MITOSIS

LAB REPORT

Name

Date

Course Name

Exercise 1: Explaining Mitosis

Introduction

Mitosis is one of the stages of the cell cycle in which replicated chromosomes are separated to give rise to two individual nuclei. This ensures that during cell division, a single cell divides into two identical cells in which the number of chromosomes is the same as that of the parent cell. Just before mitosis, the cell undergoes an interphase during which DNA replication takes place. After mitosis, the cell undergoes cytokinesis in which all the remaining organelles of the cell are divided into two and enclosed by two cell membranes. Nuclear division and cellular division, both together make up the Mitotic Phase of the cell cycle in which a single cell gives rise to two identical cells.

The entire process of mitosis is divided into five stages namely prophase, prometaphase, metaphase, anaphase, and telophase. This process takes place only in eukaryotic cells which have a well-defined nucleus enclosed by a nuclear membrane. The exception to this is reproductive cells or gametes, the sperm and the egg, that undergo division by meiosis. Before the start of the prophase, the cell undergoes interphase where the replicated chromosomes are bound together at the centromere appearing as chromatids. During mitosis, one copy of each chromatid is pulled towards the opposite poles of the cell thus retaining the genetic information of the parent cell in the resulting daughter cells. The interphase itself is divided into three phases: G1 (first gap), S (synthesis), and G2 (second gap). DNA replication takes place during the S phase alone, whereas during the G1 and G2 phases, cell proteins and organelles undergo preparation for cell division.

Stages of Mitosis

Prophase

During prophase, condensing of chromosomes takes place and the cell initiates mitotic spindle formation for the preparation of cell division. The chromatin fibres undergo condensation to form discrete chromosomes comprising of two chromatids joined together at the centromere. The mitotic spindle comprises of centrosomes and microtubules extending from the centrosomes. Disassembly of the cytoskeleton and breaking down of the nuclear envelope also takes place during the prophase.

Prometaphase

In the prometaphase stage, the broken down fragments of the nuclear envelope and the microtubules that surround the mitotic spindle move towards the chromosomes and attach to

their surface. The chromosomes along with the attached mitotic spindles start migrating towards the centre of the cell.

Metaphase

During this stage, all the chromosomes have moved towards the centre of the cell and align along the metaphase plate at the centre. The centrosomes move towards the opposite ends of the cell while still attached to the mitotic spindle on the chromosome surface. This migration of cell components accounts for metaphase being the longest stage in mitosis.

Anaphase

During anaphase, the centromeres that are holding the chromosomes together degrade and the two sister chromatids that are held together by the centromere detach from each other. Each of the individual chromatids starts moving towards the opposite ends of the cell along with the spindle fibres and part of the centromere. As the spindles start moving away in opposite directions, the cell begins to elongate pulling the chromosomes further away from each other. This is a fast process making anaphase the shortest of all mitotic stages.

Telophase

By telophase, all chromosomes are distinctly separated from each other and nuclear envelope starts forming around both the separated sets of chromosomes. The chromosomes start relaxing and soon begin to resemble normal cell nuclei.

Cytokinesis

Once the nucleus is divided into two, during cytokinesis, a cleavage furrow develops along the centre of the cell separating the two newly developed nuclei and giving rise to two individual cells.

Conclusion

The main function of mitosis is division of a parent cell into two identical daughter cells. The resultant daughter cells have the same genetic composition and chromosomal number as the parent cell. This is the most important stage for the development and growth of an organism and is used for the growth of a multicelled organism as well as the development of a multicelled organism from a single-celled body such as a zygote. It is also the primary means by which some parts of the body replace old cells with new ones, for example, in the skin and the digestive tract. Some cells such as the red blood corpuscles have a short life span of about 4 months and these are regularly replaced in the body by means of mitosis.

Mitosis is a tightly regulated process; however, errors can occur during this stage leading to disastrous consequences in the body. The main error can happen during the division of chromosomes wherein a daughter cell may have certain missing chromosomes or extra copies of certain chromosomes. This can lead to developmental errors and cancer that may manifest as physiological disturbances in the body. Sometimes, complete nondisjunction may occur, wherein the separation of chromosomes does not take place. In such instances, one cell may receive three sets of chromosomes whereas the other cell may receive just one set of chromosomes. Cytokinetic errors may also occur where cell division fails to occur resulting in a single cell having two nuclei. In all these cases, the cells are not viable and may lead to severe genetic and physiological disturbances in the organism.

