Cellular injury and cell death lecture 1

DR SAIMA NADEEM
ASSISTANT PROFESSOR
HISTOPATHOLOGY


بسم الله الرحمن الرحيم


وَإِذَا مَرِضْتُ فَهُوَ يَشْفِينِ
الشعراء:٨٠
And when I am sick it is He who cures me
Quran 26:80

Learning Objectives

- By the end of this lecture you should be able to:
- Define pathology, disease, etiology, pathogenesis, morphology, cell injury and homeostasis.
- Describe the causes of cell injury.
- Enumerate different classes of pathology.

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Explore

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Students after choosing Medical Studies.
"Haye wey Rabba kithy phas gaye"

388 likes

Disease

- A disorder of structure or function in a human, animal, or plant, especially one that has a known cause and a characteristic symptoms, signs, or anatomical changes.

INTRODUCTION TO PATHOLOGY

- Pathology is a branch of medical science primarily concerning the cause, origin, and nature of disease.

- It involves the examination of cells ,tissues, organs, bodily fluids, and autopsies in order to study and diagnose disease.

Etiology

- Etiology refers to the underlying causes and modifying factors that are responsible for the initiation and progression of disease.

- It is now clear that many common diseases, such as hypertension, diabetes, and cancer, are caused by a combination of inherited genetic susceptibility and various environmental triggers.

