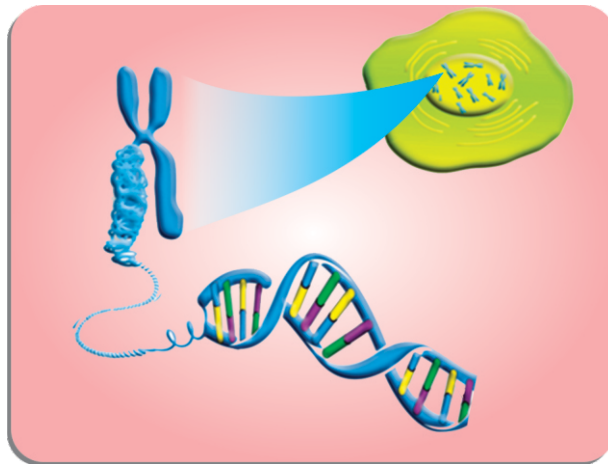


Chapter

2

CELL DIVISION



STUDENTS' LEARNING OUTCOMES

After studying this chapter, students will be able to:

- ☑ Differentiate between mitosis and meiosis.
- ☑ Identify DNA and chromosomes in the cell diagram.
- ☑ Define heredity and recognize its importance in transferring of characteristics from parents to offspring.
- ☑ Identify the characteristics that can be transferred from parents to offspring.
- ☑ Compare characteristics related to ear and eye colour.

It is our common observation that living things grow and increase in size. It is also observed that offspring resemble their parents. We have learnt that all the living things are made up of cells. Hence, more and more cells are needed for growth and development of living things. Where do new cells come from? The answer to the question is that the new cells arise by the divisions of pre-existing cells. In this chapter, we will discuss the process of cell division. Why do offspring resemble their parents? This is the heredity which produces resemblance in the offspring with their parents. Heredity and basis of heredity will also be discussed in this chapter.

2.1 Cell Division

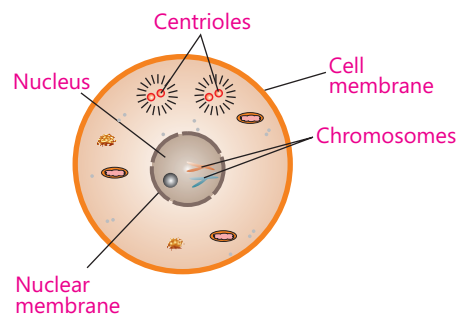
Cell division is a process by which a cell divides into two daughter cells. The cell which divides is called **parent cell**. The cells which are produced as a result of cell division are called **daughter cells**. Before the start of cell division, the parent cell passes through a

phase called **interphase**. During interphase, chromosomes in the nucleus are duplicated, i.e., copies of all the chromosomes are developed.

The process of cell division involves two phases, i.e., nuclear division and cytokinesis. Nuclear division is the division of nucleus which is followed by cytokinesis. Cytokinesis is the division of cytoplasm.

? You need to know...

- Nucleus is part of the cell which controls the activities of the whole cell.
- Chromosomes are found in the nucleus of the cell. They consist of proteins and DNA.
- DNA stands for Deoxyribonucleic Acid.
- DNA is the material that contains complete set of instructions for developing a new cell or an organism. That is why DNA is called hereditary material.
- For one kind (species) of organism the number of chromosomes in the cells remain the same. However, when an individual forms gametes (sperms or eggs in animals) or spores (in plants), the number of chromosomes is reduced to half in the gametes or spores.



Cell division is of two types which are called mitosis and meiosis.

