Chromosomes

Chromosomes consist of DNA molecules which are coiled upon histone proteins. Eight histone proteins coil together to form a structure called a nucleosome. This is then coiled upon itself.

When the cell is not dividing DNA is in uncoiled form. Thus, it appears as very thin threads present in the cytoplasm. This is called the chromatin network.

During cell division, this coils around the centromere to form chromosomes. Chromosomes have two arms one long arm is called p and a short arm is called q.

Chromosomes can be classified according to the position of the centromere.

The portion of the chromosome from the centromere to its end is called the arm of the chromosome.

The identical strands of DNA are called a chromatids. Before cell division, each chromosome has only one chromatid. After DNA replication each chromosome will have two chromatids. Thus, during cell division, the number of chromosomes remains the same while the amount of DNA is doubled.

Telomere

Each chromosome consists of a sequence of repeating nucleotides at its end called the telomere.

During every cycle of DNA replication, the end of chromosomes is shortened. To protect the DNA from cell damage telomeres are present at the end of chromosomes like a cap.

Thus, after cell division telomeres are shortened instead of chromosomes.

Cell Cycle

Each cell cycle consists of two phases.

1. Interphase
2. Mitosis

Interphase

Interphase is the non-dividing phase of the cell cycle. During this phase, the cell grows and prepares itself for the next division.

Interphase has three phases.

1) G1 Phase

During this phase, the The cell synthesizes RNA and proteins that are required for cell division.

2) S Phase

S phase is also called the synthesis phase. In this phase, the cell replicated its DNA. Before replication cell has one copy of DNA after replication it has two copies.

3) G2 Phase

The cell continues to grow in this phase. The organelles are replicated.

Mitosis

Mitosis is the dividing phase of the cell cycle. In this, the nucleus is divided into two daughter nuclei called karyokinesis.

After mitosis, the cell performs cytokinesis to divide the cytoplasm.

Phases

Mitosis is further divided into further phases.

Prophase

- During this phase, the nuclear membrane starts disappearing.
- The centrioles replicate and move towards the opposite pole.
- Chromosomes Start Coiling And Become Visible.
- Centriole starts forming spindles.

Metaphase

- Chromosomes are arranged at the equatorial plane right angle to the fibres formed by centriole.
- Chromosomes form kinetochores at the centromere for attachment of spindle fibres.

Anaphase

- Spindle fibres start shortening thus pulling each chromosome towards the opposite pole.
- Chromosomes break at the centromere and each half is moved towards the opposite side.

Telophase

- Chromosomes reach the opposite pole.
- Spindle fibres start disappearing
- The nuclear membrane starts forming around each set of chromosomes.

- Hence Two Daughter Nuclei Are Formed.

Cytokinesis

After the division of the nuclei, the cytoplasm starts diving. This process is called cytokinesis.

Significance Of Mitosis

1. Formation Of Identical Daughter Cells

Through mitosis, daughter cells can be formed which are an exact copy of the parent cells.

2. Healing Of Wounds

New cells are required for tissue repair after injury. This task is fulfilled by mitosis.

3. Growth

Mitosis helps in the production of new cells which are required for increasing the size of the organism.

4. Asexual Reproduction

Mitosis is the basis of asexual reproduction. New daughter cells are formed by a single parent.

Mitosis And Uncontrolled Cell Division

There are various genes in the cell that act as checkpoints in the cell cycle. They control when a cell will undergo division and when it will stop by responding to various stimuli.

Mutations in these genes result in uncontrolled mitosis. The cell will keep on dividing. This will result in the formation of a large number of abnormal cells. This is called a tumour. Some tumour cells might break and enter the bloodstream. Now the tumour is

said to be metastasized. These abnormal cells will deposit in other organs and form tumours there.

Stem Cells

Stem cells are pluripotent cells. These cells are undifferentiated and can divide and specialize to form cells of any lineage.