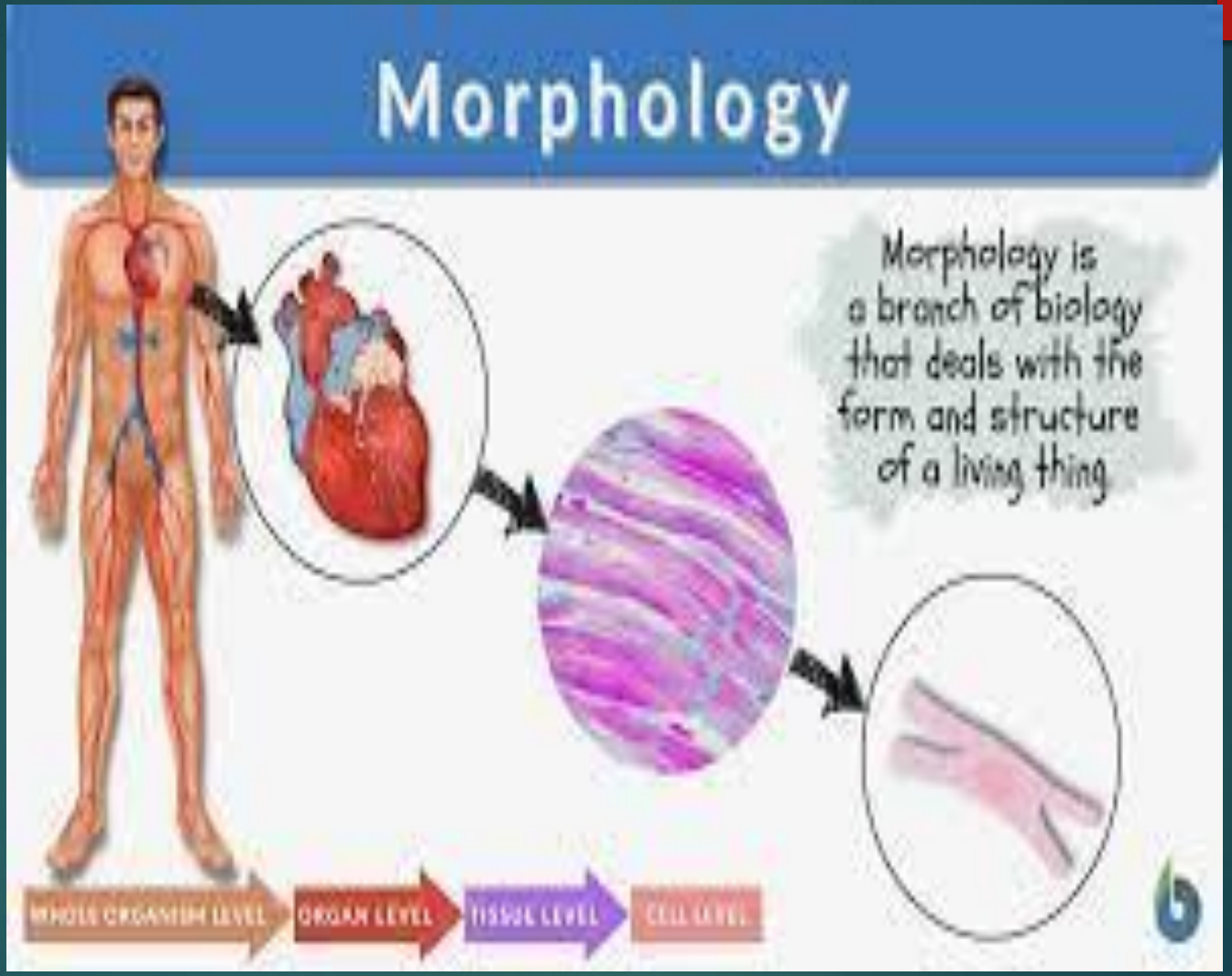
Pathogenesis

- Pathogenesis refers to the mechanisms of development and progression of disease, which account for the cellular and molecular changes.
- This give rise to the specific functional and structural abnormalities that characterize any particular disease.

- Thus, etiology refers to why a disease arises and pathogenesis describes how a disease develops.

Morphology

- Morphology deals with the study of the form and structure of organisms and their specific structural features arising as a result of various disease.
- These include both gross and microscopic changes.


Morphology
Morphology is a branch of biology that deals with the form and structure of a living thing
WHOLE ORGANISM LEVEL
ORGAN LEVEL
TISSUE LEVEL
CELL LEVEL

What should we know about a Disease?

- Definition.
- Epidemiology – Where & When.
- Etiology – What is the cause?
- Pathogenesis - Evolution of dis.
- Morphology - Structural Changes
- Functional consequences

Pathology

- Management
- Prognosis
- Prevention

Homeostasis

- Cells actively interact with their environment, constantly adjusting their structure and function to accommodate changing demands and extracellular stresses.
- The intracellular environment of cells is normally tightly regulated such that it remains fairly constant, a state referred to as homeostasis.

Classes of pathology

- General pathology.

General pathology describes a complex and broad field that involves the study of the mechanisms behind cell and tissue injury and understanding how the body responds to and repairs injury. Examples of areas that may be studied include necrosis, neoplasia, wound healing, inflammation and how cells adapt to injury.

- Systemic pathology.

Special Pathology

- Histopathology.
- Chemical Pathology.
- Hematology.
- Microbiology.

Histopathology

- This field is concerned with the study and diagnosis of illness through microscopic analysis of samples from bodily fluids, cells, tissues, organs and sometimes the entire body or autopsy. Factors that may be examined include the cell appearance and anatomical makeup.

Histopathology

Cytology

Autopsy

Chemical Pathology

- Chemical pathologists examine all aspects of disease, identifying changes in various substances found in the blood and bodily fluids such as proteins, hormones and electrolytes since these changes can indicate and provide clues about disease or disease risk.

- For example, a chemical pathologist may assess cholesterol and triglyceride levels in order to determine heart disease risk. They may also look for and measure tumor markers, vitamins, poisons, medications and recreational drugs.


