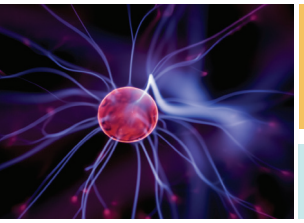


CHAPTER

1

Basics of Pathophysiology

CELL

Cells are the basic structural units of all living things. There are different cells that function for sustaining a life. Homeostasis is considered to be one of the hallmarks of all living beings and the cells have the ability to maintain this function. **Homeostasis** is the ability to maintain a relatively stable internal state that persists despite changes in the world outside. The various types of cells are shown in Figure 1.

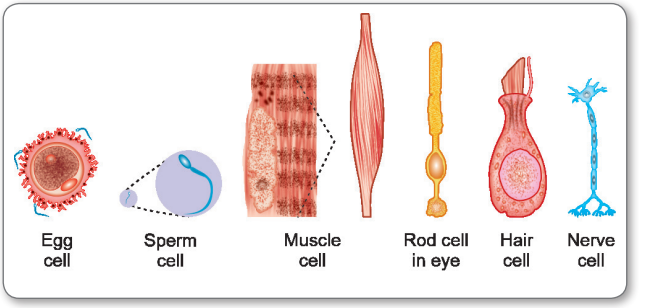


Fig. 1: Types of cells

On the other hand, the tissue is a group of cells that perform specific functions and include muscles, bones and blood. Two or more than two types of tissues form an organ like heart, liver, brain, etc. These organs further are integrated into the systems like cardiovascular, gastrointestinal, central nervous system, etc.

Components of Cell

There are three main basic components of every cell including:

1. **Cell membrane** that surrounds and protects the cell.
2. **Cytoplasm**, a watery substance containing ions, proteins and organelles.

3. **Organelles**, responsible for carrying out certain activities for the growth and reproduction of cells.

Organelles further include endoplasmic reticulum, Golgi apparatus, lysosomes and mitochondria:

- Endoplasmic reticulum provides mechanical support and synthesizes protein.
- Golgi complex synthesizes phospholipids and produces lysosomes.
- Lysosomes cause destruction of damaged cells and digestion of phagocytosed material.
- Mitochondria is responsible for production of adenosine triphosphate (ATP).

Cell Division

The division of cells is a means of reproduction in the unicellular organisms whereas it is required for growth and maintenance of tissues in case of multicellular organisms.

Mitosis is a cell division that takes place during the growth of animals and helps the tissues to get replaced or repaired. A single cell divides into two cells, which are exact copy of each other and have same number of chromosomes. In meiosis, division of a single cell occurs into four cells having half number of chromosomes.

Cell Cycle—Mitosis

Before a cell starts dividing, it is in the **interphase**, which is the period when the cell is gathering the nutrients and energy to start the cell cycle.

The phases of the cell division through mitosis are depicted in Figures 2 and 3.