Mitosis

Mitosis is a process by which the parent cell divides into two daughter cells

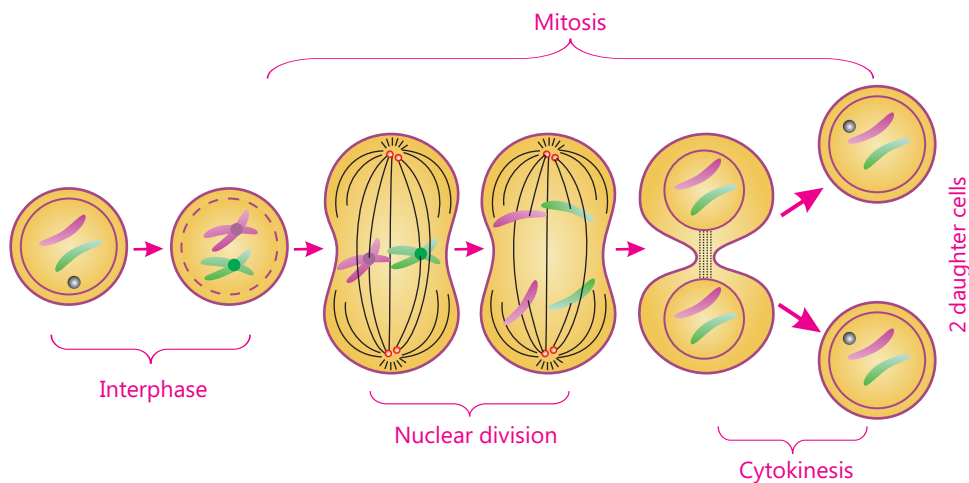


Figure 2.1 Mitosis

with same number of chromosomes as in the parent cell. The number of chromosomes is doubled during interphase. Two sets of chromosomes are formed. During mitosis when the nucleus of parent cell divides the two set of chromosomes are distributed equally in the two daughter nuclei (Figure 2.1).

After nuclear division a shallow groove arises in the middle of the cytoplasm which deepens further and divides the cell into two daughter cells, each having a nucleus.

Meiosis

Meiosis is a process by which the nucleus of a cell divides twice to form four daughter cells in such a way that the number of chromosomes in each daughter cell is reduced to half, compared to the parent cell (Figure 2.2).

