3. **The tissue level**: Different kinds of cells that work together to perform a particular function make up a *tissue*. There are four basic types of tissues: epithelial tissue, connective tissue, muscular tissue and nervous tissue (discussed later in detail).
4. **The organ level**: Different types of tissues are grouped together to form an *organ* that carry out a specific function, for example, stomach and heart.
5. **The system level**: A number of organs with a common function are grouped into systems. The human body has several systems, which work interdependently to carry out specific functions, for example, the digestive system, the urinary system and the skeletal system.
6. **The organismal level**: All the parts of the human body function together and constitute the total *organism*.

THE CELLULAR LEVEL OF ORGANIZATION

The cells are the basic structural and functional units of the human body. All cells arise from the preexisting cells through the process of cell division. The study of the structure and functions of the cell is called *cell biology*.

PARTS OF A CELL

The cell comprises three main parts: the plasma membrane, the cytoplasm and the nucleus. The cell is surrounded by the plasma membrane and comprises the nucleus and a number of organelles suspended in a watery fluid called *cytoplasm* (Fig. 1.7).

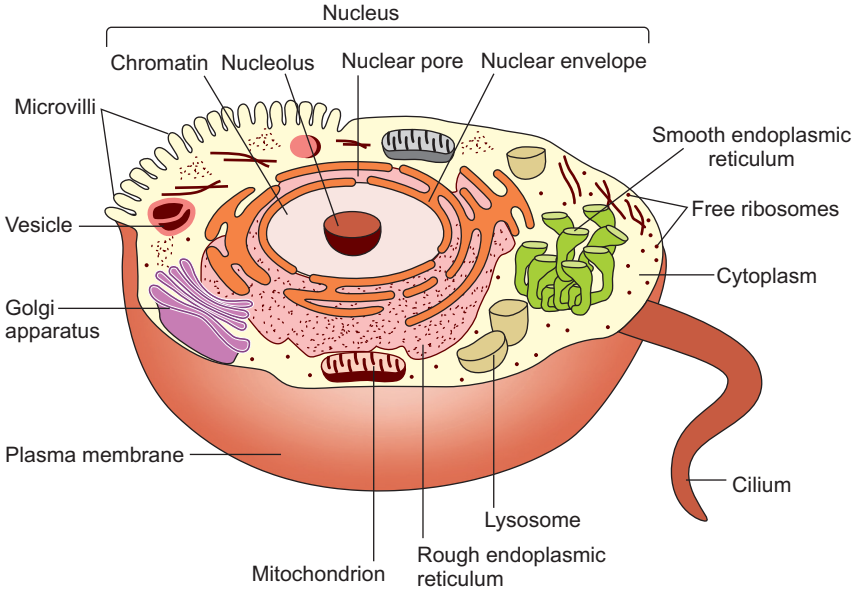

Figure 1.7 Parts of a cell.

