Basics: Cell Division

There are three types of cell division, two are specific to eukaryotes while one is specific only to prokaryotes.

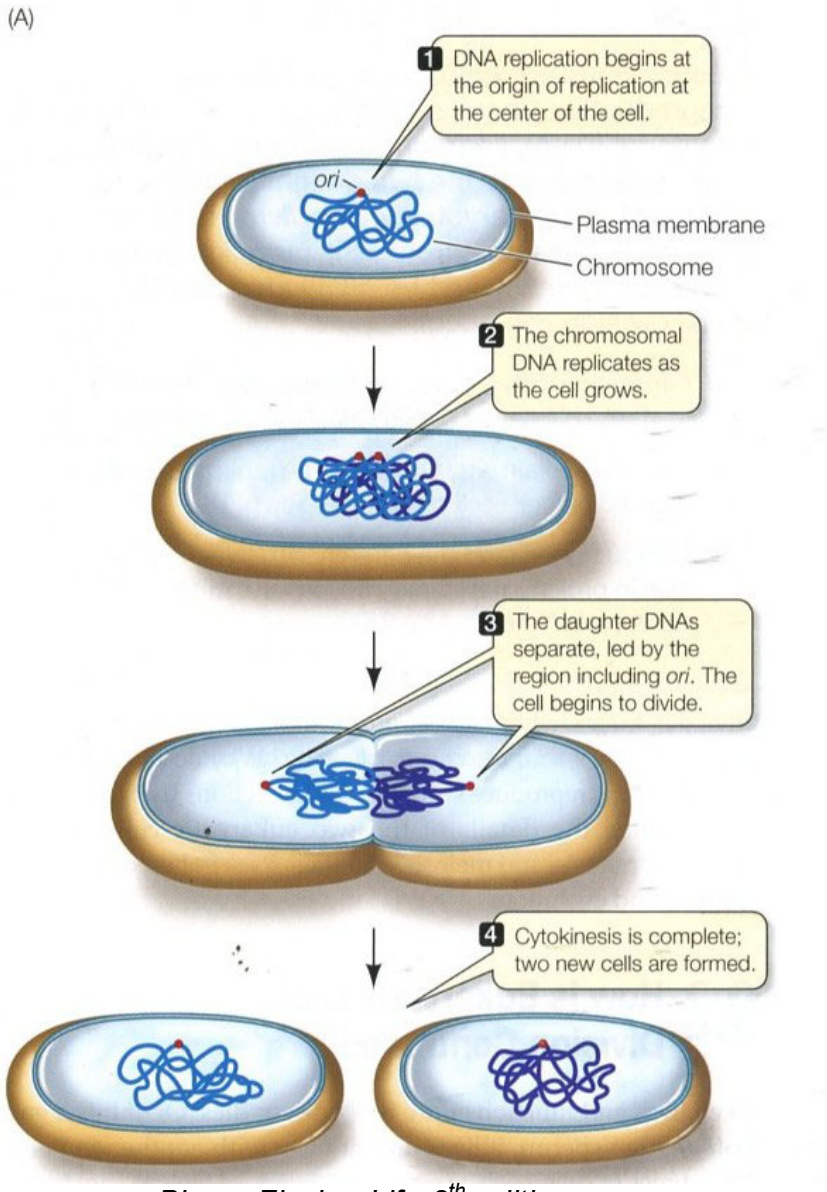
The one that is specific to prokaryotes is called binary fission. The two that apply to eukaryotes are called mitosis and meiosis. Mitosis occurs in most cells while meiosis occurs only in sex cells called gametes that produce eggs and sperms required for sexual reproduction.

Lets talk about binary fission, the type of cell division that only occur for prokaryotes. Prokaryotes are unique in that whenever they undergo cell division, they reproduce. Prokaryotes reproduce whenever there are sufficient nutrients and good environmental conditions. Thus, by improving the nutrients and environmental conditions, one could speed up the reproduction of the prokaryotes considerably. Therefore, cell division occurs frequently.