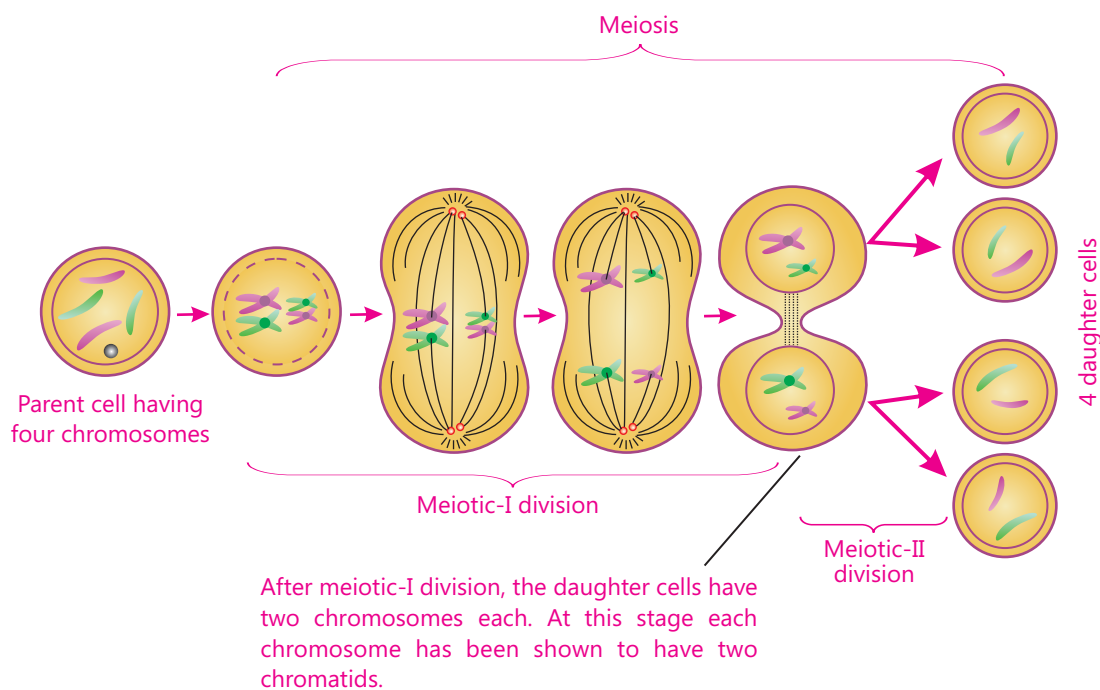


Figure 2.2: Meiosis

The process of meiosis consists of two divisions, meiotic-I division and meiotic-II division. During meiotic-I division, the number of chromosomes is reduced to half as compared to the parent cell. Meiotic-II division is similar to mitosis because the half number of chromosomes is retained in the four daughter cells.

 Activity 2.1 - (Continued...)

- What feature or features are common to you and your brothers and sisters?
- Which of these features are also present in your parents or grandparents?
- What conclusions do you draw from the above observations?
- What are the characters, which are transferred from parents to offspring, called?
- Which of your body features are different from your brothers and sisters?
- What are the characteristics, which are different in members of a family or in members of a species, called?

We know that children possess many features similar to those of their parents but they also differ from their parents in certain respects. Similarly, brothers and sisters also show differences in many characteristics. Differences among members of a family or a species are called **variations**. Beneficial variations help organisms to adapt (live successfully) their environment, have greater chances of survival and continue their race.

2.3 Basis of Heredity

The basic physical and functional unit of heredity is called gene. **Genes** act as instructions to make molecules called proteins. Genes occur in pairs. Every hereditary character in an organism (e.g., tallness, dwarfness, eye colour, free earlobe, attached earlobe, etc.) is controlled by a pair of genes. One member of a gene pair comes from male parent (father) while the other comes from female parent (mother).

Where are genes found physically? Genes are the sections of DNA (Deoxyribonucleic Acid) molecule and are located on chromosomes. As different sections of DNA (genes) are a set of information for the development of different characters in an organism, DNA is called hereditary material. DNA and proteins are the components of chromosomes.

Chromosomes are thread-like structures found in the nucleus of a cell. They appear as distinct structures only during cell division. A typical chromosome consists of two arms called **chromatids** which are attached to the same part called **centromere**. The relationship between the cell nucleus, chromosomes, genes and DNA is shown in Figure 2.3.

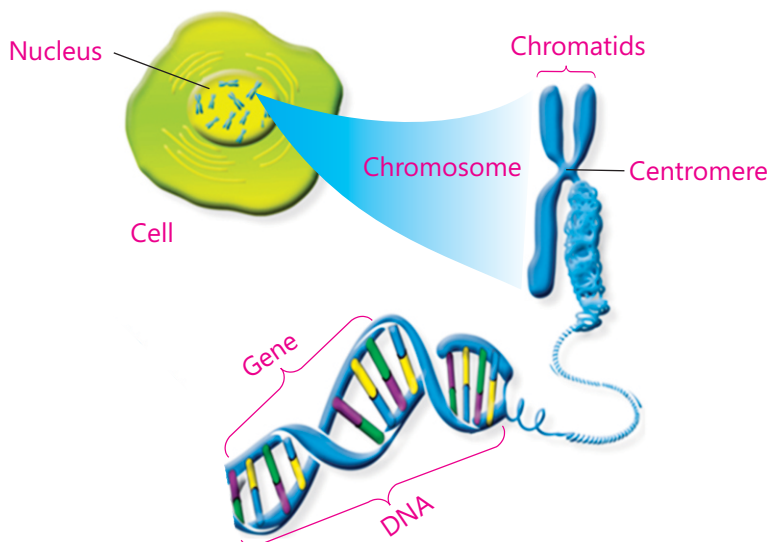


Figure 2.3: Chromosomes, genes and DNA

The number of chromosomes is specific and constant for every kind (species) of organism. In general body cells (somatic cells), the chromosomes occur in pairs but the gametes (sperms or eggs) or spores which are formed by meiosis contain one member of each chromosome pair. For example; in man, every somatic cell has 46 chromosomes in the form of 23 pairs but every sperm or egg cell has 23 chromosomes.

