Gene regulation

Gene regulation

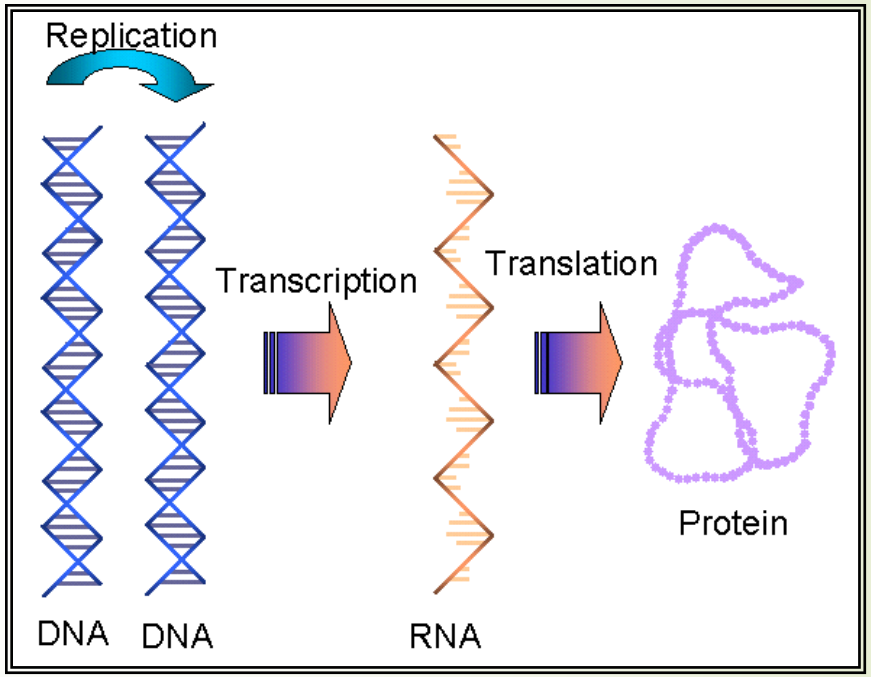
- **Gene regulation** is the process used to control the timing, location and amount in which genes are expressed. The process can be complicated and is carried out by a variety of mechanisms, including through regulatory proteins and chemical modification of DNA. Gene regulation is key to the ability of an organism to respond to environmental changes.

- Information of the DNA is copied by directing the synthesis of a RNA molecule in a process called **transcription**

- RNA directs the protein synthesis in a **translation**

- Protein's 3D structure determines it's function

- Information can transfer only in one direction

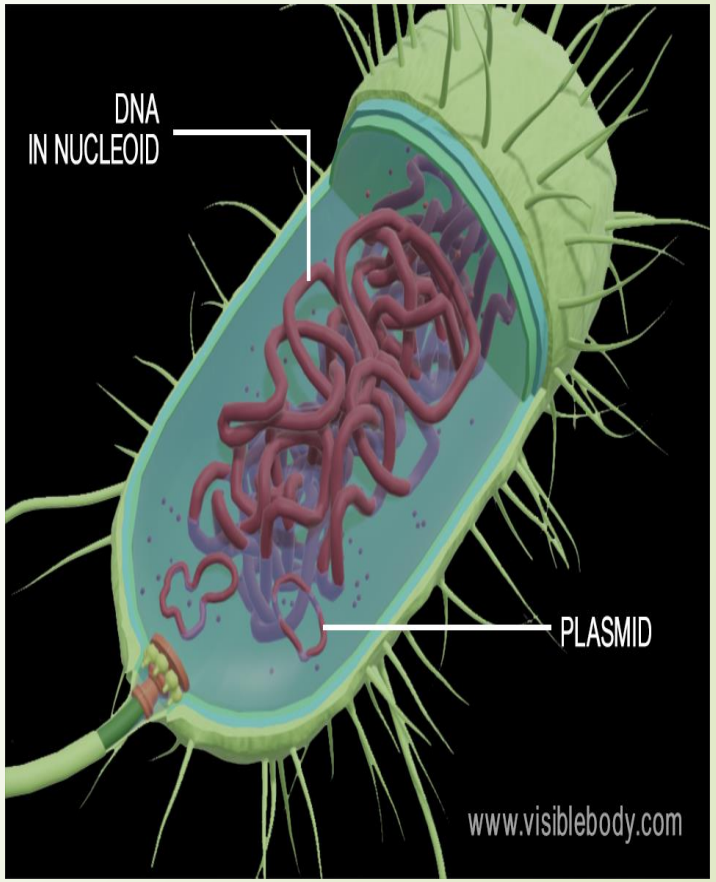


Prokaryotes

- Prokaryotic organisms are single-celled organisms that lack a cell nucleus, and their DNA therefore floats freely in the cell cytoplasm. To synthesize a protein, the processes of transcription and translation occur almost simultaneously. When the resulting protein is no longer needed, transcription stops. As a result, the primary method to control what type of protein and how much of each protein is expressed in a prokaryotic cell is the regulation of DNA transcription.

