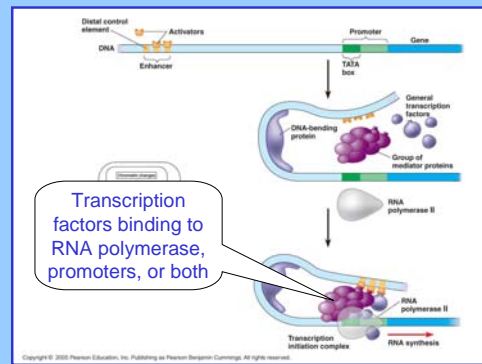
## DNA Binding Proteins

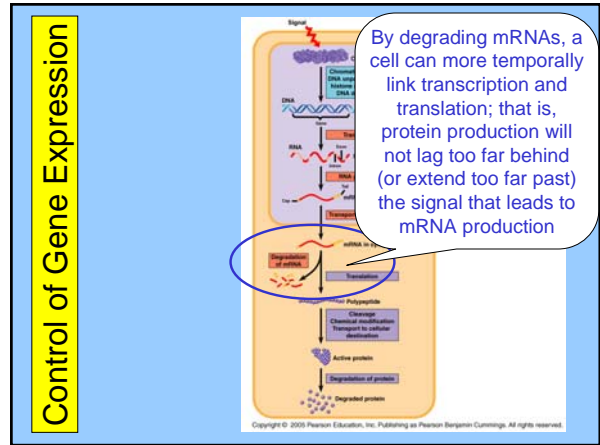
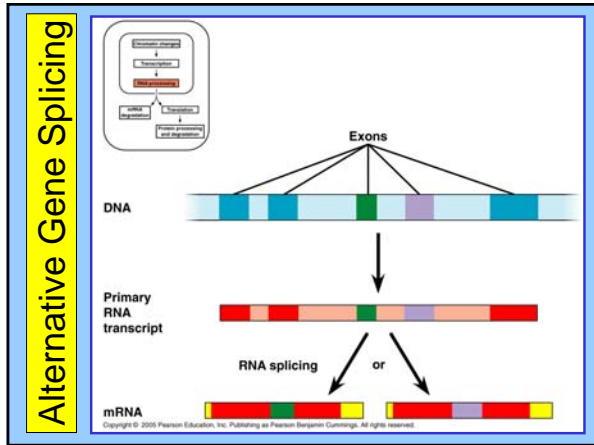
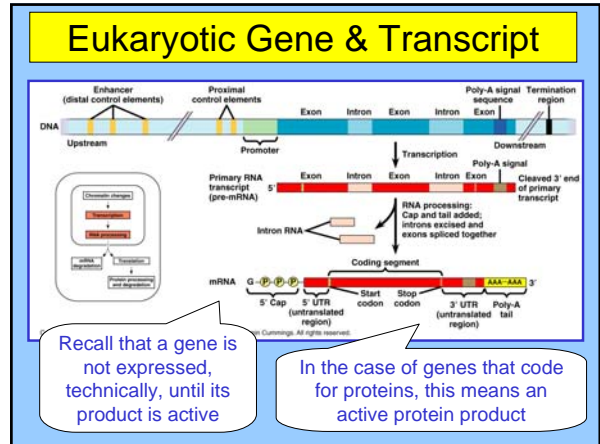
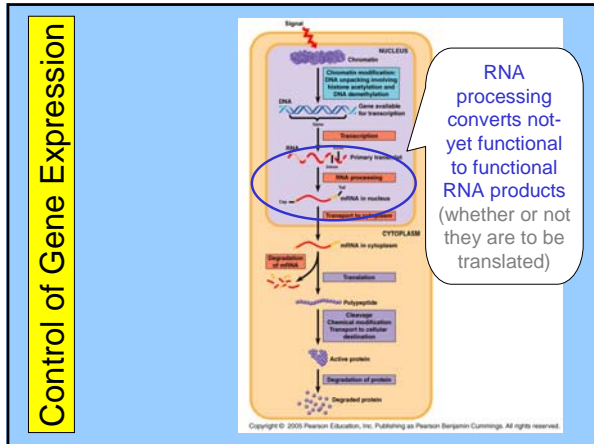


