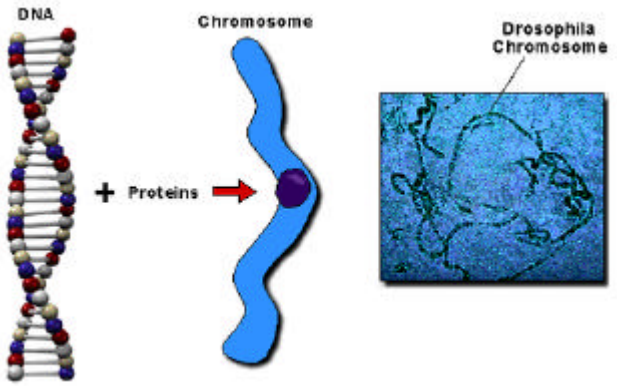
Study Guide #2

CHROMOSOME LOCATION AND COMPOSITION

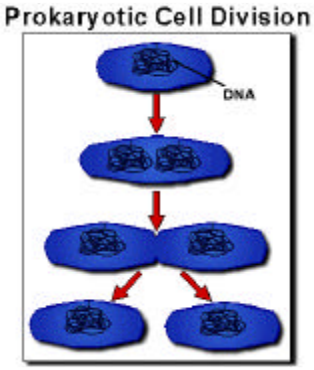
A prokaryote, you will recall, has no nucleus. Therefore, the genetic material (DNA) of a prokaryote is found suspended in the cytoplasm of that cell.

In eukaryotic organisms, genetic material is found inside of the nucleus. Therefore, the nucleus is a specialized organelle designed to house DNA (keeping it separate from the cytoplasm). Let's take a closer look at DNA in eukaryotes.

DNA (whether coming from a prokaryote or a eukaryote) is a macromolecule composed of deoxyribonucleic acid. In eukaryotes, DNA comes in very long strands. It is compacted into linear structures known as chromosomes. Compacting DNA into chromosomes is an efficient way for cells to store their genetic material. Chromosomes often come in pairs, in which case they make up a chromosome set.



DNA is very important to the cell. Within DNA are long stretches of information known genes. Genes carry all the information a cell needs to live and reproduce.



DNA in prokaryotes is also compacted. However, whereas compaction in eukaryotes results in a long, linear strand, compaction in prokaryotes results in the formation of a circular chromosome.

Cell division (reproduction) in prokaryotes is less complicated than in eukaryotes. When the time comes for prokaryotic cell division to take place, the circular chromosome duplicates itself. The two chromosomes move apart and the cell then pinches in half to form two independent cells. In each identical cell is one circular chromosome.

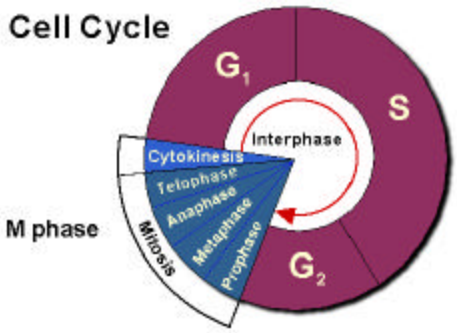
In the next study guide, we'll take a look at eukaryotic cell division.

Study Guide #3

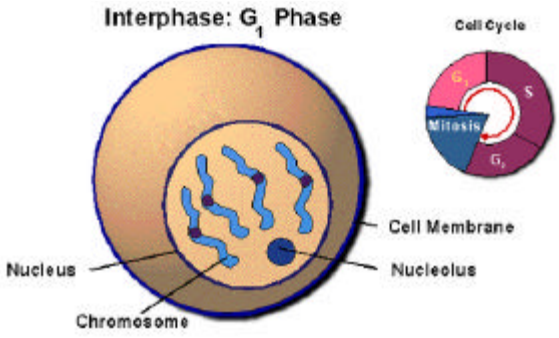
INTRODUCTION TO EUKARYOTIC CELL DIVISION AND INTERPHASE

As stated earlier, eukaryotic cell division is more complicated than prokaryotic cell division. Prokaryotes have only a single chromosome to copy when undergoing cellular division.

