Quadrants II Template - Notes

Programme	**:** Bachelor of Science (First Year)
Subject	**:** Zoology
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Unit	**:** Chromosome Structure (Unit 9)
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Name of the Presenter	**:** Cynera Pereira

Prokaryotic and Eukaryotic Chromosomal Organization

Chromosomes

A chromosome is a single, long molecule of DNA. These highly organized structures store genetic information in living organisms. Small sections of the chromosome, called genes, code for the RNA and protein molecules required by an organism. In some organisms, like humans, chromosomes are linear, but in other organisms, like bacteria, chromosomes are typically circular. In prokaryotes, the circular chromosome is contained in the cytoplasm in an area called the nucleoid. In contrast, in eukaryotes, all of the cell's chromosomes are stored inside a structure called the nucleus. Each eukaryotic chromosome is composed of DNA coiled and condensed around nuclear proteins called histones.

Humans inherit one set of chromosomes from their mother and a second set from their father. In total, most human cells contain 46 chromosomes with 22 pairs of autosomes, or non-sex chromosomes, and two sex-determining chromosomes. The sex chromosomes in humans are called X and Y. Females carry two X chromosomes, while males carry one X and one Y chromosome.

Cells of the body that contain two sets of chromosomes are called diploid. Meanwhile, germ line cells, which go on to produce egg or sperm cells, are called haploid because they contain half the chromosomes of diploid cells.

Chromosomes are often observed and depicted as X-shaped structures. DNA takes this form following DNA replication during the process of cell division when the two replicated chromosomes, called chromatids, are highly condensed and still attached to one another at a point called the centromere. Human chromosomes can be differentiated from one another under a microscope by their lengths and by the position of the centromere.

Since prokaryotic cells typically have only a single, circular chromosome, they can replicate faster than eukaryotic cells. In fact, a prokaryotic cell can undergo two rounds of DNA replication before the cell, itself, has divided. This means that DNA replication can occur during cell division in prokaryotes.

Since eukaryotic cells typically have multiple linear chromosomes, capped with telomeres, eukaryotic DNA replication and cell division (mitosis and meiosis) are a bit more complicated. In eukaryotic cells, DNA replication occurs before mitosis begins, and it can't occur while the cell is dividing. In addition, the telomeres—repeating DNA sequences at the ends of each chromosome—limit the number of times a cell can divide before it dies or becomes senescent. Each time a typical or somatic eukaryotic cell divides, the telomeres get shorter. Eukaryotic chromosomes are located within the nucleus, whereas prokaryotic chromosomes are located in the nucleoid.

Eukaryotic cells have a membrane-bound nucleus, but prokaryotic cells do not.

The key difference between prokaryotic and eukaryotic cells is that eukaryotic cells have a membrane-bound nucleus (and membrane-bound organelles), whereas prokaryotic cells lack a nucleus. In eukaryotic cells, all the chromosomes are contained within the nucleus. In prokaryotic cells, the chromosome is located in a region of the cytoplasm called the nucleoid, which lacks a membrane.

One interesting implication of this difference in the location of eukaryotic and prokaryotic chromosomes is that transcription and translation—the processes of creating an RNA molecule and using that molecule to synthesize a protein—

can occur simultaneously in prokaryotes. This is possible because prokaryotic cells lack a nuclear membrane, so transcription and translation occur in the same region. As the RNA is being transcribed, ribosomes can begin the translation process of stringing together amino acids. In contrast, in eukaryotic cells, transcription always occurs first, and it takes place within the nucleus. The RNA molecule needs to undergo editing before it leaves the nucleus. Then, translation is conducted by a ribosome in the cytoplasm.

In eukaryotic chromosomes, DNA is wound around histone proteins, and then, it is further compacted by supercoiling and folding. In prokaryotic chromosomes, DNA is supercoiled and compacted by nucleoid-associated proteins.

CHROMOSOMAL ORGANIZATION

Eukaryotic vs. Prokaryotic Chromosomes

Most eukaryotic cells have multiple linear chromosomes, whereas prokaryotic cells have just one circular chromosome. As a result, Prokaryotic cell can undergo two rounds of DNA replication during cell division. Whereas Eukaryotic cell undergoes DNA replication before cell division. Due to the difference in the location of chromosomes in Prokaryotic and Eukaryotic cells, the transcription and translation process differs in their origins. Prokaryotes have no nuclear membrane so the transcription and translation process can takes place in the same region. But in Eukaryotes, the transcription process will take place first in the nucleus region and translation is followed up in the cytoplasm.

