



Chapter 5: Mitotic cell cycle

▼ 5.1. Chromosomes

▼ What are gametes?

Gametes are reproductive cells; they were all derived from one cell, the zygote, which was the cell formed when two gametes from your parents fused.

▼ What are chromosomes?

Chromosomes are structures made of DNA and histones, found in the nucleus of a eukaryotic cell; the term bacterial chromosome is now commonly used for the circular strand of DNA present in a prokaryotic cell.

▼ What is the structure of chromosomes

Chromosomes are made of two identical structures called **chromatids** held together by a centromere. Each chromatid has one DNA molecule.

▼ What is centromere?

Centromere holds the two chromatids together. There are no genes in this region.

▼ What is DNA?

DNA is the molecule of inheritance and is made up of a series of genes.

▼ What is chromatin?

Chromatin is the combination of DNA(acidic) wound around histone proteins(base). The two types of chromatin are:

▼ 1. Heterochromatin: tightly coiled(condensed)

1. Most condensed metaphase.
2. Densely stained.

▼ 2. Euchromatin: loosely

1. At interphase. (between divisions)
2. Not as densely stained.

▼ Nucleosome

Nucleosome is a bead-like structure made of eight histone molecules, around which DNA is wrapped nucleosomes are the fundamental subunits of chromatin. (11nm wide by 6nm long) (1.2/3 turns) (147 base pairs)

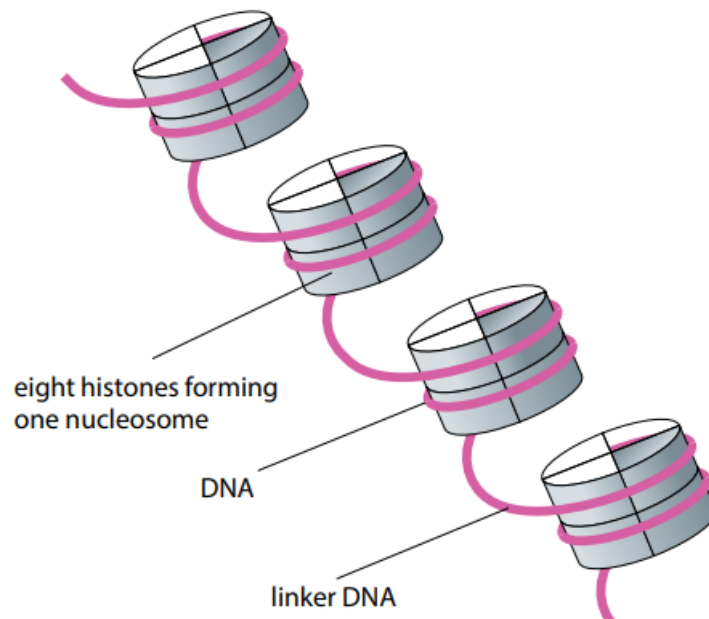


Figure 5.4 How nucleosomes are involved in DNA coiling. Note that you do not need to learn about nucleosomes.

