The Cell

Relative volumes of intracellular organelles (hepato

Compartment	% total volume	number/cell
Cytosol	54%	1
Mitochondria	22%	1700
Rough ER	9%	1*
Smooth ER, Golgi	6%	1*
Nucleus	6%	1
Endosomes	1%	200
Lysosomes	1%	300
Peroxisomes	1%	400

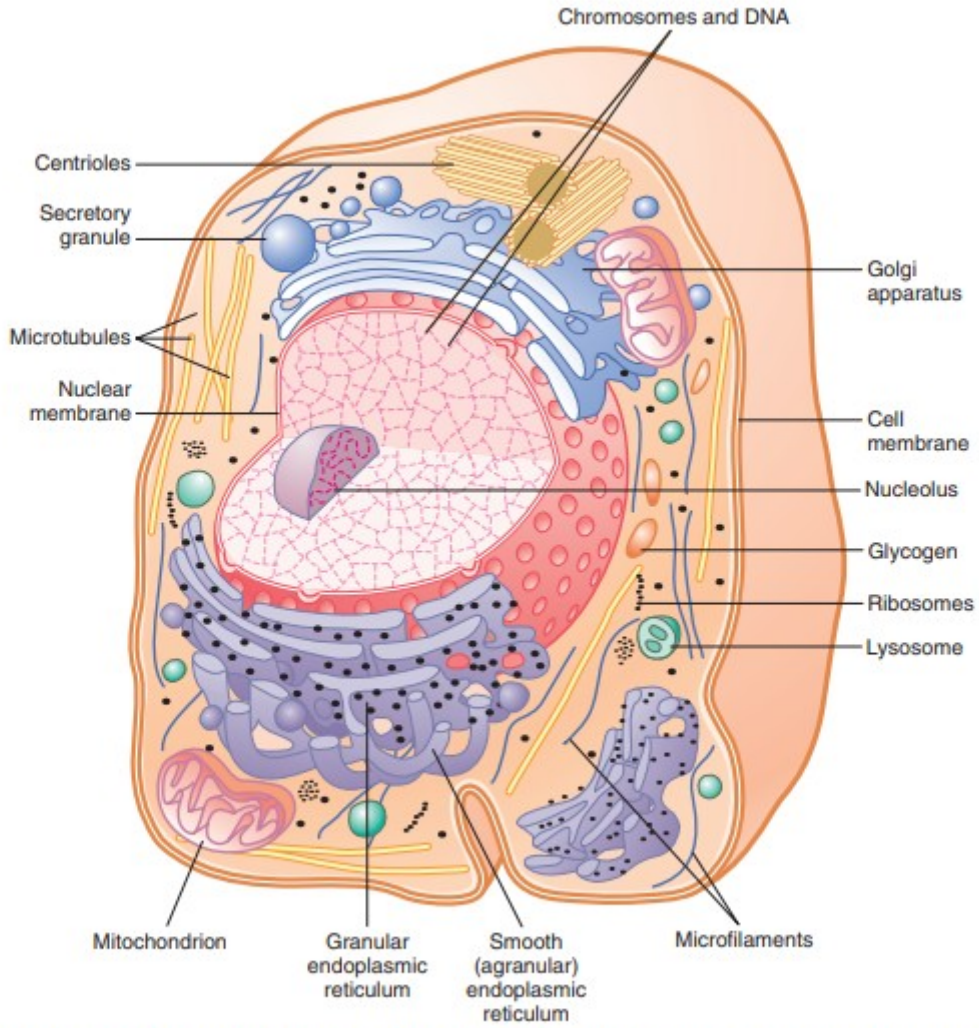

Figure 2-2. Reconstruction of a typical cell, showing the internal organelles in the cytoplasm and in the nucleus.

TABLE 1.1: Functions of cytoplasmic organelles

Organelles	Functions
Rough endoplasmic reticulum	1. Synthesis of proteins 2. Degradation of worn-out organelles
Smooth endoplasmic reticulum	1. Synthesis of lipids and steroids 2. Role in cellular metabolism 3. Storage and metabolism of calcium 4. Catabolism and detoxification of toxic substances
Golgi apparatus	1. Processing, packaging, labeling and delivery of proteins and lipids
Lysosomes	1. Degradation of macromolecules 2. Degradation of worn-out organelles 3. Removal of excess of secretory products 4. Secretion of perforin, granzymes, melanin and serotonin
Peroxisomes	1. Breakdown of excess fatty acids 2. Detoxification of hydrogen peroxide and other metabolic products 3. Oxygen utilization 4. Acceleration of gluconeogenesis 5. Degradation of purine to uric acid 6. Role in the formation of myelin 7. Role in the formation of bile acids
Centrosome	1. Movement of chromosomes during cell division
Mitochondria	1. Production of energy 2. Synthesis of ATP 3. Initiation of apoptosis
Ribosomes	1. Synthesis of proteins
Cytoskeleton	1. Determination of shape of the cell 2. Stability of cell shape 3. Cellular movements
Nucleus	1. Control of all activities of the cell 2. Synthesis of RNA 3. Sending genetic instruction to cytoplasm for protein synthesis 4. Formation of subunits of ribosomes 5. Control of cell division 6. Storage of hereditary information in genes (DNA)