Eukaryotes, on the other hand, can have many pairs of linear chromosomes housed in the nucleus. For a eukaryotic cell to successfully divide, its entire complement of chromosomes as well as its nucleus must be duplicated. Only if this duplication process is carried out precisely will both the parent cell and the new cell receive a nucleus and chromosome set.

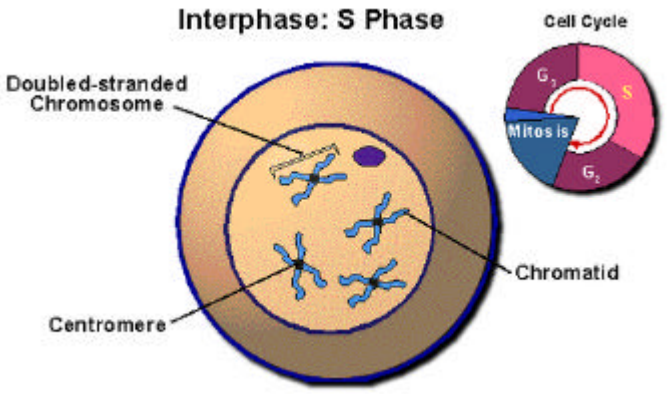


Eukaryotic cells have a distinctive cell cycle of growth and division. During this cycle, the G1 phase, S phase, and G2 phase make up what is called interphase. A eukaryotic cell spends about 90% of its time in interphase. Here is what happens at each of the 3 phases of interphase.



G1 phase: This stage in the cell cycle of a eukaryotic cell is one of general growth. During the G1 phase, each chromosome in the chromosome set consists of one uncondensed strand DNA.

S phase: During the S phase, each chromosome is copied. This results in two identical chromosomes that remain attached to each other by a centromere. (To visualize this, think of the letter X. Each side of this letter represents one chromosome, and where the



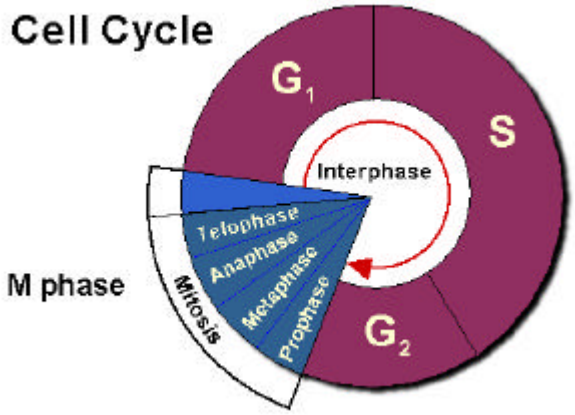
two sides come together is the centromere) Each chromosome now consists of two identical strands of DNA known as chromatids. (Each side of the letter X is a chromatid)

G2 phase: In the last phase of interphase, the cell readies itself for mitosis.

Study Guide #4

MITOSIS

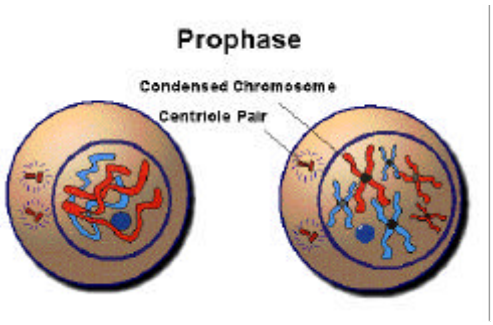
At the end of mitosis, two cells with equal number of chromosomes are formed. Here is a look at how this process works.



There are four stages in mitosis. These stages are prophase, metaphase, anaphase, and telophase. Let's look at these in order.

Prophase

When cells enter prophase, their chromosomes have been copied. However, these chromosomes are uncondensed. That is, they are long, stretched out, and difficult to see. In the first part of prophase, the chromosomes condense, becoming visible in the process. Condensed chromosomes make division easier for the cell. (Just like moving a very long thread is easier if the thread is wound onto a spool) During prophase in animal cells, rod-shaped structures known as centrioles appear and move to opposite sides of the cell.

