However in unequal cytokinesis, the cell content is divided unequally between the two daughter cells. A very good example of this is formation of the ovum. In a female when an ovum is formed the daughter cells do not receive equal amount of cytoplasm one of them gets about 90 percent of it of the cell contents and the other has about 10%. This 90 percent survives while the 10 percent degenerates. This 10 percent exists just to make the chromosome number half.

These are the two types of cytokinesis however cytokinesis also differs between a plant cell and an animal cell major reason why this happens is that a plant cell does not have any rigid cell wall holding it together. so a cleavage furrow can easily be formed. the cell can just divide like in case of an amoeba that's not exactly how mitosis occurs.

but we know that during binary fission, the cell just forms a deep furrow and eventually divides. However in a plant cell there is a cell wall surrounding the cell. This cell wall does not allow cleavage to occur, therefore the plant cell has to develop some new techniques some different mechanism than the animal cell to divide.

cytokinesis starts somewhere between in the late anaphase and ends with the telophase. This is variable, this can change from cell to cell, but it's more or less the average duration that cytokinesis takes.

During the anaphase, the chromosomes have aligned in the middle and they're starting to move away from each other and it's time to start dividing the cytoplasm so that the two new daughter cells can be formed.

As the cell decides to divide there is a division plane that is set up before anything happens.

so as a division plane is formed a protein known as Rho-A which is a gt pase, which means that this protein needs energy to work. It will break down the gtp into gdp and gtp is like atp it functions exactly as atp does.

The bonds this phosphate group store are released and Rho-A can then form a contractile ring.

Rho-A calls out for help it wants some proteins to come in and form this contractile ring. Two proteins work in contractile are actin and myosin. Here it is myosin-II.

Therefore this contractile ring can contract and it will use energy. the contractile ring will be set up something like this around the cell uh now this is a 2d plane but you can imagine it in 3d that is going from forward to backwards and in between there is the metaphase plate as this contractile ring is set the chromosomes are continuing to move to opposite poles by the end of the telophase or during the late telophase we know that the two nuclei have started to form.

now this nuclear envelope is developing the chromosomes are again condensing back into they are loosening up into chromatins and a cell has started to divide.

the contractile ring now starts to move inwards it has started to contract due to the actin in myosin.

as the contractile ring starts to contract this entire region that is present here which is being divided forms the mid-body structure.

now the organelles are divided equally between the two cells. In this mid-body structure are present the cytoplasm the microtubules that has degenerated here and all of the structure that will be attached to the middle of the cell for example the endoplasmic reticulum that are present in the mid body structure later form the gap junctions in the animal cells and these gap junctions are used for transfer of material or communication between the two cells.

now this mid-body structure moves inwards and as this contraction continues a final step comes which is known as abscission this final step is the step where this contractile ring has now completely contracted and the two cells have now pinched off from each other and divided to form two daughter cells in this case with equal number of cytoplasm this was the process of cytokinesis in an animal cell that is without cell wall.

Cell cycle completed in 2 phases- Interphase and M-phase. M-phase is the actual cell division phase in which Cytokinesis and Karyokinesis two process occurred. It starts with nuclear division, leads to karyokinesis and usually ends with cytokinesis.

When cell enters into the cell cycle it goes through various phases like synthesis of DNA, duplication of cell organelle, synthesis of various protein, required for mitosis.

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| In Animal cell- It is achieved by the appearance of a cleavage furrow in PM gradually deepens and divides the cell cytoplasm.  IN plant cell- It is achieved by wall formation, starts in the centre of the cell and grows outwards to meet the existing lateral wall.  New cell wall forms with the formation of a simple precursor i.e, cell plate, middle lamella. |

When Karyokinesis is not followed by cytokinesis, multinucleate condition arises leading to the formation of synctium. E.g- liquid endosperm in coconut.

Cytokinesis is one of the most significant events that occur during the last phase of cell divisions. Some distinct features exist in cytokinesis of microbes, animal and plant cells. The partitioning of cytoplasm during meiosis and related sexual reproduction also act to determine the fate of resulted daughter cells.

Cytokinesis the word meaning is cyto means cell whereas kinosis means movement. Actually it is a cytoplasmic division after mitosis or meiosis. After the mitotic phase two daughter cells are formed and these cells should be separated and both the cytoplasm and the genome should be equally distributed to this daughter cells and that process is called the cytokinesis. It can be defined as a cytoplasmic division of a cell at the end of mitosis or meiosis bringing about the separation into two daughter cells.

## Cytokinesis

Cytokinesis is the division or partitioning of the cytoplasm following the equal division of genetic material into the daughter cells. Before a given cell can divide, its genetic material – deoxyribonucleic acid or DNA has to be duplicated through DNA replication. The identical copies of DNA are then separated into one of the two daughter cells through a multiple step process, of which details vary among prokaryotes, plants and animals.