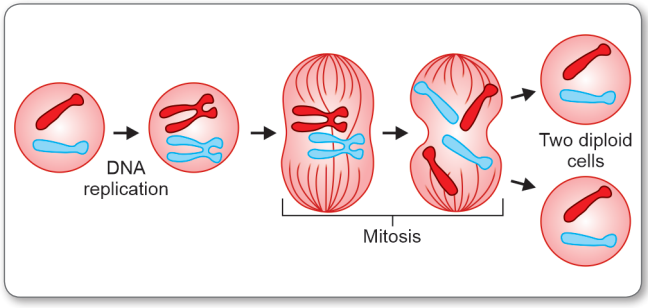


Fig. 2: Mitosis

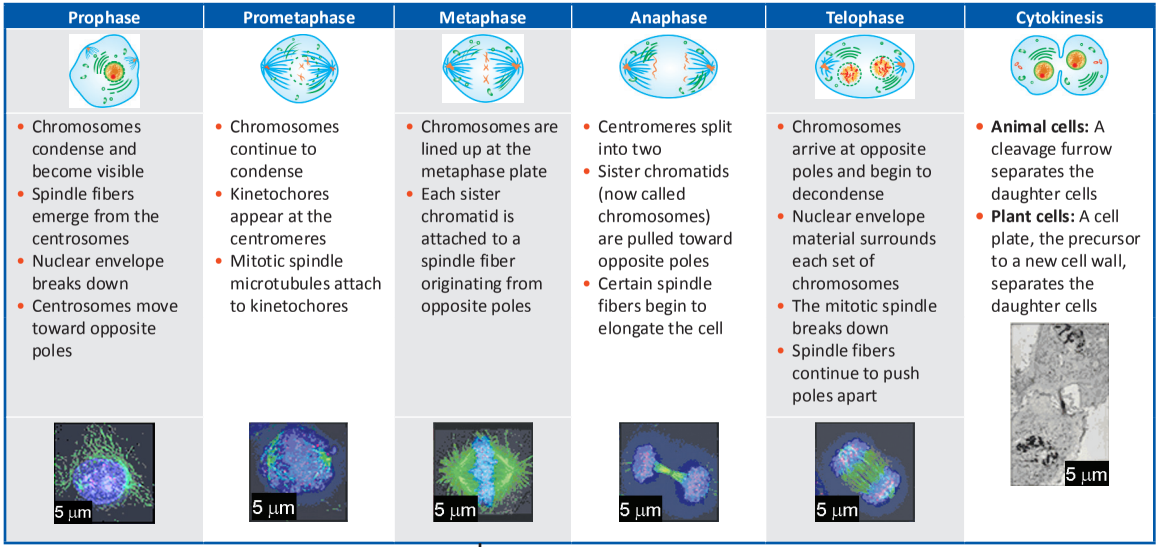


Fig. 3: Phases of mitosis

CELLULAR ADAPTATION

Whenever there is an injury to the cells, there will be either reversible cell injury leading to adaptation or an irreversible cell injury causing death of cells and damage to tissues.

The disease conditions occur for various reasons that sometimes cause alterations in the cellular function or the disease condition can be the result of failure of cells to maintain homeostasis. In such cases, the cells must adapt to the changes. Basically, cellular adaptation refers to all the changes made by the cells in response to adverse environmental changes. The adaptation may be either physiologic or pathologic.

The five major types of cell adaptations are depicted in Figures 4 and Figure 5 exhibits the diagrammatic presentation of cell adaptations.

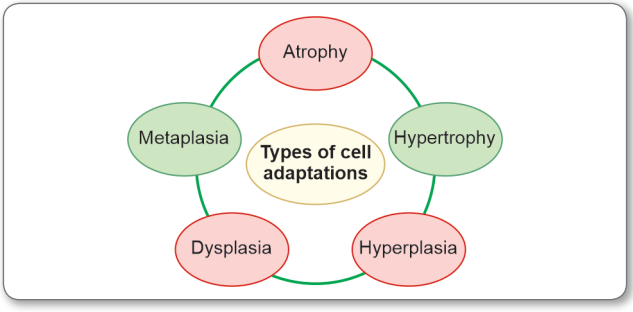


Fig. 4: Types of cell adaptations

1. **Atrophy:** It refers to decrease in size of the cells and also degeneration of tissues that is caused by a decrease in synthesis of proteins.
2. **Hypertrophy:** An increase in the size of tissues through the enlargement of cells is the result of an increase in the organelles and proteins. An increase in skeletal muscles in case of body-builders is an example of physiological hypertrophy whereas an enlargement of cardiac muscle as a result of hypertension is pathological hypertrophy.
3. **Hyperplasia:** It is an increase in the number of cells occurring as a result of increased mitosis. When there is an increase in functional capacity as required, it results in physiological hyperplasia.

Pathologic hyperplasia is the result of an excessive stimulation of hormones or growth factors.