HA
HA

hematology

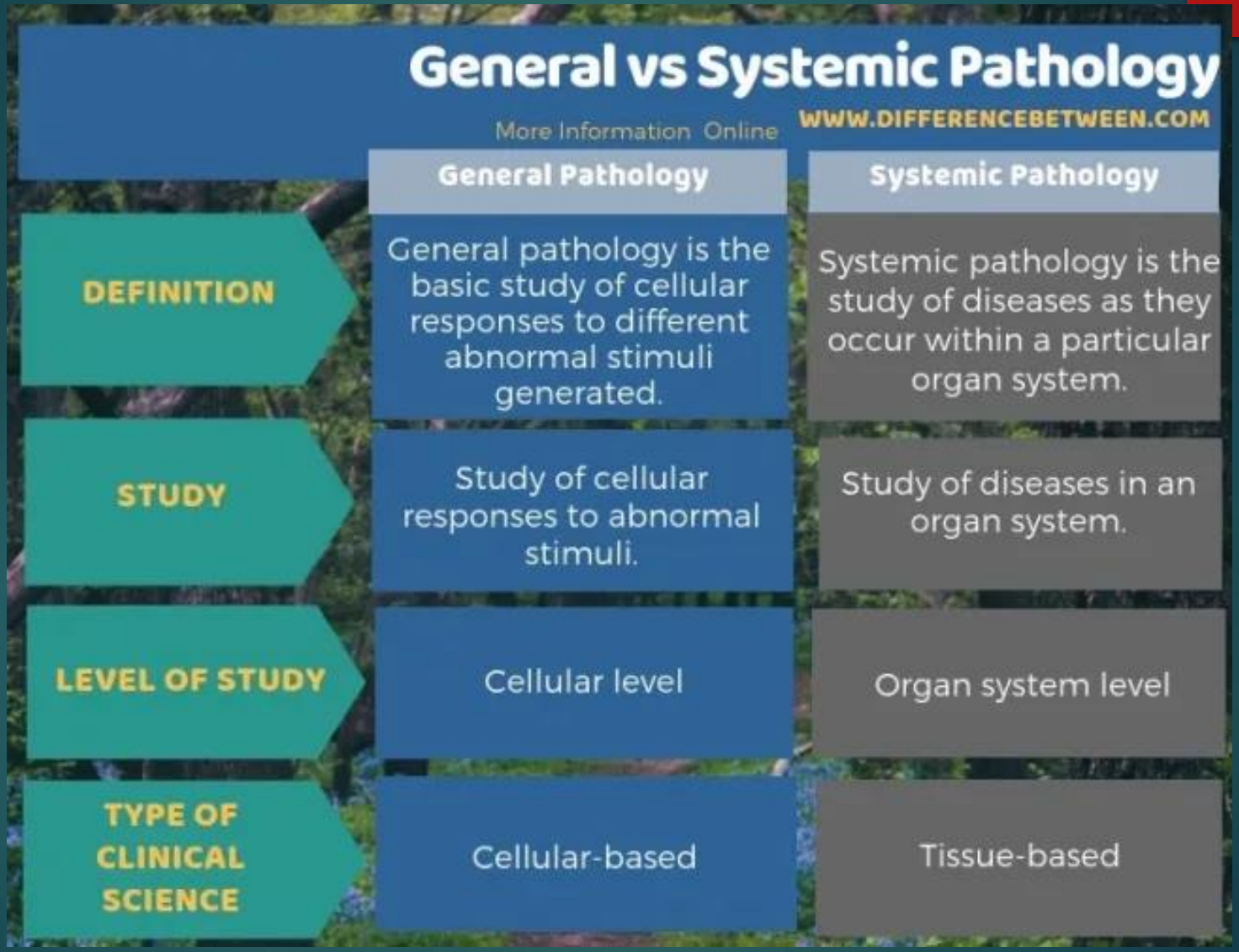
- This field is concerned with various disease aspects that affect the blood, including bleeding disorders, clotting problems, and anemia, for example. Another area of hematology is **transfusion medicine**, which involves performing blood typing, cross-matching for compatibility and managing large amounts of blood products. An example of a test a hematologist may perform is a blood clotting test to check whether a patient's dose of warfarin needs increasing or decreasing.