Prokaryotic chromosome

Prokaryotic chromosomes are **found in the nucleoid of prokaryotic cells, and they are circular in shape**. Unlike eukaryotic cells, prokaryotic cells don't have a membrane-bound nucleus. Instead, their genetic material can be found in a region of the cytoplasm called the nucleoid.



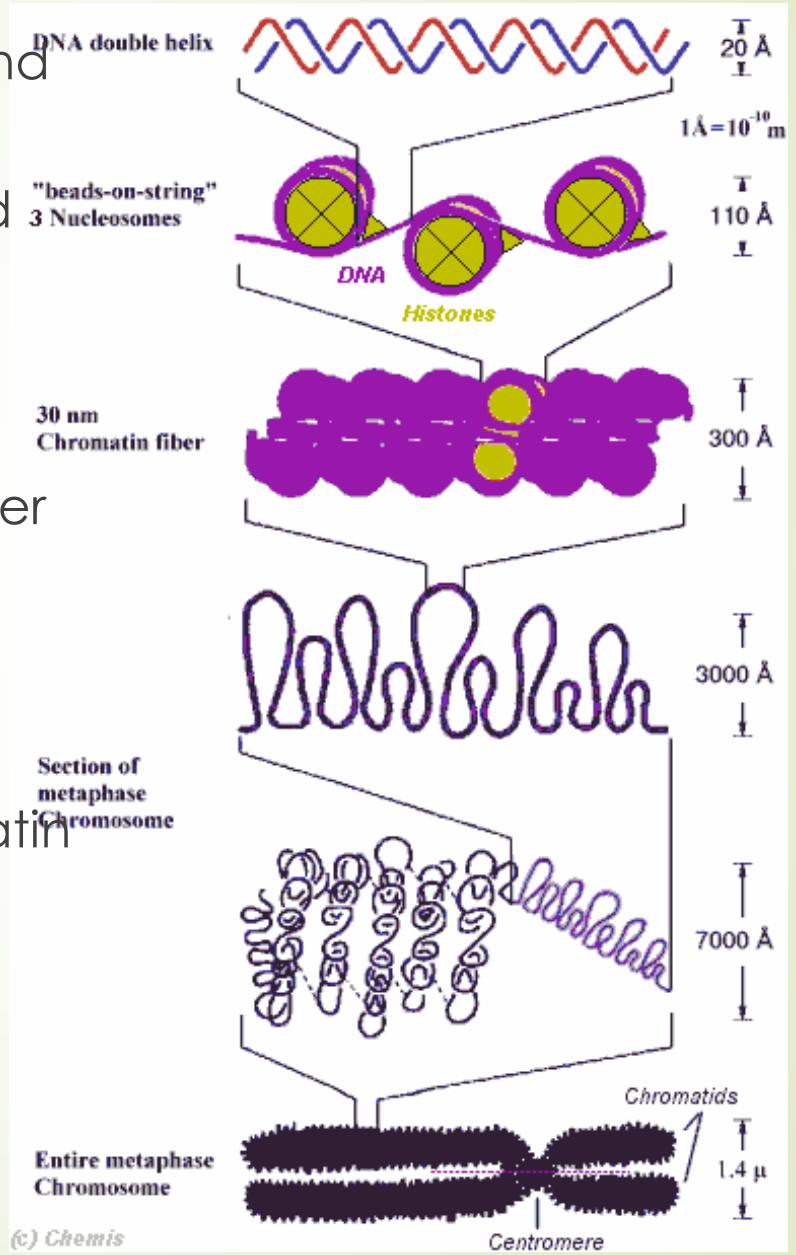
Eukaryotes

- Eukaryotic cells, in contrast, have intracellular organelles that add to their complexity. In eukaryotic cells, the DNA is contained inside the cell's nucleus and there it is transcribed into RNA. The newly synthesized RNA is then transported out of the nucleus into the cytoplasm, where ribosomes translate the RNA into protein. The processes of transcription and translation are physically separated by the nuclear membrane; transcription occurs only within the nucleus, and translation occurs only outside the nucleus in the cytoplasm.