Cytokinesis is the next step of the division of the cell cycle. So, till the telophase this cell had formed two daughter nuclei. The division is occured by all the four phases of mitosis and the meiosis-I and meiosis-II. Then the cell has to divide its cytoplasm, the cell contents, and all the cell organelles equally between the two daughter cells or four.

In case of meiosis that stage is known as cytokinesis. now cytokinesis can be equal or unequal. Equal cytokinesis is where the cytoplasm is divided equally between the two cells you can see this in normal mitotic divisions.

And in case of meiosis it is seen very prominently during spermatogenesis or the formation of sperm cells where all of the sperms receive equal amount of cytoplasm.

### Cytokinesis in Prokaryotic cells:

With a single chromosome and no nucleus, prokaryotes (such as bacteria) utilize a simple method of cell division called binary fission (meaning “splitting in two”). The single circular DNA molecule is replicated rapidly and split into two. Each of the two circular DNA then migrates to the opposite pole of bacterial cell. Eventually, one bacterial cell splits into two through binary fission. On average, a bacterial cell can go through the whole process of cell division within 20 minutes.

### Cytokinesis in Eukaryotic cells:

In eukaryotes, cell division is a more complex process than in prokaryote due to the presence of nucleus and multiple DNA molecules (chromosomes). Each of the DNA will need to be replicated exactly once in preparation for the division. The replication process is completed during the interphase. Once replicated, two copies of the same DNA are connected together in a region called centromere. The DNA molecules then go through a process of shortening, condensing and packing with proteins to form chromosomes visible through light microscope. Chromosomes then migrate and line up at the equator plate of the parent cell before they split. The divided chromosomes are then pulled to two opposite poles and the two daughter cells separate in the middle (equator) of the parent cell.

cytokinesis generally follows nuclear division, whether in mitosis or in meiosis.

### Mitotic or Mitosis phase in Cytokinesis

Mitotic cell division ensures the same number of chromosomes in daughter cells as in parent cells. Major steps in plants and animals are same. Mitosis complete in 2 steps-

Karyokinesis- It is the division of Nucleus in 4 phases-

Prophase- In this phase, nuclear envelope disintegrate and chromatin condenses into chromosomes and then the centrosome moves towards the opposite poles.

Metaphase- Here the chromosomes line up along Metaphase plate (imaginary plate).

Anaphase- Chromosomes break at centromere and sister chromatids move towards opposite poles.

Telophase- It is totally reverse of prophase. Chromosomes again form chromatin in this phase. Spindle fibers disorganise and nuclear envelops forms.The nucleus is completely divided in this phase.

### Meiosis in Cytokinesis

* Meiosis I is a unique cell division that occurs only in germ cells and their various steps included, Metaphase I, Anaphase I, Telophase I and Cytokinesis.
* Meiosis is a special type of cell division necessary for sexual reproduction.
* During meiosis the cell divides twice producing four haploid cells containing one copy of each chromosome.
* The first meiosis division separates pairs of homologous chromosomes creating two haploid cells with only one set of chromosomes.
* The second Meiosis division II separates the chromatids in each chromosome.
* The end result is a production of four haploid cells each with a single chromatid from each chromosome. when haploid sperm and egg unite during fertilization the resulting cell is diploid having received one chromosome of each pair from each parent. (1n+1n=2n).

## Cytokinesis in Animal cells

In bacteria, the circular chromosome attaches to the plasma membrane at one point. The chromosome is then replicated. The two copies are attached to the membrane at nearby points. As the cell elongates, new plasma membrane is added between the attachment points, pushing them apart. As the two chromosomes move toward opposite poles of the cell, the plasma membrane grows inward at the middle (equator) of the cell. The parent cell splits into two daughter cells, completing binary fission. Each daughter cell receives exactly one copy of DNA and about half of the cytoplasm.

In animal cells, cytokinesis normally begins during telophase following the completion of chromosome segregation. First, microfilaments attached to the plasma membrane form a ring around the equator of the cell. This ring then contracts and constricts the cell’s equator, much like pulling the drawstring around the waist of a pair of sweatpants. Eventually the “waist” is pinched through and contracts down to nothing, partitioning the cytoplasm equally into two daughter cells.