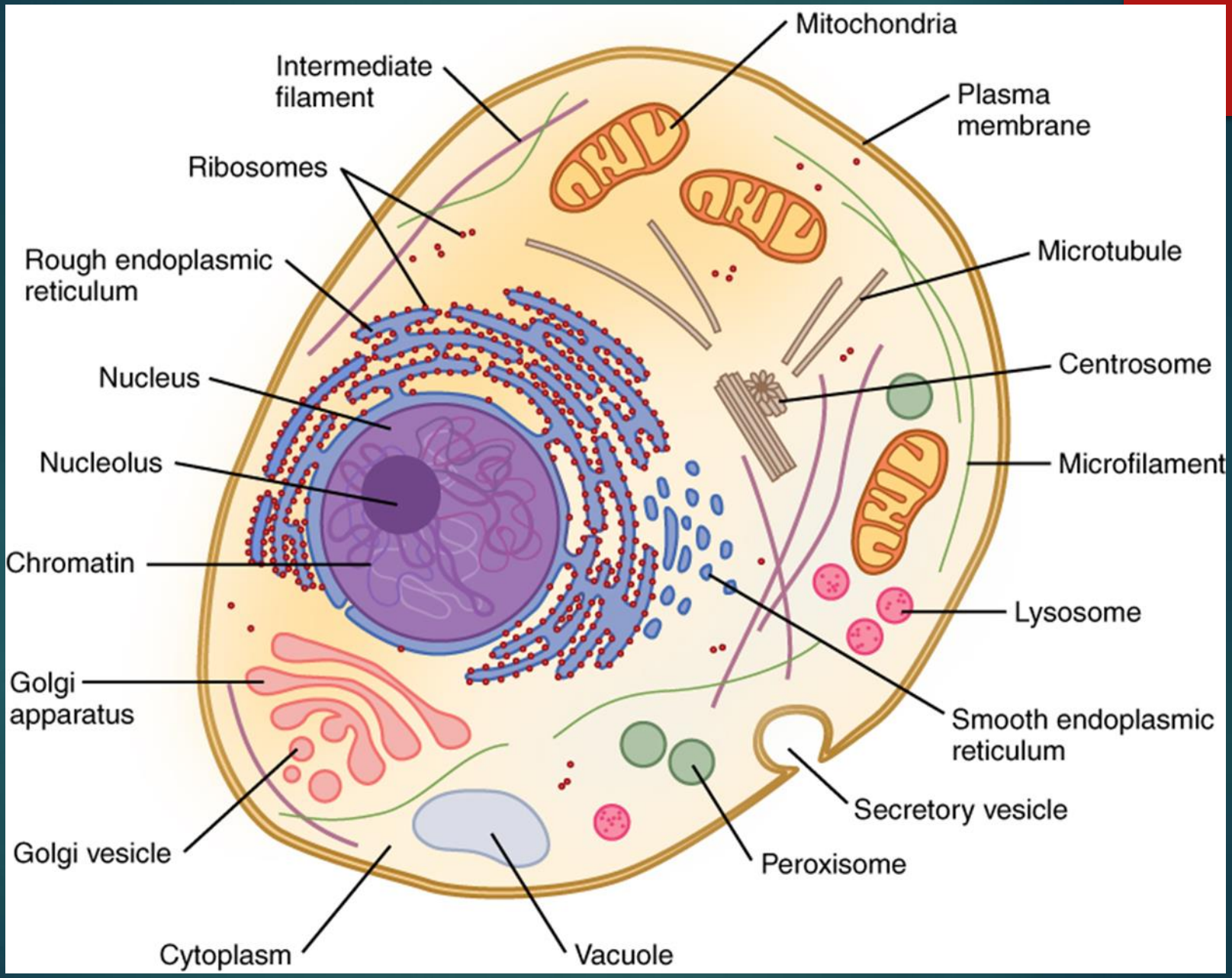
Microbiology

- Immunology:

Immunologists perform immune function tests to establish whether or not a patient is suffering from an allergy . Autoimmune diseases. There is a range of immunological tests that can detect markers of autoimmune diseases such as rheumatoid arthritis, diabetes and lupus.

- Microbiology is concerned with diseases caused by pathogenic agents such as bacteria, viruses, parasites and fungi


General vs Systemic Pathology
More Information Online
WWW.DIFFERENCEBETWEEN.COM
General Pathology
Systemic Pathology
DEFINITION
General pathology is the basic study of cellular responses to different abnormal stimuli generated.
Systemic pathology is the study of diseases as they occur within a particular organ system.
STUDY
Study of cellular responses to abnormal stimuli.
Study of diseases in an organ system.
LEVEL OF STUDY
Cellular level
Organ system level
TYPE OF CLINICAL SCIENCE
Cellular-based
Tissue-based


Mitochondria
Intermediate filament
Plasma membrane
Ribosomes
Rough endoplasmic reticulum
Microtubule
Nucleus
Centrosome
Nucleolus
Microfilament
Chromatin
Lysosome
Golgi apparatus
Smooth endoplasmic reticulum
Secretory vesicle
Golgi vesicle
Peroxisome
Cytoplasm
Vacuole