4. **Dysplasia:** A disordered growth of epithelium leads to dysplasia. It is not considered to be true adaptation and is related to hyperplasia.
5. **Metaplasia:** It is a reversible change in which one cell type is replaced by another. For example, in case of chronic smokers, ciliated columnar epithelium lining the trachea and bronchi is transformed into stratified squamous epithelial cells.

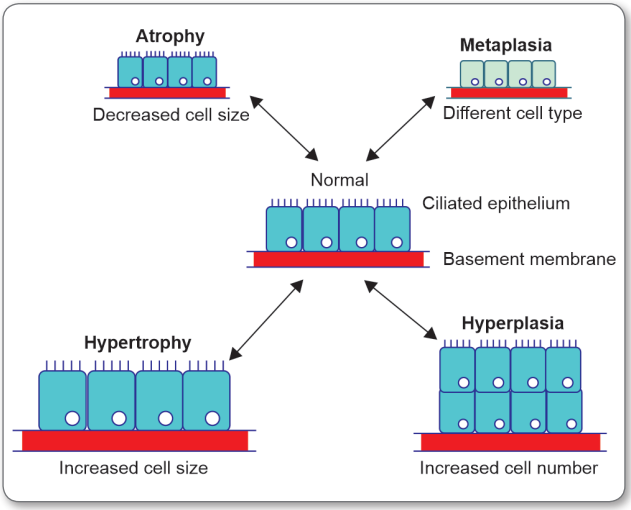


Fig. 5: Diagrammatic representation of different types of cell adaptations

Types of Cell Injury

Damage to the cells results from changes in either internal or external environments, and this damage can be reversible or irreversible. Homeostasis is restored based upon the extent of injury or damage. Hypoxia is known to be the most common cause of cell injury. Reversible cell injury leads to adaptation whereas irreversible injury causes death of cells.

Two broad categories of cell injury involve the acquired and genetic causes.

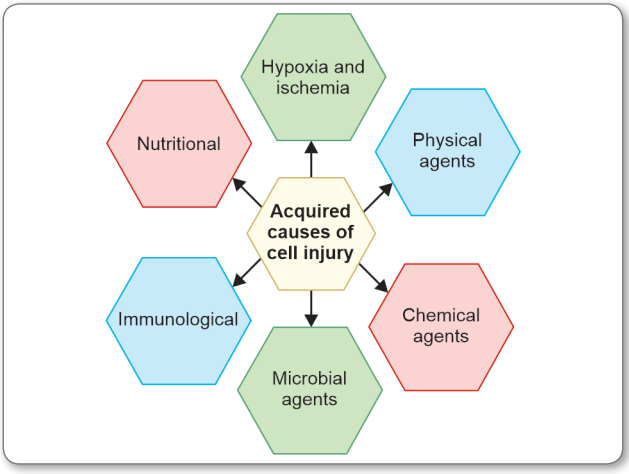


Fig. 6: Acquired causes of cell injury

- **Acquired causes:** Hypoxia and ischemia as a result of oxygen deprivation leading to failure of aerobic metabolism and generation of free radicals are the main causes. Physical agents like heat, radiation or direct trauma also cause cell damage. Lack of oxygen and glucose cause impaired nourishment of cells that results in cell injury (Fig. 6).
- **Genetic causes:** About 50% of total mortality in infancy and childhood in Western countries and 95% of that in developing countries are contributed by genetic defects. Examples include Down's syndrome and sickle cell anemia.

REPAIR OF CELLS

The body tries to repair or replace the cells in case of a cellular injury so as to continue the normal functions. In case of cell death, it is removed and replaced so as to provide structural support to the remaining cells through the attachment with connective tissues.

Normal cells try to regenerate the damaged cells, which is not always possible, so the purpose of repair process is to fill the gap caused by the damaged cells so as to maintain structural continuity.

HOMEOSTASIS

Homeostasis refers to the ability of body to regulate its internal environment in response to changes or fluctuations in the internal or external environment. The brain, kidneys, liver and pancreas are involved in maintaining homeostasis.