## Cytokinesis in Plants cell

Two events that occur in cell division are unique to plants. First, the nucleus must migrate to the center of the cell before mitosis can begin. The nucleus becomes anchored initially by cytoplasmic strands, which gradually merge to form a transverse sheet of cytoplasm that bisects the cell in the plane where it ultimately will divide. This sheet of phragmosome, contains both microtubules and actin filaments involved with its formation. Secondly, cytokinesis in plant cell mitosis is quite different from that of animal cell. The presence of a tough cell wall (made up of cellulose, lignin, hemicellulose, etc) makes it nearly impossible to splitting one cell into two by pinching the “waist”. Instead, cell division occurs by formation of a cell plate. In early telophase, an initially barrel-shaped system of microtubules called phragmoplast form between the two daughter nuclei. The cell plate is then initiated as a disk suspended in the phragmoplast.

The cell plate is formed by fusion of secretory vesicles derived from the Golgi apparatus. Apparently, the carbohydrate-filled vesicles are directed to the division plane by the phragmoplast microtubules, possibly with the help of motor proteins. The vesicles contain matrix molecules, hemicelluloses and/or pectins that form the cell plate. As the vesicles fuse, their membranes contribute to the formation of the plasma membrane on either side of the cell plate. When enough vesicles have fused, the edges of the cell plate merge with the original plasma membrane around the circumference of the cell, completing the separation of two daughter cells. In between the two plasma membranes lie the middle lamella that separates two daughter cells. Each of the two daughter cells then deposits a primary wall next to the middle lamella. In addition, each daughter cell deposits a new layer of primary wall around the entire protoplast. This new wall is continuous with the wall at the cell plate. The original wall of the parent cell stretches and ruptures as the daughter cells grow and expand.

## Cytokinesis in Sexual Reproduction

In animal oogenesis, the formation of ova or eggs occurs in the female reproductive organs called ovaries. Although the daughter cells resulting from the two meiotic divisions receive equal amounts of genetic material, but they do not receive equal amounts of cytoplasm. In meiosis I, unequal partitioning of cytoplasm during cytokinesis produces the first polar body almost void of cytoplasm, and the secondary oocyte with almost all cytoplasm from the mother cell – primary oocyte. During meiosis II, cytokinesis again partitions almost all cytoplasm to one of the two daughter cells – ootid, which will eventually grow and differentiate into mature ovum or egg. Another daughter cell, the secondary polar body, receives almost no cytoplasm. This concentration of cytoplasm is necessary for the success of sexual reproduction by animals because a major function of the mature ovum is to nourish the developing embryo following fertilization.

## Phases of Cytokinesis:

There are four phases of cytokinesis:

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| **Phases** | **Explanation** |
| **1. Initiation** | The contractile ring initiates and starts to build a cleavage furrow. This happens in the anaphase. |
| **2. Contraction** | As telophase starts and anaphase ends, the contractile ring keeps contracting and widening the cleavage furrow. |
| **3. Membrane Insertion** | The process of inserting a newly produced cell membrane between two newly forming cells is known as membrane insertion. |
| **4. Completion** | The contractile ring closes and divides the two new cells from one another at the point of completion. |

## Purpose of cytokinesis

The division of the cytoplasm that occurs following the duplication of chromosomes during cell division is termed cytokinesis.

Once the nuclear divisions have occurred (whereby the genetic material is duplicated), the cytokinesis of the parent cell takes place.

This results in the division of the parent cell's cytoplasm to form two daughter cells.

The process begins with the development of a cleavage furrow at the equatorial plane of the parent cell.

This is mediated by the cytoskeletal proteins present in the cytoplasm.

As the furrow deepens, the cytoplasm is separated to form two separate cells.

Cytokinesis occurs in mitosis at the end of telophase and in meiosis II at the end of telophase II.

## Characteristics of cytokinesis:

Cytokinesis is generally defined as the division of the cytoplasm during the M phase of the cell cycle.

It is the 2nd step in the M phase.

This process also cannot occur without karyokinesis.

It is generally the final stage of mitosis, whereby cytoplasm & other cell organelles divide between the two daughter cells.

Cytokinesis also happens during the growth and repair of tissues in higher plants and animals as well as during the development of the embryo.

The cell membrane constricts at the cell equator during cytokinesis, creating the cleavage furrow, which is a cleft.

Whether in mitosis or meiosis, it often happens after nuclear doubling.

## Facts about cytokinesis:

## Protein involved in Cytokinesis

## • Actinomycin D

• Myosin

• Septins

• Additional proteins

## FAQs on Cytokinesis

### What is the function of cytokinesis?

\_Cytokinesis is the process in which the cytoplasmic content of the cell is divided into two new cells. Cytokinesis ensures each daughter cell receives all the cytosol and cellular organelles it needs to begin its new life.

What does cytokinesis literally mean?

Cytokinesis comes from the Greek words "Cyto-," meaning compartment or cell, and "-kinesis," meaning movement. Cytokinesis final step of cell division wherein the cytoplasms of the two daughter cells are separated.