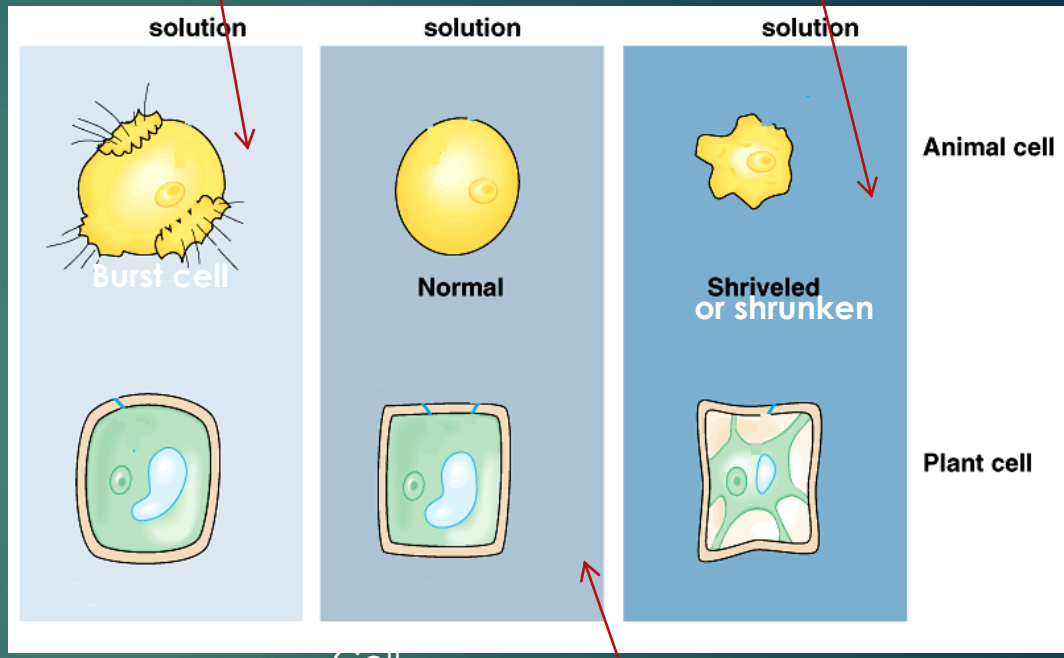
Injured or ill Cell

Cell injury:

- Normal cells are in a state of homeostasis (i.e., an equilibrium with their environment)
- Cell injury is defined as "a set of biochemical or morphologic changes that occur when the state of homeostasis is disturbed".

Hypotonic solution

Hypertonic solution



Cell homeostasis

Isotonic solution

- It can also be defined as the effect of a variety of stresses on a cell resulting in changes in its internal and external environment.
- Cell injury can be

1. Reversible
2. Irreversible

1.Reversible injury:

- Usually mild or of transient duration.
- Following removal of the adverse stimulus, the cell reverts to its normal steady state.
- Cell has got ability to withstand increased physiologic demands by maintaining homeostasis.
- Cell undergoes different reversible adaptations, which can lead to reversible injury if demand increases and homeostasis is disturbed.