i For your information

Number of Chromosomes in different organisms

Man	46	Monkey	48	Cat	30
Maize	20	Onion	16	Pea	14

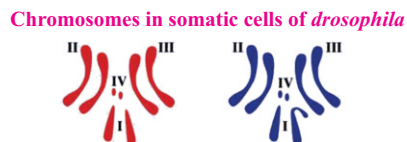
Mini Exercise

Observe the figure and answer the questions:

1. What is the number of chromosomes in a somatic cell of *Drosophila*?



2. What will be the number of chromosomes in the gametes of *Drosophila*?



Watson and Crick Model of DNA

Each DNA molecule is made of thousands of small units called **nucleotides**. There are four types of nucleotides in DNA. These are **Adenine (A) nucleotide**, **Thymine (T) nucleotide**, **Cytosine (C) nucleotide** and **Guanine (G) nucleotide**.

According to Watson and Crick, the DNA molecule consists of two strands formed of nucleotides. The two strands of DNA are linked to each other by cross bands like a ladder (Figure 2.4).

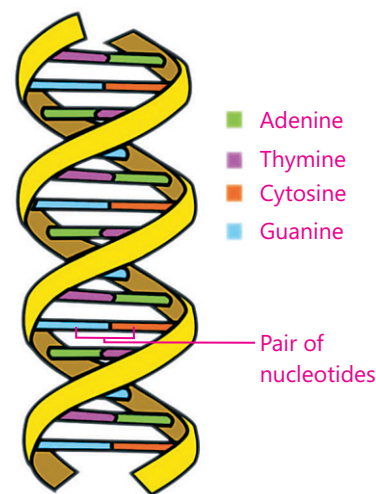


Figure 2.4: Watson and Crick Model

Transmission of Characters

When an organism forms gametes (sperms or eggs) by meiosis, the number of chromosomes is reduced to half in the gametes, i.e., **haploid (n)** sperms or eggs are produced. It means, the hereditary material (DNA) is also reduced to half in the gametes. When male and female organisms mate, the haploid (n) sperm cell from male and haploid (n) egg cell from female fuse with each other to form a **diploid (2n)** cell called **zygote**. In this way the complete hereditary material (DNA) is restored in the zygote, i.e., the physical and functional units of all the characters (gene pairs) are transferred in the zygote. The zygote after passing through various changes develops into a full organism with specific characteristics from both parents. Thus, zygote is the first cell from which the life of an organism starts.

Inheritable and Non-inheritable Characters

The characters such as eye colour, skin colour, hair colour, free or attached earlobes, height, intelligence, etc., are transmitted from parents to the offspring. Such characters that are transmitted from one generation (parents) to the next generation (offspring) are called **inheritable characters**. Inheritable characters are controlled by genes.

Many characters of parents are not transferred to their offspring because these are not developed by genes. Such characters are called **non-inheritable characters**. For example, if a body organ of a person is lost or weakened due to disease, this character is not transferred to his or her children.

Examples of Inheritable Characters

i. Eye colour

The colour of eyes in an organism is controlled by a pair of gene. Thus, it is an inheritable character. The genes control the production of brown pigment in the iris of the eyes. If the genes work and produce more pigment, the eyes are black. Production of very less pigment results in light brown eyes (Figure 2.5). Blue, green, and hazel eye colours are developed due to the production of brown pigment in different amounts.