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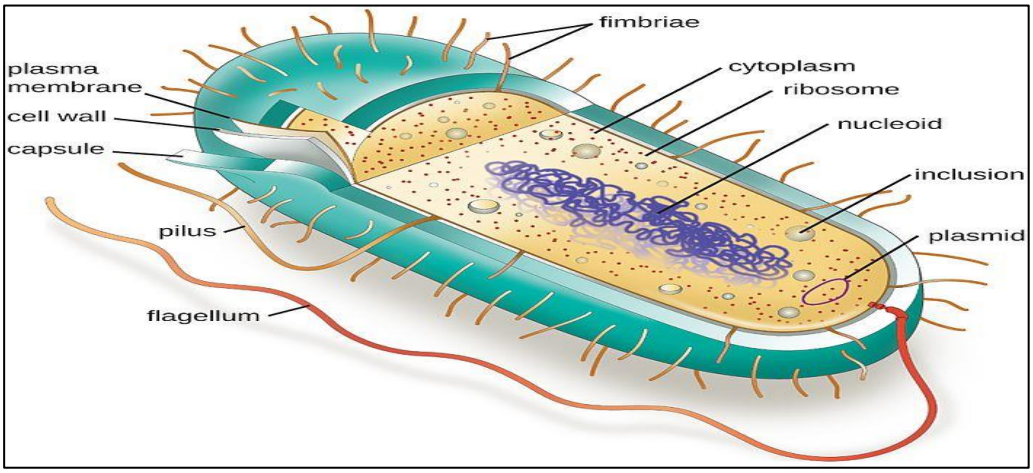
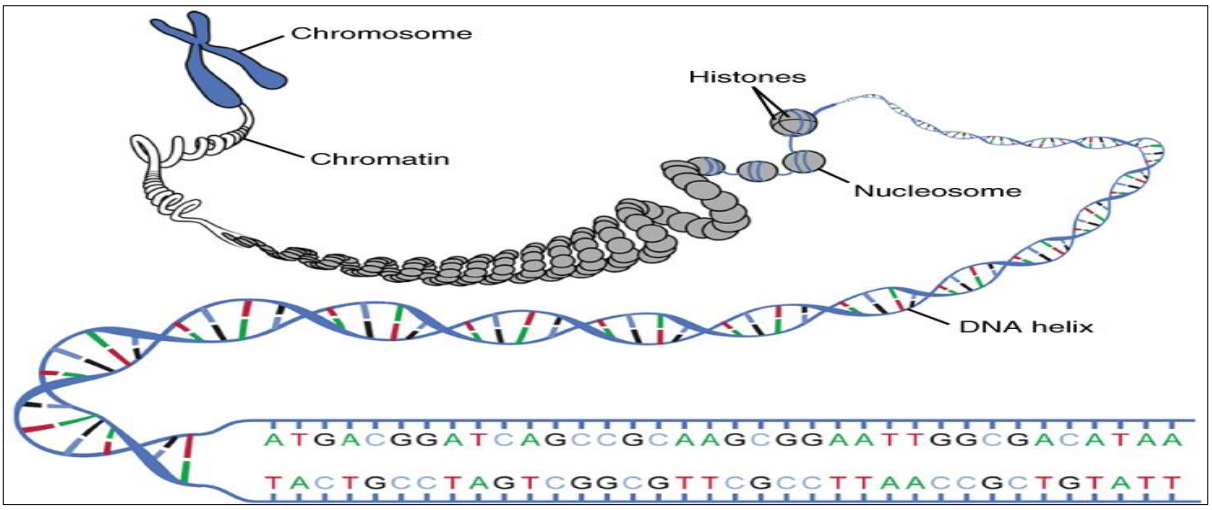
In general, eukaryotic cells contain a lot more genetic material than prokaryotic cells. In eukaryotic cells, chromatin consists of all the DNA within the nucleus and its associated proteins, called histones. First, the DNA is wrapped around clusters of histones, forming nucleosomes. Prokaryotic cells also have a lot of DNA, but the molecules don't need to be packaged up quite as tightly as they do in eukaryotic cells. Although most prokaryotic cells don't use histones to coil up their DNA, they have various proteins and enzymes that introduce folds to produce a complex, compacted structure.





0321_DNA_Macrostructure.jpg
By OpenStax
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	Eukaryotic Chromosome	**Prokaryotic Chromosome**
Shape	Linear	Circular
Size	Large	Small
Number	Multiple	Single
Location	Nucleus	Nucleoid (region in cytoplasm)
Storage proteins	Histones	Nucleoid-associated proteins