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1.0.1 | Overview

- Organisms turn genes on and off which is called Gene Expression
 - This can be done in response to external and internal signals
 - These signals are based off of environmental factors
 - This is also be done in order to specialize cells
 - Certain cells need certain genes to preform their specific role

Differential Gene Expression

- Human Cells can express about 20% of it's protein coded genes at any given time
- Most cells contain the same genome
 - Each cell type must use specific parts of this genome
 - This is called Differential gene expression
 - Exception would be cells of the immune system
- Due to the importance of gene expression when it has issues it can affect the organism significantly
- Process of Gene expression in a Eukaryotic cell
 - Chromatin (DNA unpacking) ->
 - RNA processing ->
 - Transport to cytoplasm ->
 - Translation ->
 - Protein processing ->
 - Transport to cellular destination->
- This process can often be equated to transcription for Prokaryote cells

1.0.2 | Regulation of Chromatin Structure

- The chromatin structure itself allows for the regulation of gene expression
 - This is partially due to the location of the promoter
- Chemical modifications to the histone proteins can affect the structure
 - This in turn can affect gene expression
 - Histone proteins are the proteins in which the DNA is wrapped
 - There are many types of modifications that can take place
 - Histone acetylation can tend to promote transcriptions by opening up the chromatin
 - Additional methyl groups tend to close up the chromatin and decrease transcription
 - DNA methylation occurs in most plants and animals as well as fungi
 - Methylated DNA will stay methalated through cell divisions
 - This accounts for genomic imprinting
 - These epigenetic markers can be inherited

- There is continually more evidence for the importance of epigenetics in gene expression
- ### Regulation of Transcription

- Chromatin changes are not permanent and can be reversed
- The next step of gene expression regulation is in the transcription factors
 - These either allow for or inhibit transcription
- These factors usually bind to proteins, but some of them bind to DNA
- High levels of transcription factors created for specific genes are associated with another protein thought creatively of as specific transcription factors
- Gene expression is dramatically increased or decreased by the binding of specific transcription factors
 - These are either activators or repressors
- There are many transcription factors
 - Repressors act in many different ways, but some bind directly to control element DNA blocking activator binding
 - Others interfere with the activator itself
- Coordinated control of genes can need to happen when multiple genes need to be expressed at the same time for something to function
 - These can often be signaled from the outside with something like a hormone
- The activation of receptors on the surface of the cell can release specific repressors and activators

Mechanisms of Post-Transcriptional Regulation - Transcription is not the only thing that regulates gene expression - How much of the protein is created once the RNA is received is also a factor - RNA can be interpreted in different ways with different things being introns and others being exons - This allows for the creation of multiple proteins from the same strand of RNA - RNA splicing is critical since it allows a lot of information to be fit on a single strand of RNA - Around 75-100% of human genes with multiple exons undergo RNA splicing allowing for our genome to describe a lot of complexity without needing as many genes - Translation is another stage at which gene expression occurs - Some regulatory proteins can block translation of an mRNA by preventing attachment to a ribosome - Length by which an mRNA is around is also crucial - This can vary greatly depending on the cell - Cells can mark proteins for destruction using something called ubiquitin