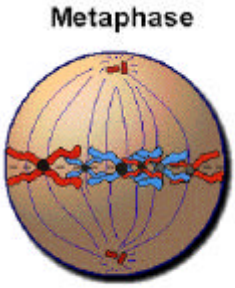


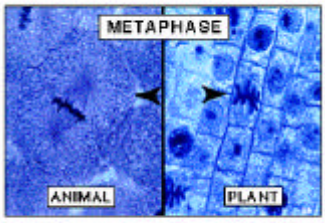
At the beginning of prophase, the cell's nucleus and nucleolus are readily visible. During prophase, the nucleus and nucleolus gradually fade until, at the end of prophase, both of these structures are no longer visible.

After the centrioles have moved to opposite sides, they extend fiber-like structures called microtubules. These microtubules form a spindle between the two centrioles. While plant cells do not have centrioles, they do form spindles.

Some of the microtubules that form the spindle attach to the doubled chromosomes. During prophase, all chromosomes become attached to microtubules. As prophase continues, the microtubules begin to pull the chromosomes towards the center of the cell, known as the equator. At the end of prophase, all chromosomes are attached to microtubules and positioned at the equator. The cell now enters the next phase; metaphase.

Metaphase





At the beginning of metaphase, all chromosomes are lined up along the equator. They are attached to microtubules in a very specific way.

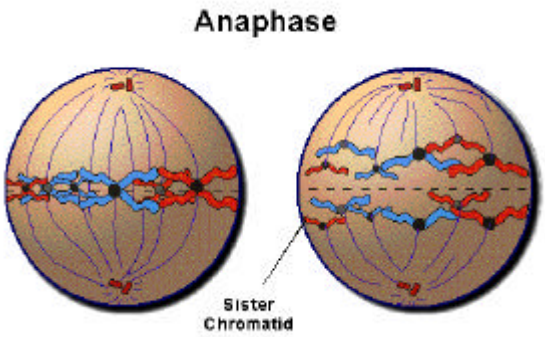
Remember that each chromosome is doubled. That is, each chromosome has been copied and now consists of a pair of chromatids connected by a centromere. Attached to each centromere are two microtubules; one from each centriole.

As metaphase progresses, each doubled chromosome splits at the centromere, forming and unattached pair of matching chromatids. At this point, the cell moves into the third phase of mitosis; anaphase.

Anaphase

Anaphase opens with the splitting of the centromeres at the end of metaphase. In a highly organized manner, the cell then equally divides the pairs of chromatids. One chromatid

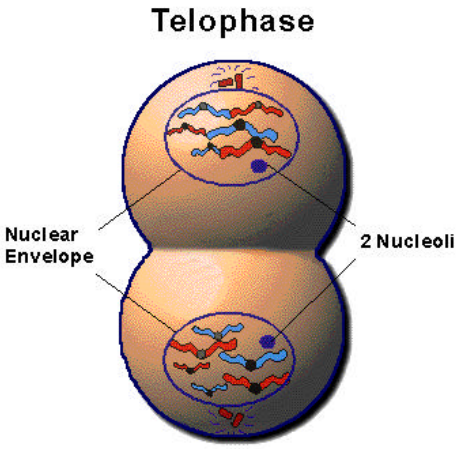
from each pair is pulled towards one of the centrioles, and the second chromatid is pulled towards the other centriole.



At the end of anaphase, each side of the cell has received one complete set of chromosomes. At this point, the cell is ready to enter the final phase of mitosis; telophase.

Telophase

As the cell enters telophase, it has two complete sets of chromosomes (each positioned at opposite sides of the cell). During telophase, a nuclear envelope forms around each of the two sets of chromosomes. As this nucleus forms, a nucleolus begins to appear and the spindles begin to disappear. Finally, as mitosis comes to a close, the chromosomes begin to uncoil, stretching out and once again becoming indistinguishable.



Now that the cell has two nuclei, each with a complete set of chromosomes, the cell is ready to divide into two cells. This final phase of the cell cycle is known as cytokinesis.