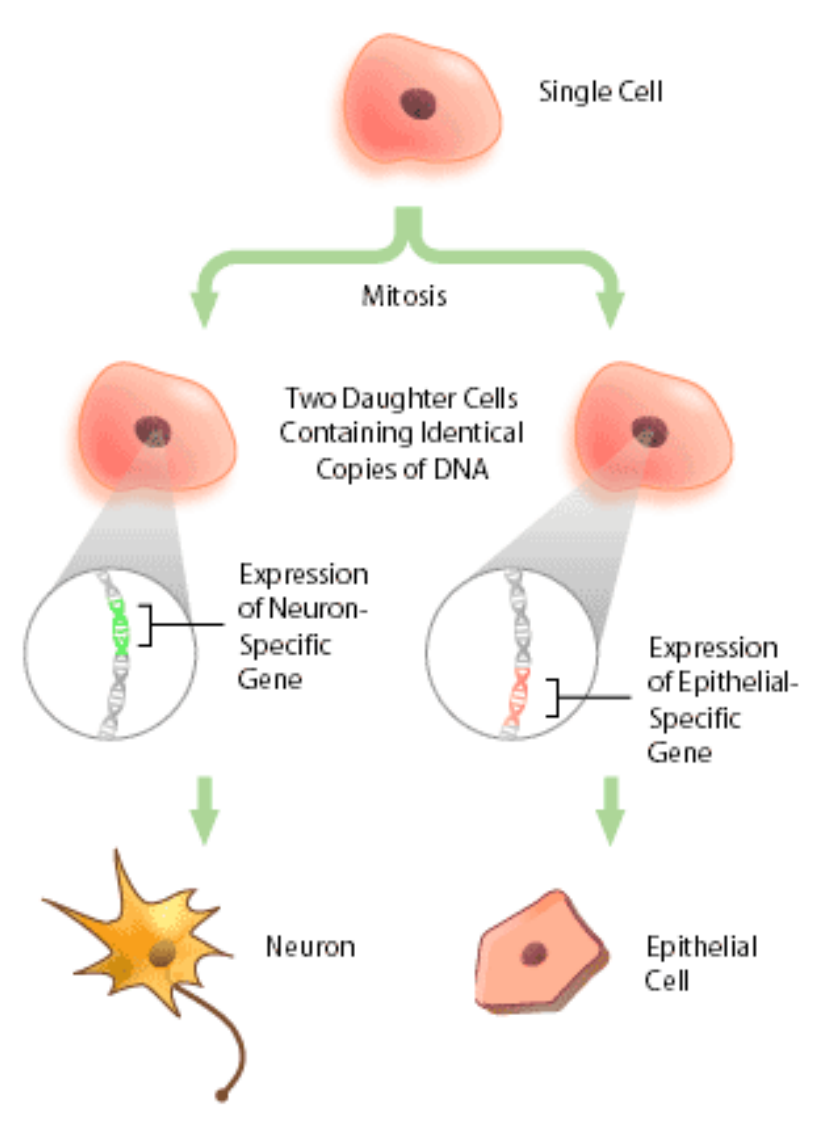
1. Eukaryotic cells have many more genes (i.e. 23,000 in human cells) in their genomes than prokaryotic cells (i.e. average 3000).
2. Physically there are more obstacles to regulate eukaryotic genes because there is so much more DNA to manage. For example, eukaryotic chromatin is wrapped around histone proteins.
3. In addition there are other nonhistone proteins that are used in eukaryotic gene expression that are not used in prokaryotic gene expression.

Eukaryotic Chromosome

- **Chromosomes** – tightly coiled DNA around proteins during cell division
- **Chromatin** – loosely packed DNA around proteins
- **Histones** – protein which the DNA wraps around
- **Nucleosomes** – grouped histones together
  - **Heterochromatin** – tighter packed chromatin
    - Not transcribing
  - **Euchromatin** – looser packed chromatin
    - Transcription occurring



Gene Expression: Eukaryotes



- **<u>Cell Differentiation</u>** – cell specialization
- All cells contain the same genes
- The genes that are expressed determines the type of cell
  - Ex: Skin cell vs. a nerve cell

Differences

Prokaryotic organisms	Eukaryotic organisms
Lack nucleus	Contain nucleus
DNA is found in the cytoplasm	DNA is confined to the nuclear compartment
RNA transcription and protein formation occur almost simultaneously	RNA transcription occurs prior to protein formation, and it takes place in the nucleus. Translation of RNA to protein occurs in the cytoplasm.
Gene expression is regulated primarily at the transcriptional level	Gene expression is regulated at many levels (epigenetic, transcriptional, nuclear shuttling, post-transcriptional, translational, and post-translational)

Thank you for your attention!