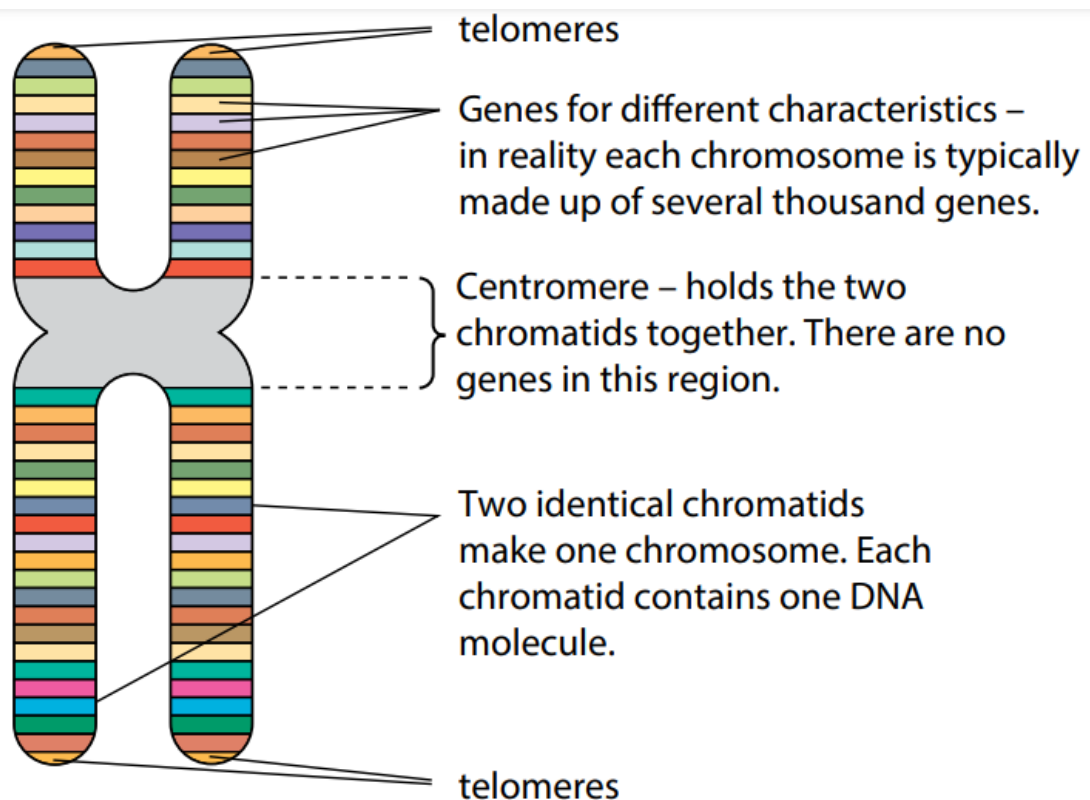


Figure 5.3 Simplified diagram of the structure of a chromosome.

▼ 5.2. Mitosis

▼ What is the cell cycle

The **cell cycle** is the sequence of events that takes place from one cell division until the next; it is made up of **interphase**, **mitosis**, and **cytokinesis**.

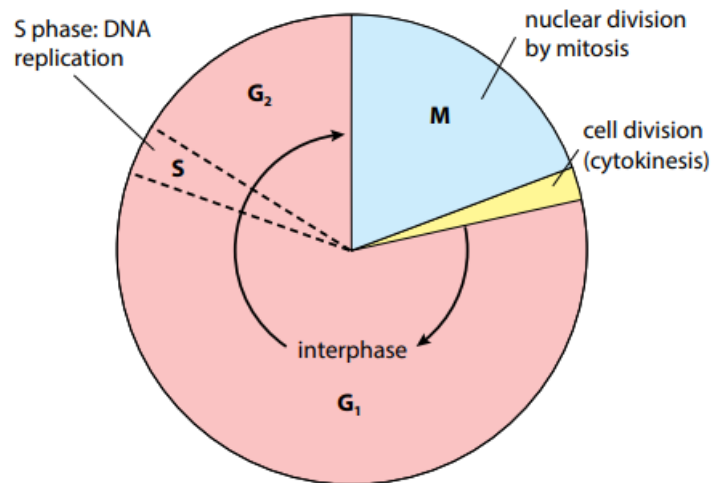


Figure 5.6 The mitotic cell cycle. DNA replication takes place during interphase, the period between cell division and the next nuclear division: **S** = synthesis (of DNA); **G** = gap; **M** = mitosis.

▼ Mitosis

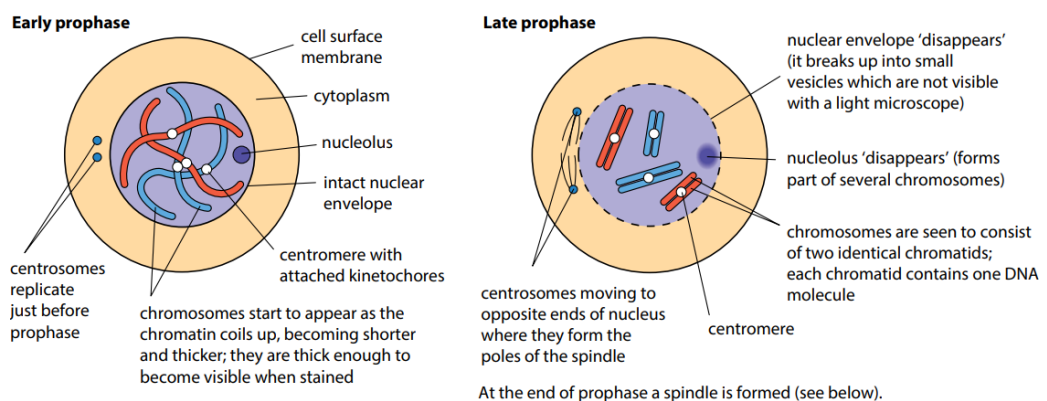
Mitosis is the division of a nucleus into two so that the two daughter cells have exactly the same number and type of chromosomes as the parent cell. Responsible for reproductivity, repair and growth.

▼ What are the stages of mitosis?