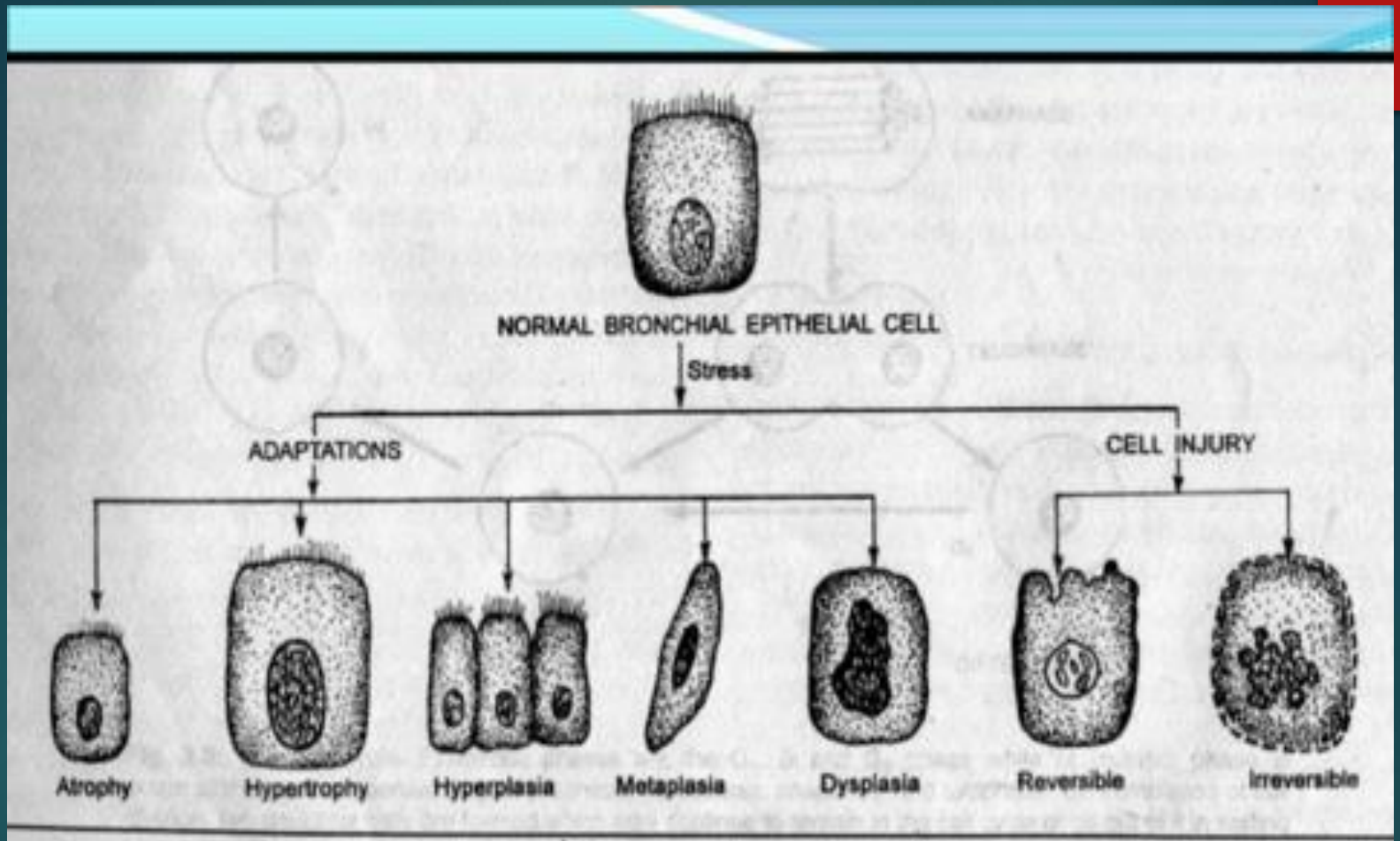


Fig. 4.1: Cellular responses to cell injury.

- Prominent features of reversible injury are

a. Cellular swelling and swelling of its organelles like mitochondria and ER.

b. Nucleolar changes (structural and functional changes)

c. Reduced oxidative phosphorylation.