Exercise 2: Observing Mitosis in Cells

Introduction

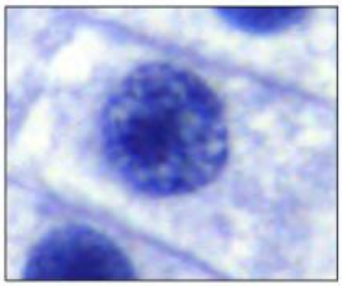
Both plant cells and animal cells undergo mitotic division where the nuclear material of the parent cell is replicated and divided into two distinct sets of chromosomes. This is the primary means by which both plants and animals carry out cell division for growth, development, cell replacement, and regeneration processes.

Mitosis in plant and animal cells has both similarities and differences depending on the individual cell structure and presence of organelles. The four main stages of mitosis are similar in both plant and animal cells – prophase, metaphase, anaphase, and telophase. However, the mitotic spindle apparatus is different in plant and animal cells because plant cells lack centrioles and spindle pole bodies that act as microtubule organization centres in animal cells. Also, cell division in plant cells takes place by the formation of a cell plate between the two daughter nuclei, whereas in animal cells, division takes place by the formation of a cleavage furrow that gradually divides the parent cell into two daughter cells.

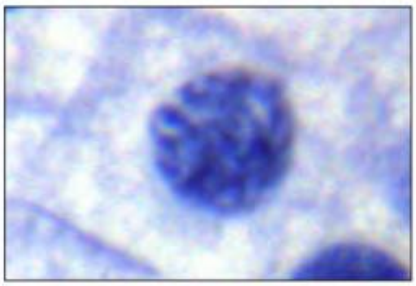
The various mitotic stages of plant and animal cells can be visualized under the microscope by using specific stains. These stains react with specific biological parts in a sample giving them a characteristically distinct colour. Most commonly, acetocarmine is used to stain nuclei acids to visualize their condensation, disintegration, and migration during the different stages of mitosis. Stained nucleic acids along with a clear idea of what happens in each stage of mitosis can help track the process of cell division in plant and animal cells.

Results

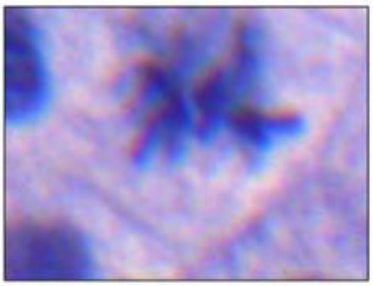
Based on the description of various mitotic stages and the processes that takes place in each stage, the following figures of mitotic stages of a plant cell were arranged in their correct order.