Most prokaryotes only have a single chromosome and this chromosome is usually circular. It has a region called *ori* that marks the start of the DNA replication and another region called *ter* that marks the end. DNA replication occurs near the center of the cell in a region called the “replication complex”. As DNA replication occurs, the cell grows to accumulate the newly formed DNA.

Segregation of DNA occurs as ori regions of each duplicated chromosome moves towards the opposite poles of the cell. Cytoskeletons within the cell aids this process by acting actively moving the chromosome or by acting as “railroad tracks”.

As soon as chromosomes are moved to opposite poles, the plasma membrane pinches in at the middle and divides the cell apart. New cell wall materials are synthesized at the same time that the plasma membrane pinches in. This particular process is called cytokinesis. Please note that cytokinesis is not separate from nuclear division. This will become clear when we talk about mitosis.



Binary Fission-Life-8th edition

Eukaryotes' cell division differs from prokaryotes in a number of ways.

First of all, eukaryotes do not divide whenever environmental factors favor it. The signal for cell division comes from the need of the organism.

Secondly, most eukaryotes have many chromosomes; this greatly complicates the division process.

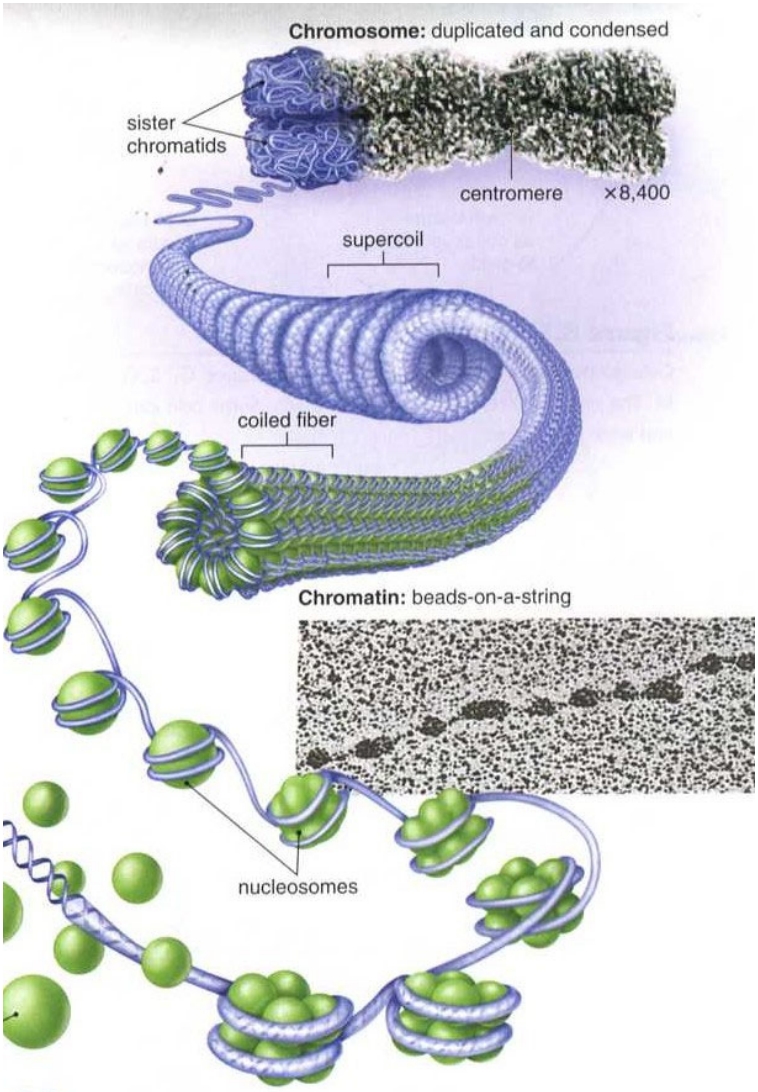
Thirdly, due to the presence of the nucleus in eukaryotic cells, nuclear division, mitosis, is separate from the division of the cytoplasm, cytokinesis.