For example:

A stem cell can specialize to form a red blood cell or it can be specialized to form liver cells. This depends on the group of genes that are activated during their maturation. In order to become RBC, only genes coding haemoglobin will be activated while others will be turned off.

Significance Of Stem Cell In Tissue Repair

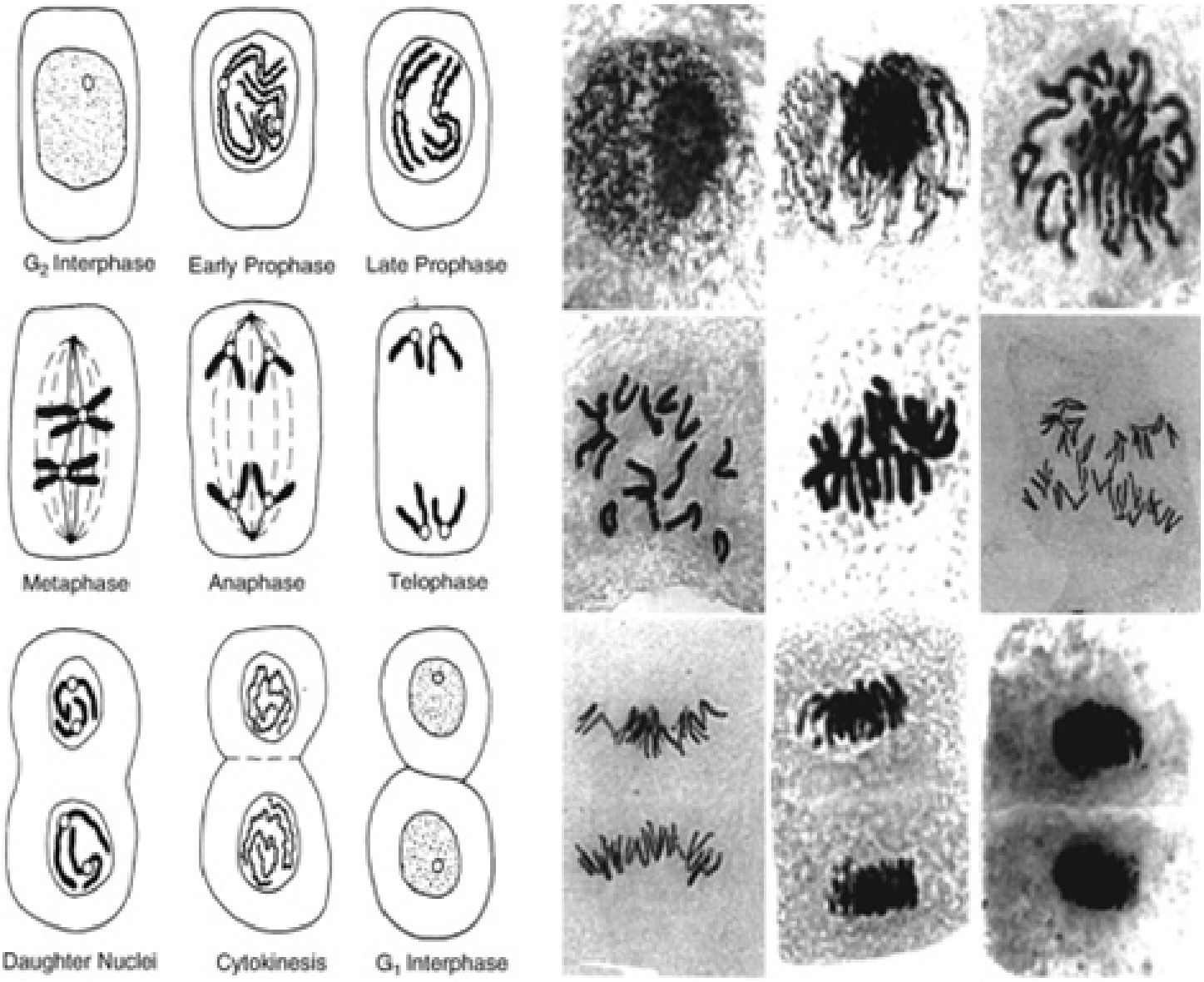
There are two types of stem cells.