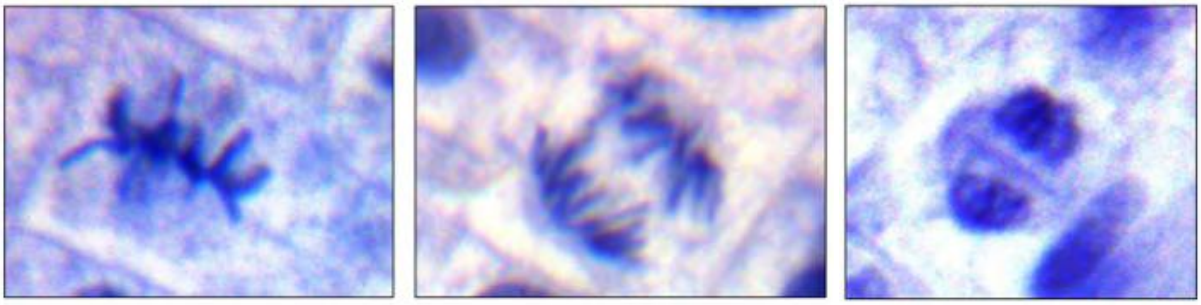
G2 of interphase



Prophase

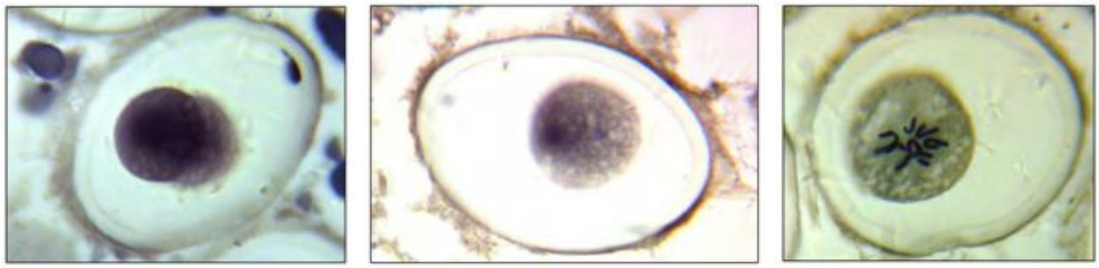


Prometaphase

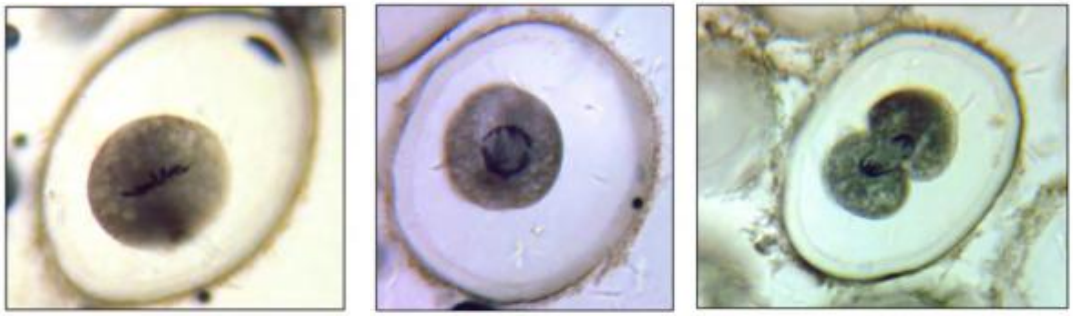


Metaphase Anaphase Telophase

Based on the description of various mitotic stages and the processes that takes place in each stage, the following figures of mitotic stages of an animal cell were arranged in their correct order.



G2 of interphase Prophase Prometaphase



Metaphase Anaphase Telophase

Discussion

The images of mitotic stages of plant and animal cells were segregated and arranged based on their specific step of the cell cycle. Several similarities and differences in the set of images were observed.

In the G2 stage of interphase, both plant and animal cells show a distinct nucleus with darkly stained genetic material in the centre. The rectangular rigid cell wall of plant cells can be clearly seen whereas in animal cells, the cell shape is round and enclosed by a thin cell membrane. In prophase of both cells, the chromosomes start condensing and becoming clearer under the microscope. Also, the gradual disintegration of the nuclear envelope can be seen in both cases. During the prometaphase stage, the chromosomes along with their individual chromatids start becoming clearer and they can be seen moving towards the centre of the cell. In the metaphase stage, all chromosomes can be seen clearly aligned along the metaphase plate in both animal and plant cells. During anaphase in both plant and animal cells, individual chromatids are pulled apart along with their spindle fibres towards the opposite ends of the cell. Finally, during telophase, clear differences can be seen in cytokinesis in plant and animal cells. In the case of plant cells, a cell wall is formed separating the two daughter nuclei, whereas in the case of animal cells, a cleavage furrow is formed starting from the periphery and moving towards the centre. Ultimately, both result in division of the parent cell into two daughter cells with identical genetic and cytoplasmic material.

Conclusion

Mitosis is the process by which both plant and animal cells undergo division to form two identical cells. There are several steps of the cell cycle where marked differences can be seen in the cell division processes of plant and animal cells. The shape of plant cells is retained throughout the cell division process whereas the shape of an animal cell becomes circular during the cell cycle. Mitosis in plant cells is induced by cytokinins, whereas in animal cells, the compound that induces mitosis is yet to be identified. The entire mitotic spindle apparatus is quite different in both plant and animal cells. The plant cell lacks centrosomes, centrioles, and spindle pole bodies, and the chromatids are held together by nucleated microtubules at the centre of the cell. During cytokinesis, the plant cell divides by the formation of a rectangular plate at the centre of the cell, whereas the formation of a cleavage burrow from the periphery towards the centre divides the animal cell.

Apart from this, the events that take place during the prophase, metaphase, anaphase, and telophase stages are quite similar. Both cells undergo the condensation of chromosomes, breakdown of nuclear envelope, alignment along the metaphase plate, separation of sister chromatids and migration towards the opposite poles of the cell, and division of the parent cell into two daughter nuclei. The need for mitosis in both cases is the same which is the growth and development of the organism; however, in animals, cell division can take place in any part of the body, whereas in plants, cell division only takes place in specialized regions known as meristems which are present at the tips of roots and shoots of the plant.