Cell injury

- Cell injury is defined as the effect of a variety of stresses due to etiologic agents a cell encounters resulting in changes in its internal and external environment.
- When the stress is mild to moderate, the injured cell may recover (reversible cell injury), while persistent and severe form of cell injury may cause cell death (irreversible cell injury).
- cellular adaptations: When there is increased functional demand, the cell may adapt to the changes which are expressed morphologically, which then revert back to normal after the stress is removed.

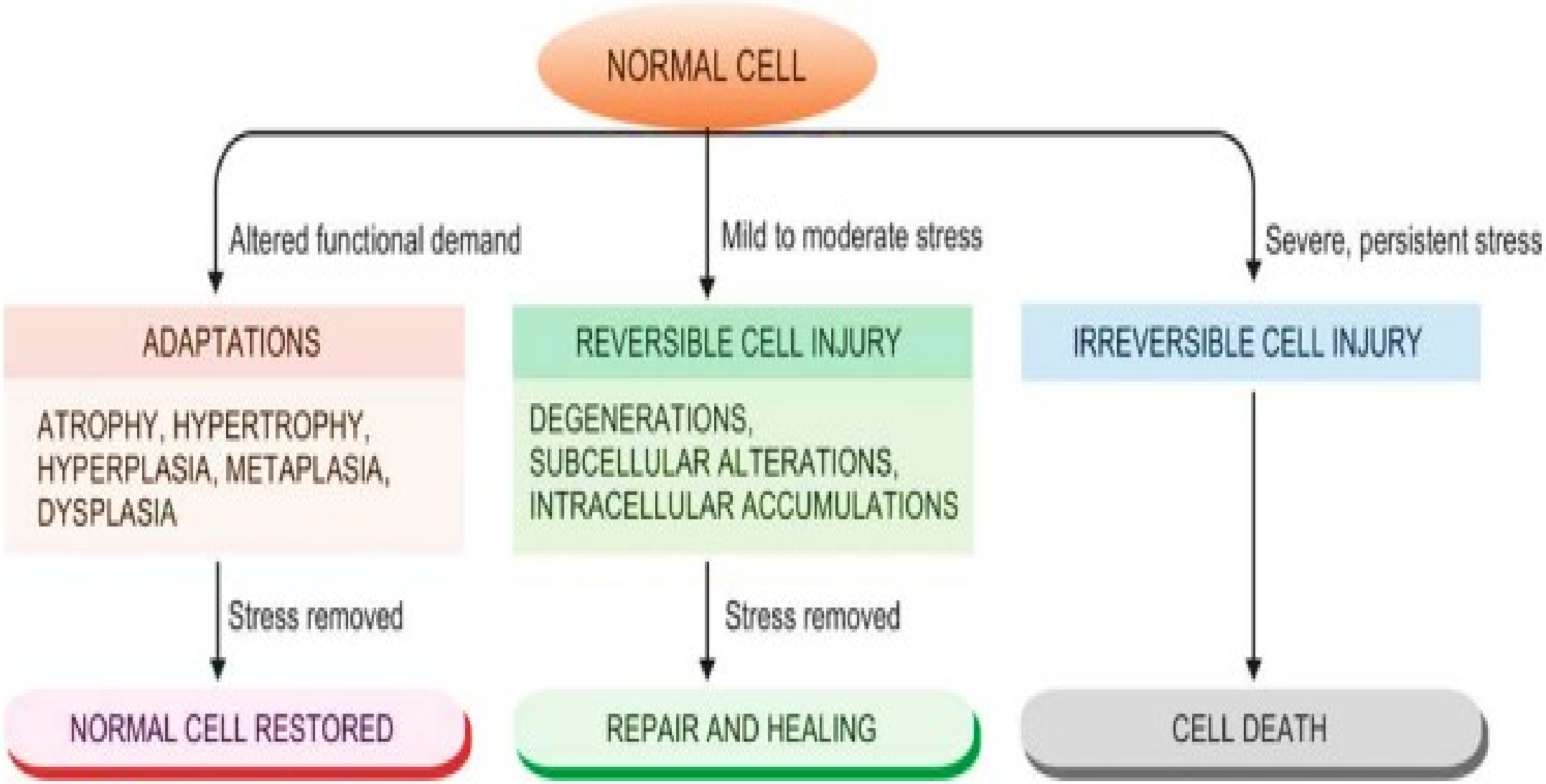

Figure 2.1 Cellular responses to cell injury.