d. Reduced oxidative phosphorylation is due to swelling of mitochondria which leads to;

e. Decreased ATP production

2.Irreversible injury:

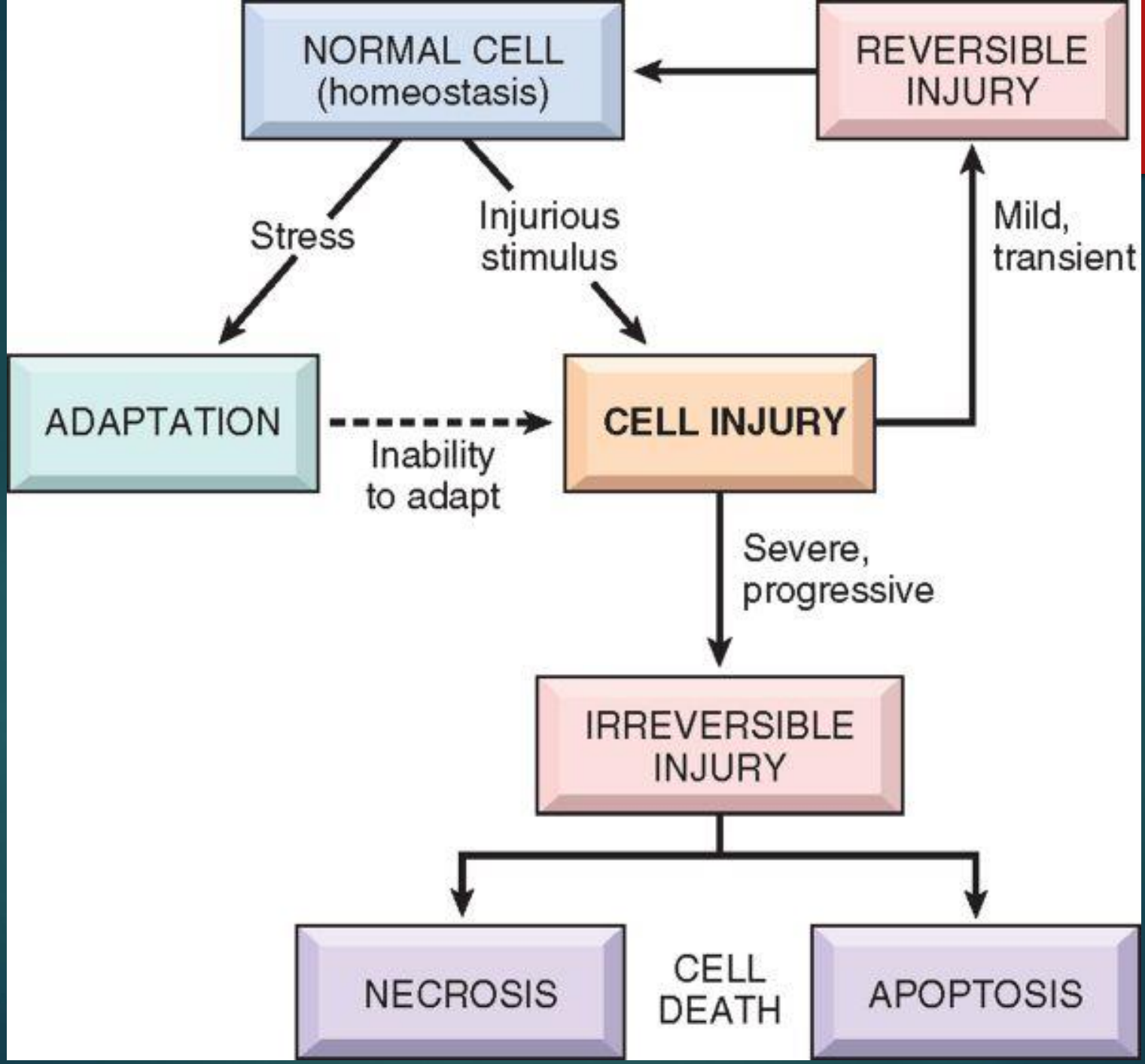
- If injury is severe or the stimulus causing injury is persistently present and cell cannot recover, the injury becomes irreversible.