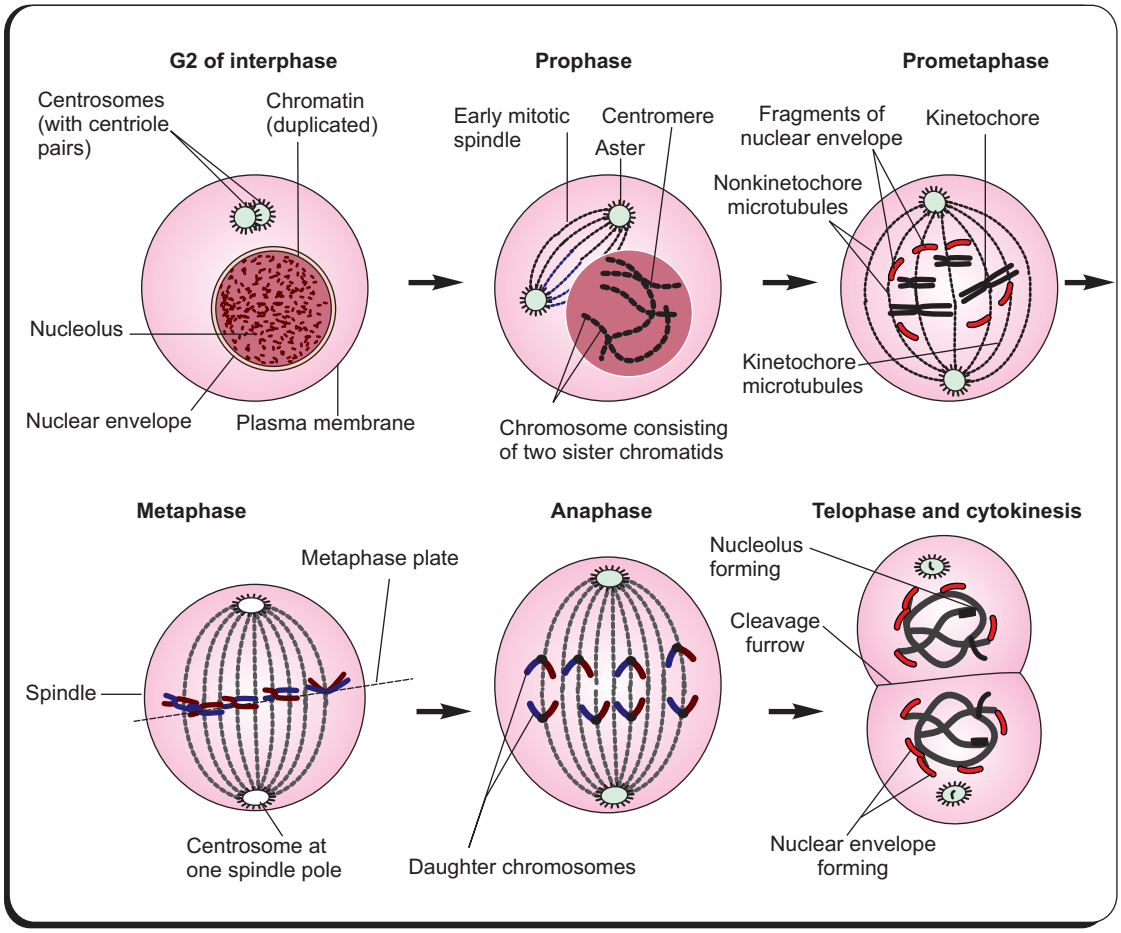

Figure 1.20 Somatic cell division.

Prophase

- During early prophase, the sister chromatids that are attached to one another at the centromere become visible within the nucleus.
- Each centrosome moves to an opposite pole (end) of the cell, where the pericentriolar area of the centrosome starts to form the *mitotic spindle*, a football-shaped assembly of microtubules. The lengthening of microtubules between the centrosomes pushes the centrioles present within the pericentriolar area to the ends of the cell. At this time, the nuclear membrane breaks down and the nucleolus disappears.
- As prophase continues, microtubules of the mitotic spindle extend from the poles (ends) towards the centromeres of the chromosomes. The microtubules coming from two poles (ends) attach to the opposite sides of the centromere in such a way that each of the two sister chromatids are attached to microtubules from different poles. This alignment ensures the separation of the sister chromatids to the opposite poles of the cell.