▼ Prophase, Prometaphase

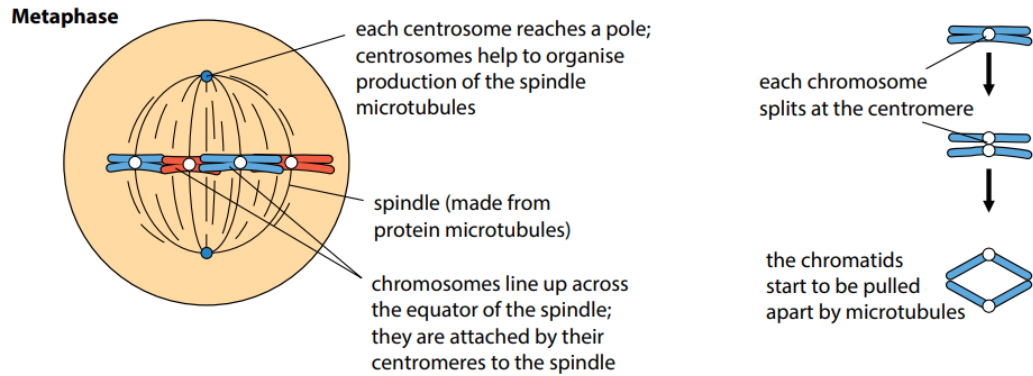
In the **prophase** the chromosomes condense and become visible. The spindle fibers emerge from the centrosomes. The nuclear envelope breaks down and the nucleolus disappears.

In the **prometaphase** chromosomes continue to condense while kinetochores appear at the centrosomes. Mitotic spindle microtubules attach to the kinetochores. Centrosomes move towards opposite poles.



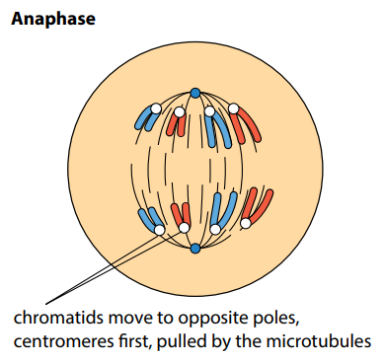
▼ Metaphase

During the metaphase the mitotic spindle is fully developed, from the centrosomes at opposite poles of the cell. Centrosomes are lined up at the metaphase plate. Each sister chromatid is attached to a spindle fiber originating from oppositely poles.



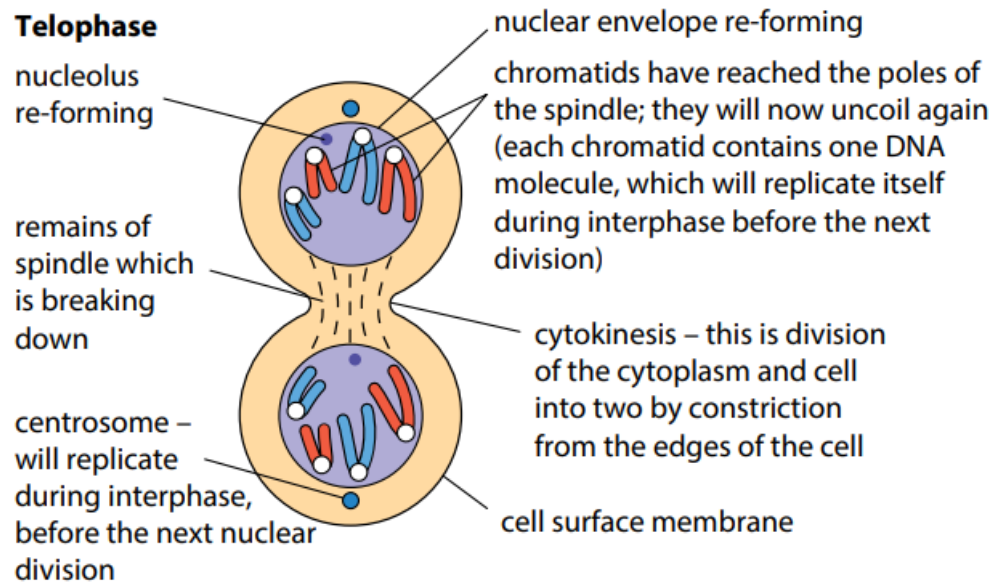
▼ Anaphase

Anaphase is the stage where the protein binding the sister chromatids break down. The sister chromatids (now called chromosomes because they are separated) are pulled toward opposite poles by the microtubules.



▼ Telophase

In the telophase the chromosomes arrive at opposite poles and begin to decondense. Nuclear envelope re-forms and surrounds each set of chromosomes. The mitotic spindle breaks down.



▼ Cytokinesis:

Cytokinesis is the division of the cytoplasm and cell into two by constriction from the edges of the cell.

▼ Centromeres, centrosomes and centrioles

Each metaphase chromosome has two kinetochores at its centromere, one on each chromatid.

Kinetochores are protein structures found at the centromere of a chromatid to which microtubules attach during cell division. Bundles of microtubules called spindle fibres extend from the kinetochores to the poles of the spindle during mitosis. Construction of kinetochores begins before nuclear division starts (during the S phase of the cell cycle) and they are lost again afterwards.