1) Embryonic stem cell

2) Adult stem cell

These cells can be used for the repair of various tissues due to their ability to form cells of any lineage. They divide by mitosis either to form a new stem cell or a cell that goes on to mature into a specialized cell type.

Chromosome Behaviour In Mitosis



Source: SpringerNature

Prophase

Chromosomes start coiling during prophase. Thus, they become more visible under a microscope as seen in the photomicrograph.

The centrioles divide and move to the opposite ends of the cell.

Metaphase

Spindles are formed during the metaphase.

Chromosomes are present at the equator and arranged perpendicular to the fibres.

Anaphase

During anaphase spindles start shortening. This results in the pulling of chromosomes at opposite ends.

Chromosomes break at the centre and move towards the opposite pole.

Telophase

Chromosomes have reached the opposite pole.

The nuclear membrane is formed again.

Observing Stages Of Mitosis In Temporary Root Tip Preparations

The tip of the root contains meristematic tissue which is actively dividing to increase the height of the plant. Thus, a sample of cells can be obtained to observe mitosis.

Method:

1 Cut the tip of the root.

2 transfer it to a watch glass.

3 Add 30 drops of ethano arcein stain with 3 drops of HCL.

4 Heat it in a water bath for 2 to 3 minutes.

5 Transfer the tip to slid and add few more drops of stain.

6 Cover the root tip with a coverslip.

7 Observe it under a microscope.

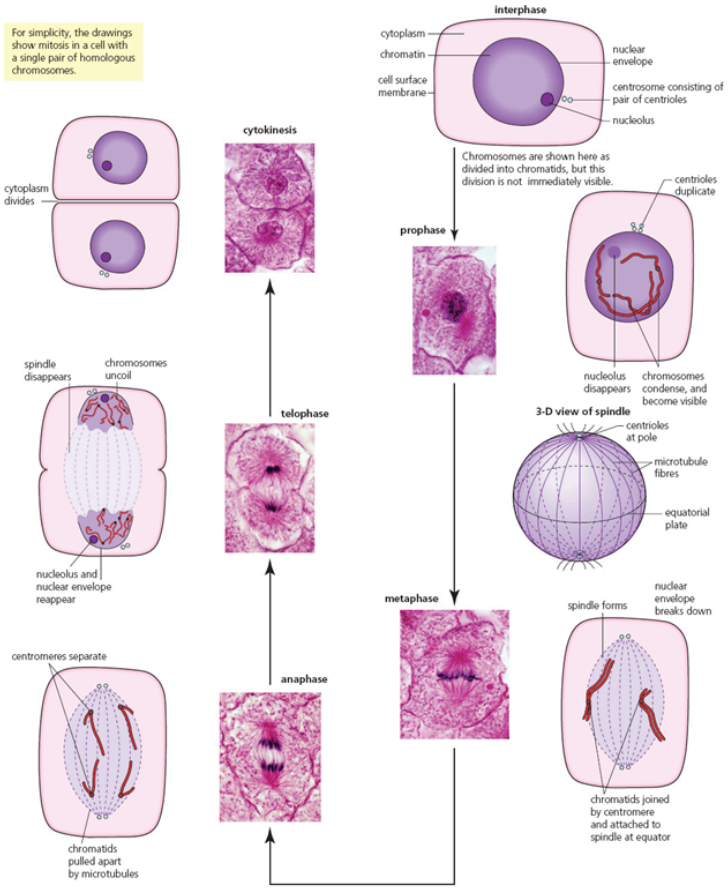


Figure 5.8 Mitosis in an animal cell

Source: Dynamic Learning