Etiology

1. Genetic causes

2. Acquired causes

- 1. Hypoxia and ischaemia
- 2. Physical agents
- 3. Chemical agents and drugs
- 4. Microbial agents
- 5. Immunologic agents
- 6. Nutritional derangements
- 7. Ageing
- 8. Psychogenic diseases
- 9. Iatrogenic factors
- 10. Idiopathic diseases

Cellular adaptation occurs by any of the following mechanisms.

- 1. Atrophy
- 2. Hypertrophy
- 3. Hyperplasia
- 4. Dysplasia
- 5. Metaplasia

ATROPHY:

Atrophy means decrease in size of a cell. Atrophy of more number of cells results in decreased size or wasting of the concerned tissue, organ or part of the body.

Causes of Atrophy:

Atrophy is due to one or more number of causes such as:

i. Poor nourishment

ii. Decreased blood supply

iii. Lack of workload or exercise

iv. Loss of control by nerves or hormones

v. Intrinsic disease of the tissue or organ.

Types of Atrophy: two types, physiological atrophy and pathological atrophy.

Examples of:

The physiological atrophy are the atrophy of thymus in childhood and tonsils in adolescence.

The pathological atrophy is common in skeletal muscle, cardiac muscle, sex organs and brain.

HYPERTROPHY

- Hypertrophy is the increase in the size of a cell. Hypertrophy of many cells results in enlargement or overgrowth of an organ or a part of the body.
- Hypertrophy is of three types.

1. Physiological Hypertrophy : Physiological hypertrophy is the increase in size due to increased workload or exercise. The common physiological hypertrophy includes:

i. Muscular hypertrophy: Increase in bulk of skeletal muscles that occurs in response to strength training exercise

ii. Ventricular hypertrophy: Increase in size of ventricular muscles of the heart which is advantageous only if it occurs in response to exercise.

2. Pathological Hypertrophy:

Increase in cell size in response to pathological changes is called pathological hypertrophy.

Example is the ventricular hypertrophy that occurs due to pathological conditions such as high blood pressure, where the workload of ventricles increases.

3. Compensatory Hypertrophy:

Compensatory hypertrophy is the increase in size of the cells of an organ that occurs in order to compensate the loss or dysfunction of another organ of same type.

Examples are the hypertrophy of one kidney when the other kidney stops functioning; and the increase in muscular strength of an arm when the other arm is dysfunctional or lost.

Hyperplasia

Hyperplasia is the increase in number of cells due to increased cell division (mitosis). It is also defined as abnormal or unusual proliferation (multiplication) of cells due to constant cell division.

Hyperplasia results in gross enlargement of the organ. Hyperplasia involves constant cell division of the normal cells only.

Hyperplasia is of three types:

1. **Physiological Hyperplasia:** Physiological hyperplasia is the momentary adaptive response to routine physiological changes in the body. For example, during the proliferative phase of each menstrual cycle, the endometrial cells in uterus increase in number.

2. Compensatory Hyperplasia: Compensatory hyperplasia is the increase in number of cells in order to replace the damaged cells of an organ or the cells removed from the organ. Compensatory hyperplasia helps the tissues and organs in regeneration.

It is common in liver. After the surgical removal of the damaged part of liver, there is increase in the number of liver cells resulting in regeneration.

Compensatory hyperplasia is also common in epithelial cells of intestine and epidermis.

3. Pathological Hyperplasia:

Pathological hyperplasia is the increase in number of cells due to abnormal increase in hormone secretion. It is also called **hormonal hyperplasia.**

For example, in gigantism, hypersecretion of growth hormone induces hyperplasia that results in overgrowth of the body.

DYSPLASIA

Dysplasia is the condition characterized by the abnormal change in size, shape and organization of the cell.

Dysplasia is not considered as true adaptation and it is suggested as related to hyperplasia.

It is common in epithelial cells of cervix and respiratory tract.

METAPLASIA

Metaplasia is the condition that involves replacement of one type of cell with another type of cell. It is of two types.

1. Physiological Metaplasia:

Replacement of cells in normal conditions is called physiological metaplasia.

Examples are transformation of cartilage into bone and transformation of monocytes into macrophages.

2. Pathological Metaplasia:

Pathological metaplasia is the irreversible replacement of cells due to constant exposure to harmful stimuli.

For example,

chronic smoking results in transformation of normal mucus secreting ciliated columnar epithelial cells into non-ciliated squamous epithelial cells, which are incapable of secreting mucus.

These transformed cells may become cancerous cells if the stimulus (smoking) is prolonged.