Figure 2.5: Different eye colours

ii. Attached and Detached Earlobes

In some people the earlobes are attached with the sides of the face while others have free earlobes (Figure 2.6). This character is also controlled by genes. When the said genes work, the earlobes hang freely (detached earlobe). Some people do not have this gene. Their earlobes remain attached with the sides of the face.



Figure 2.6: Attached and detached Earlobes

Activity 2.2: Comparing characteristics related to eye colour

Observe the eye colour of your classmates and friends and record your observations in the table given below:

No.	Name of your friend	Eye colour (Black/ Blue/ Brown/ Grey)	Which of the parents or grandparents (both paternal and maternal) he/she has received this character from?
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Activity 2.3: Comparing characteristics related to earlobe

Observe the ears of your classmates and friends and record your observations in the table given below:

No.	Name of your friend	Earlobe (Free/attached)	Which of the parents or grandparents (both paternal and maternal) he/she has received this character from?
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

i For your information

- Characters of living things are controlled by the genes on the chromosomes. Mitosis is a great blessing of nature. If there were no mitosis, the number of chromosomes could not have been maintained constant.
- Similarly, meiosis has also a significant importance in controlling the hereditary characters generation after generation.

KEY POINTS

- The process by which a parent cell divides into two daughter cells is called cell division.
- Mitosis is a process in which a parent cell divides into two daughter cells with same number of chromosomes as in the parent cell.
- Meiosis is a process in which a cell divides twice to form four daughter cells in such a way that the number of chromosomes in daughter cells is reduced to half compared to that in the parent cell.
- The transmission of characters from parents to offspring is called heredity.
- The characters which are transmitted to next generation are called inheritable characters.
- Eye colour, skin colour, hair colour, free or attached earlobes, height, intelligence, etc., are inheritable characters.
- The basic physical and functional unit of heredity is called gene.
- Genes act as instructions to make molecules called proteins. Genes are located on chromosomes.
- The number of chromosomes is constant for every kind (species) of organisms.
- When a sperm and an egg fuse to form zygote, the characters (genes) are transferred in the zygote. Zygote after passing through various changes develops specific characters in the new baby.

- (x) Which statement is correct?
- DNA has instructions for making proteins
 - Protein has instructions for making DNA
 - Both of these
 - None of these

2.2 Match the words of column A with the relevant words in column B.

A	B
DNA	Haploid cell
Cytokinesis	Diploid cell
Free earlobe	Division of cytoplasm
Zygote	Gene
Egg	Hereditary character

2.3 Give short answers.

- Name two inheritable characters.
- Name two non-inheritable characters.
- What is a gene?
- Define heredity.
- What are haploid cells?

2.4 Describe mitosis.

2.5 Describe meiosis.

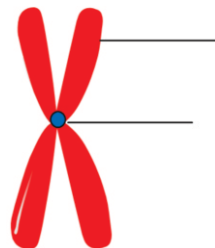
2.6 Define heredity and describe its importance in transferring of characteristics from parents to offspring.

2.7 Describe the characteristics that can be transferred from parents to offspring.

2.8 Write notes on:

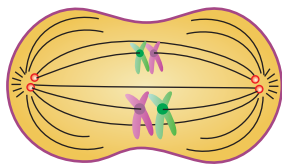
- (a) DNA (b) Chromosomes (c) Genes

2.9 Identify and label the following diagram:

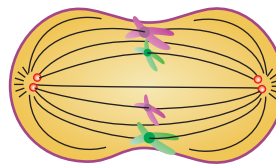


Critical Thinking

1. Gametes are haploid cells. What do you think would happen if the gametes forming a zygote are diploid?
2. An injury on a person's body needs more and more cells for the repair of his body. What type of cell division do you think will provide more and more cells for his body repair?
3. Which of the following figures represent a phase of mitosis and the other a phase of meiosis?



(a)



(b)

Online Learning

www.pitb.gov.pk

www.uic.edu/classes/bios101/genes

www.human-nature.com/drawin/

www.en.mimi.hu/Biology/