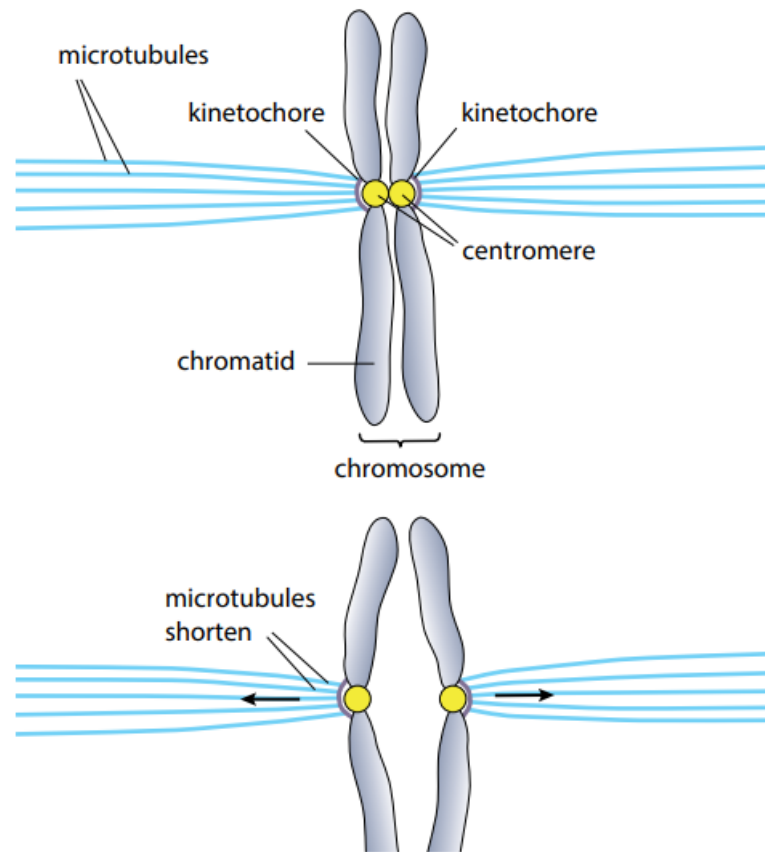


Figure 5.10 Role of the centromere, kinetochores and microtubules during mitosis.

▼ Biological significance of mitosis

- ▼ Growth
- ▼ Replacement of cells and repair of tissues
- ▼ Asexual reproduction
- ▼ Immune response

▼ 5.3. The significance of telomeres

▼ What are telomeres?

Telomeres are a repetitive sequences of DNA at the end of chromosomes that protect genes from the centrosome shortening that happens at each cell division.

▼ Telomerase (enzyme)

The enzyme that makes sure all the useful DNA are copied.

▼ What are the significance of telomeres?

1. Ensures ends of DNA are included during cell division.
2. Copying enzyme can't copy the end of DNA so pieces of information are lost; eventually including loss of vital genes; eventually including loss of vital genes.
3. Ageing: Specialized cells don't top up their telomeres after DNA replication, therefore causing loss of genes, DNA and cell death.

▼ 5.4. Stem cells

▼ What are stem cells?

Stem cells are relatively unspecialized cells that retain the ability to divide an unlimited number of times.

▼ What is the power of stem cells to produce other cells called?

The extent of the power of a stem cell to produce different cell types is variable and is referred to as its potency

▼ Name the three types of stem cells.

1. Totipotent: Cells that can divide repeatedly to form any other cell in the body. e.g. zygote.
2. Pluripotent: Embryonic stem cells that lead to development of the embryo later the adult. They are not specialized into placenta.
3. Multipotent: Adult stem cells that are only able to produce a few types of cells e.g. stem cells in bone marrow
Their telomeres don't shorten as telomerase is present and active. Its activity is diminished after birth, Except in reproductive and adult stem cells.

▼ 5.5. Cancer

A change in any gene is called a mutation.

▼ Oncogene

A gene that is mutated to cause cancer is **oncogene**.

▼ Carcinogen

Any agent that causes cancer is called a carcinogen and is described as carcinogenic.

▼ What is cancer?

Cancer is the disease, often but not always treatable, that **results from a breakdown in the usual control mechanisms that regulate cell division**; certain cells divide uncontrollably and form tumours, from which cells may break away and form secondary tumours in other areas of the body (metastasis)

▼ What is malignant tumours?

Malignant tumours are tumours that spread through the body, invade other tissues and destroy them. These cells break off from the tumour and form secondary growth known as metastasis.

If you have any questions reach out to: **23C Chinguun.M**, IG: **@chinguun__0511**, FB: **Chinguun Tsetsgee**.

Or post questions on the discord server for help!