The regulation of body temperature, heart rate, blood pressure, and circadian rhythms is done by the hypothalamus. The kidneys regulate the blood-water level, reabsorption of substances in blood, maintenance of electrolyte levels, regulation of pH, and removal of toxic products. The metabolization of toxic substances and maintenance of carbohydrate and lipid metabolism is done by the liver.

Homeostasis can be influenced by internal (intrinsic) or external (environmental) conditions. A receptor or sensor, integrating center and effector are the basic components of every homeostatic response. Positive and negative feedback mechanisms enable these three components to maintain homeostasis (Figs 7 to 9).

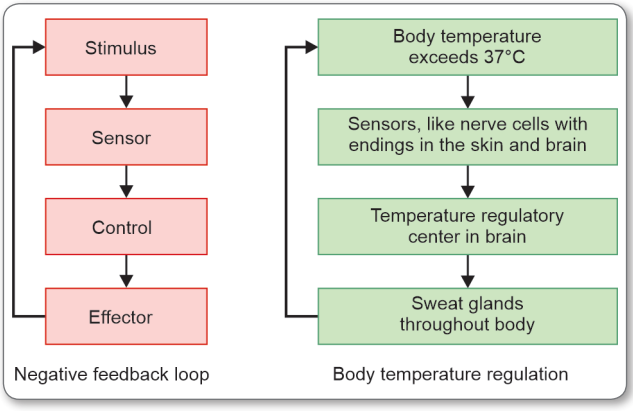
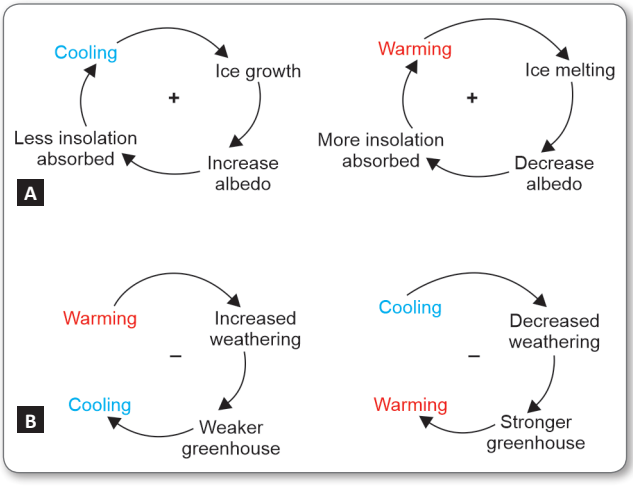


Fig. 7: Maintenance of homeostasis



Figs 8A and B: **A.** Positive feedback mechanism; **B.** Negative feedback mechanism

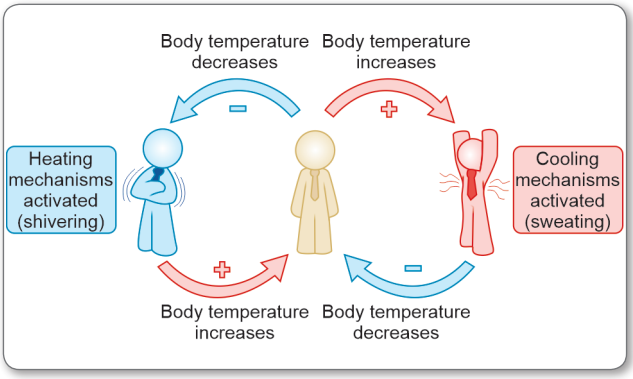


Fig. 9: Example of negative feedback

DISEASE, SICKNESS AND ILLNESS

Generally, these terms are thought of as synonyms but actually there is a difference between these. Diseases are to be cured while illness can be managed. Sickness is a reaction the patient shows when acquires a disease condition. The patient's experience can be well described through these three terms (Fig. 10).