It is also important to note that cytokinesis is different in plants and animals.

Eukaryotic cells have what's called a cell cycle. It describes the events in the life cycle of a cell. This cycle is usually divided into two major phases, mitosis and interphase. Interphase is in turn divided into three subphases, G1, S, and G2. S stands for synthesis, G1 stands for Gap1 and G2 stands for Gap2. Before we get into the details of the cell cycle, it is important to define some terms.

DNA in cells normally occurs as long strands called chromatins. These chromatins take up a lot of space and thus can be difficult to move around during cell division. Therefore, when cell division begins, the chromatins are "squeezed" into a compact structure called chromosomes. Each chromatin wrap around a group of 8 proteins called histones. This group of 8 histones is called a nucleosome. The histones are responsible for packing the chromatins into a compact structure.

Several nucleosomes coil together to form a long fiber that loops to produce a highly compact structure we called the chromosome.



Chromatin to chromosome. Essentials of Biology

G1 is a crucial subphase in a cell's life. This subphase will decide if the cell will divide or die. Different types of cells have different periods of time they spend on the G1 stage. During this time, some organelles (i.e. mitochondria and ribosomes) will also replicate to prepare for cell division. Cells may enter an inactive G0 phase and reenter G1 when called upon.

S is the subphase where the duplication of DNA starts.

G2 phase is when cells prepare for mitosis. Synthesis of microtubules needed to move the chromatids occur here.

Mitosis and cytokinesis are both part of the M stage. Mitosis marks the beginning of the M stage with its own phase called the prophase. During the prophase, chromosomes are formed from chromatins. Since there are two copies of each chromosomes (due to DNA replication in the S-subphase), these two copies are joined together at *centromere* to form *sister chromatids.*

Spindles are made up of microtubules that can assemble and dissemble itself. They are the structures used by eukaryotic cells to pull the sister chromatids apart to form the *daughter chromosomes.* They start to duplicate at the S subphase and complete duplication by G2. During prophase, they separate and begin to assemble at the *centrosomes* of each pole of the cell.

Nucleolus also disappears during the prophase. Nuclear envelope also breaks down. This greatly facilitate the movement of chromosomes within the cell.

During the 2nd stage of mitosis, metaphase, chromosomes line up at the spindle equator midway between the spindle poles.

At 3rd stage of mitosis, anaphase, sister chromatids are separated by spindles and form daughter chromosomes. Spindle fibers begin to disassemble, forcing chromosomes to move to opposite poles.

The 4th stage of mitosis, telophase, marks the end of mitosis. Spindle disappears and new nuclear envelope form around the daughter chromosomes. Cytokinesis begins here.

The important thing to know about mitosis is that it is a cell division that results in chromosomes that are identical to the parent cell. Thus, whatever the genetic material your parent cell have, you and the other daughter chromosome will also have an exact copy.

Unlike in prokaryotes, cytokinesis is a separate process and may or may not occur. If it does not occur, it can results in multinucleated cell.

Cytokinesis occurs differently in plants and in animals. In animal cells, a *cleavage furrow*, indentation of the membrane between 2 daughter nuclei forms as anaphase draws a close. This furrow is deepened by actin filaments that form a circular drawstring that tightens and eventually separate the cytoplasm. (Contractile ring)

Plants cells have a rigid cell walls that does not permit furrowing, Therefore, cytokinesis in plant cells involves building of new plasma membrane and cell walls between two daughter cells. Vesicles arrive from the Golgi apparatus and form a cell plate that expands until it reaches the old plasma membrane and fuse with it. The new membrane will then release molecules that form new plant cell walls.