## Transcription Factors

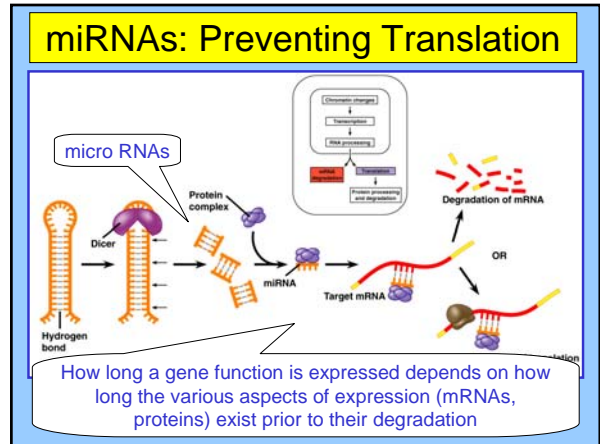
- Transcription factors are proteins (rather than DNA sequences)
- Some transcription factors bind to DNA; others bind to RNA polymerase, affecting what promoter sequences are recognized
- By varying the transcription factors synthesized, a cell can vary what array of genes are expressed
- In this way cells with metabolically related genes found on many different chromosomes may be simultaneously transcribed (this is instead of operon-mediated control of gene expression)
- That is, similarly expressed genes would have similar promoters and enhancer sequences and thus respond similarly to specific arrays of transcription factors

## Activation of Transcription





- ### RNA Degradation
- The more temporally linked transcription and translation, the more rapidly a cell can respond to its environment via transcription
  - The strong temporal linkage between transcription and translation is how prokaryotes achieve rapid adaptation to environmental cues
  - mRNAs in eukaryotic cells, in addition to posttranscriptional modification, typically require activation via specific protein binding in order for subsequent translation to take place
  - For example, whole arrays of mRNAs may be synthesized but not expressed until a time that is appropriate, such as following the fertilization of an egg
  - How long a gene function is expressed depends on how long the various aspects of expression (mRNAs, proteins) exist prior to their degradation
  - Alternatively, the longer mRNAs last, the more protein synthesis which may be acquired per mRNA produced, thus reducing some of the cost of protein synthesis



### Control of Gene Expression

“Translation presents another opportunity for regulating gene expression; such regulation occurs most commonly at the initiation stage.” p. 369, Campbell & Reece (2005)

The diagram illustrates the flow from DNA to RNA to protein. A callout box highlights the translation step, indicating it as a key point for regulation. Below the main flow, a box lists 'Cleavage', 'Chemical modification', and 'Transport to cellular destination' as ways to modify an active protein, leading to 'Degradation of protein'.

### Control of Gene Expression

Eukaryotic cells achieve their more-rapid cellular adaptation to environmental conditions through protein activation/inactivation

Part of protein activation involves processing, which can include polypeptide cleavage, addition of carbohydrate, and targeting to appropriate locations

This diagram is similar to the first one but includes callouts. One callout points to the translation step, stating that eukaryotic cells adapt to environmental conditions through protein activation/inactivation. Another callout points to the post-translation processing of polypeptides, noting that this involves cleavage, addition of carbohydrates, and targeting to specific locations.

### Protein Activation/Inactivation

A rapid means of changing phenotype via a modification of protein expression is the simple activation of and inactivation of cellular proteins

The diagram shows a signal molecule binding to a receptor, which activates a relay molecule. This leads to a cascade of protein kinases: Inactive protein kinase 1 becomes Active protein kinase 1, which then activates Inactive protein kinase 2 to become Active protein kinase 2, and so on, eventually leading to an Active protein that triggers a Cellular response. The activation steps are shown to require ATP and release ADP.

### Control of Gene Expression

Just as with mRNA degradation, a cell may be able to respond to its environment more quickly by selectively degrading no longer needed cellular proteins

This diagram is similar to the first one but includes a callout box. The callout states that just as with mRNA degradation, a cell can respond to its environment more quickly by selectively degrading no longer needed cellular proteins. The diagram also shows the nuclear processes of chromatin modification, transcription, and RNA processing before mRNA moves to the cytoplasm.

### Protein Degradation

Tags protein for degradation

Protein to be degraded → Ubiquitinated protein → Protein entering a proteasome → Protein fragments (peptides)

The diagram shows a protein being tagged with ubiquitin molecules. This ubiquitinated protein then enters a proteasome, which degrades it into protein fragments (peptides). A callout box says 'Tags protein for degradation'. A separate box shows the steps: 'Chemical changes' → 'Transcription' → 'RNA processing' → 'mRNA degradation' → 'Gene expression'.