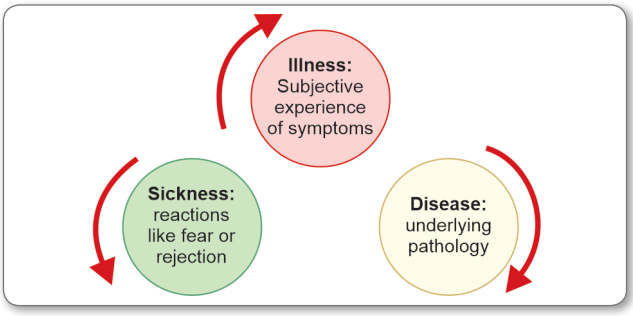


Fig. 10: Disease, illness and sickness

PATHOPHYSIOLOGY AND DISEASE

Pathophysiology, the concurrence of pathology and physiology, is the study of deranged physiological processes that are associated with a disease condition or an injury. Pathology describes the abnormal condition or state whereas pathophysiology explains about the changes in functions that take place in an individual as a result of disease or pathologic condition.

Phases of Diseases

Diseases progress through five stages as: (1) incubation period, (2) prodromal phase, (3) period of illness, (4) period of decline and (5) period of convalescence (Fig. 11).

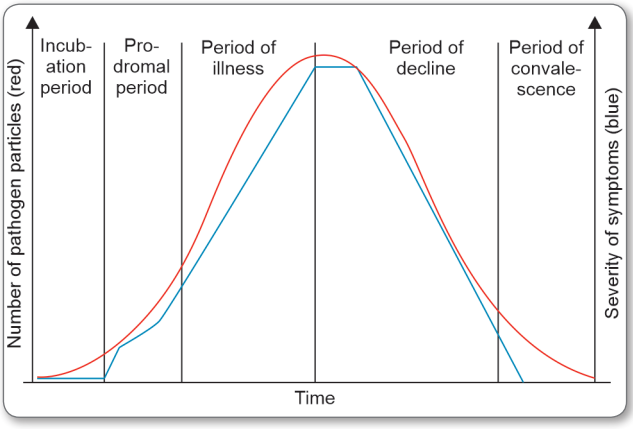


Fig. 11: Phases of disease

1. The **incubation period** occurs after an initial entry of pathogen into the host and before the occurrence of symptoms when the pathogen is multiplying. Depending upon the type of pathogen, the incubation period varies from one to two days in acute diseases and months or years in chronic diseases.
2. In the **prodromal period**, there is a continuous multiplication of the pathogens and the signs and symptoms of disease become apparent. These symptoms are however, unspecific to the pathogen like fever or headache.
3. The prodromal period is followed by the **period of illness**, in which the symptoms become specific and severe.
4. The **period of decline** is characterized by a decrease in number of pathogens and also a decline in the signs and symptoms of disease. As the immune system is weakened by the primary infection, the patients become susceptible to the development of secondary infections in the decline phase.
5. The last phase is known as **convalescent period** where recovery takes place. The patient generally returns to the normal level of functioning, however, in some cases where a permanent damage occurs, there will not be a full repairing of tissues.

IMPORTANCE OF PATHOPHYSIOLOGY IN NURSING

As discussed, the study of physical and biological disturbances that occur in the body as a result of the disease is termed as pathophysiology. Pathophysiology serves as the basis of nursing practice, as it helps in forming a strong foundation for the major nursing roles and responsibilities like opting for diagnostic examination, managing the acute and chronic illnesses, taking care of patient's health in general and also preventing the occurrence of disease. The end result of understanding the pathophysiological changes and recognizing the signs and symptoms is provision of quality nursing care, which is the main aim of nursing. For putting the pathophysiological changes into practice, the nurses need to have a strong clinical knowledge and critical thinking as well.

While studying the pathophysiology of disease conditions, the students focus on the understanding of biophysiological processes, the disturbances in these processes and also the scientific concepts that are related to the biology of disease conditions.

The pathophysiological changes related to disease conditions of various body systems are discussed in the subsequent chapters of this book.