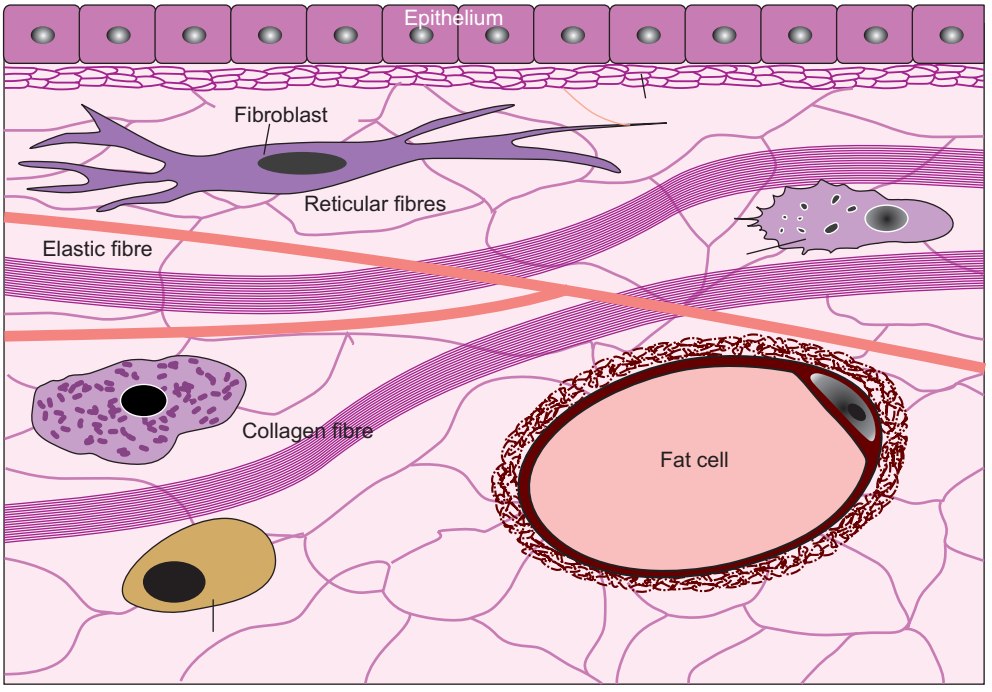

Figure 1.28 Components of connective tissue.

fibres and the connective tissue's extracellular matrix, i.e. the material present between its widely spread cells.

2. **Fat cells or adipocytes**: These cells store triglycerides (fats) and are abundant in the adipose connective tissue.
3. **Macrophages** (*macro*: large; *phages*: eaters): Macrophages are irregular-shaped cells that are capable of engulfing cell debris, bacteria and other foreign bodies by phagocytosis. Some macrophages are fixed (i.e. attached to connective tissue fibres), whereas others are wandering or motile (i.e. they have the ability to move throughout the tissue).
4. **Leukocytes or white blood cells**: These cells are found in small numbers in normal healthy connective tissue but migrate from blood into the connective tissues in response to infections or allergy (e.g. neutrophils, a type of WBC migrates from blood and gather at the site of infection as the body's defence response).
5. **Plasma cells**: They are small cells that develop from B-lymphocytes, a type of white blood cell. They secrete specific proteins called *antibodies* that attack and neutralize the foreign substances in the body.
6. **Mast cells**: Mast cells are mainly found in loose connective tissue and around blood vessels. They produce granules that contain heparin and histamine, which are released when there is cell injury. *Histamine* is a chemical that dilates small blood vessels and is involved in inflammatory response. Heparin prevents blood coagulation and helps in the passage of protective substances from blood to the affected tissue.

SYSTEMIC LUPUS ERYTHEMATOSUS

It is a chronic inflammatory disease of connective tissue that results in tissue damage in almost every body system.

Symptoms are Painful joints, fatigue, weight loss, mouth ulcers and anorexia.

In severe conditions, it may cause inflammation of the kidneys, liver, spleen, lungs, brain and gastrointestinal tract.

Effect of Ageing on Cells

- Ageing is a normal process that produces observable changes in the structure and function and makes us more vulnerable to disease and environmental conditions. As we age, cellular repair and cell division to replace old cells become slower, causing delay in wound healing and gradually ceases to occur, thereby leading to cellular deterioration and death.
- Collagen fibres become structurally irregular, lose their strength and extensibility and thus become more fragile. Elastic fibres thicken, fragment and thus lead to changes that may be associated with the development of atherosclerosis. The muscle cells and neurons decrease with age, causing decline in memory, reduced brain capacity and decreased muscle contraction in the elderly.

Review Questions

Long Answer Questions

1. Describe the basic characteristics of living organisms.
2. Describe the levels of organization of the human body.
3. List the four principal types of tissues and describe the functions of each.
4. What is a negative feedback, and how is it used to help maintain homeostasis?
5. Describe the anatomical position of the human body.
6. Describe the composition of cell (plasma) membrane.
7. Discuss the various processes by which substances are transferred across cell membranes.
8. Describe the structure and function of various organelles in the cell.
9. Describe the processes of mitosis and meiosis.
10. Discuss the various types of epithelial tissues.
11. Describe the characteristics, locations and functions of the connective tissue.
12. Describe muscle tissue and distinguish between the three types.