- A theoretical ‘‘point of no return’’ separating the reversible from irreversible injury cannot be precisely defined even under tightly controlled experimental conditions.
- All the changes found in reversible injury become severe in intensity in irreversible injury(quantitative difference).

- Later on some other changes occur.

1. There is profound damage to cells' plasma membrane leading to leakage of contents.
2. Nuclear changes.

- Irreversible cell injury always leads to cell death.


NORMAL CELL
(homeostasis)
REVERSIBLE
INJURY
Stress
Injurious
stimulus
Mild,
transient
ADAPTATION
Inability
to adapt
CELL INJURY
Severe,
progressive
IRREVERSIBLE
INJURY
NECROSIS
CELL
DEATH
APOPTOSIS


AS LONG AS YOU'RE MY PATIENT
THE LAST THING YOU'RE GOING TO DO IS DIE

CAUSES OF CELL INJURY:

A. Oxygen Deprivation:
B. Physical agents:
C. Chemical Agents:
D. Infectious Agents.
E. Immunologic Reactions.
F. Genetic Defects:
G. Nutritional Imbalances.
H. Ageing

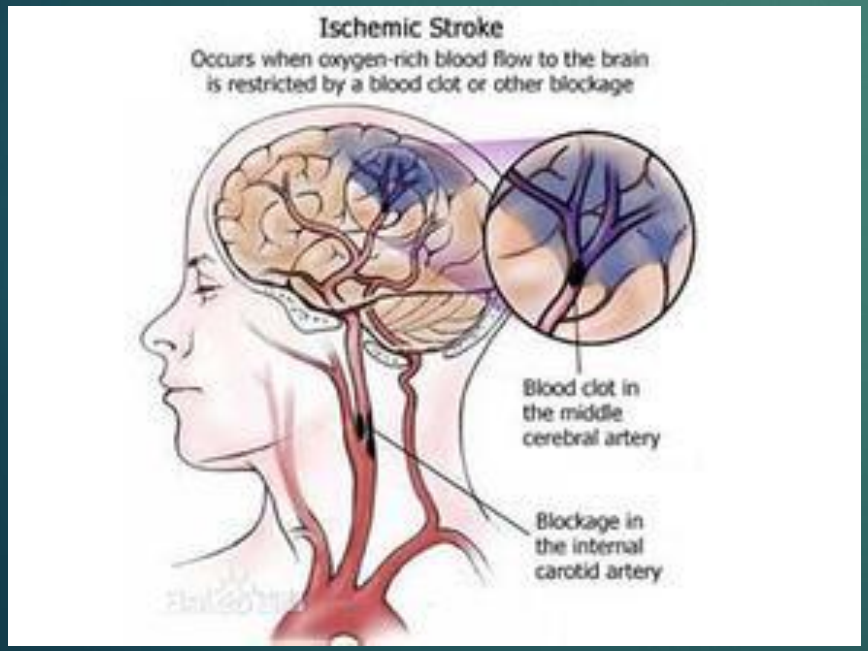
A. **Oxygen Deprivation:**

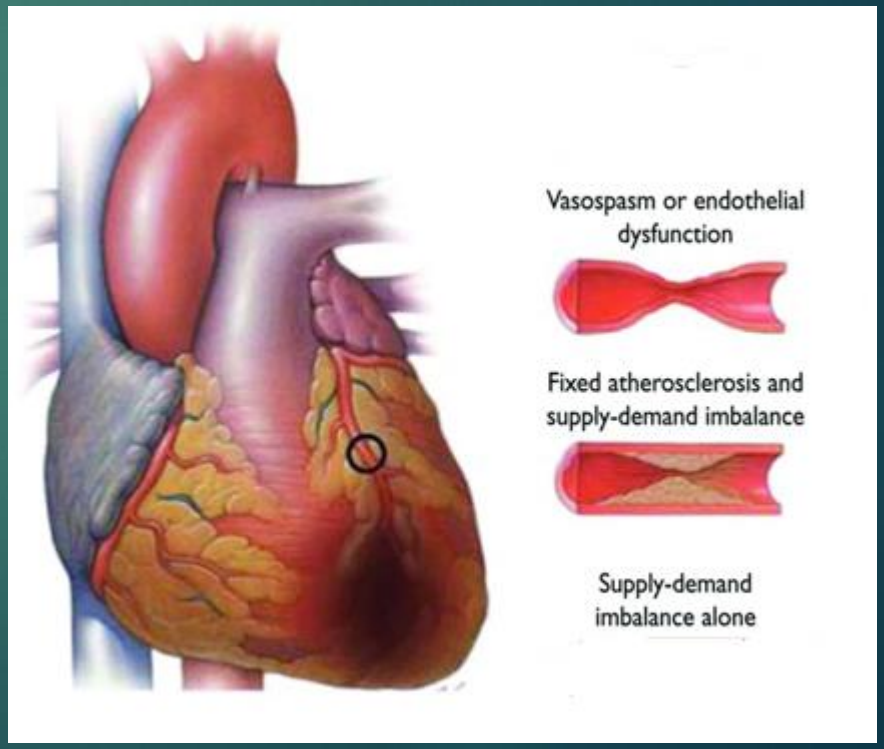
Oxygen deficiency (hypoxia) disturbs cell's oxidative respiration and is an extremely important and common cause of cell injury and death.

- Oxygen deficiency may be due to

1. Ischemia (loss of blood supply) due to arterial or venous blockade.

2. Loss of oxygen carrying capacity as in anemia (especially blood loss anemia) or CO poisoning.
3. Improper oxygenation of blood due to pulmonary disease.
4. Decreased blood supply to tissues as seen in shock.





B. **Physical agents:**

- These include.

1. Trauma.
2. Extremes of temperatures.
3. Radiation.
4. Electric shock.
5. Sudden changes in atmospheric pressure.

C. **Chemical Agents:**

- Any chemical substance can cause injury.
- Even substances like glucose or salt disturb the osmotic environment and cause injury or cell death.
- Oxygen at sufficiently high pressures is also toxic.
- Poisons cause severe damage altering cell membrane permeability or damage the enzyme systems of cells.

- Examples include arsenic, cyanide or mercuric salts (within minutes to hours).
- Insecticides, carbon monoxide, alcohol also cause injury.
- Therapeutic drugs are important chemical agents in causing cell injury .
- **Infectious Agents.** These range from submicroscopic viruses to meter-long tapeworms; in between are bacteria, fungi, and protozoa.

D. **Immunologic Reactions.**

- Although immune system defends the body yet it can also cause damage to the body. Examples include

1. Allergic reactions against environmental substances
2. Autoimmune diseases.

F. **Genetic Defects:**

- Single base substitution, addition of a chromosome or deletion of a part of chromosome can lead to enormous derangements.

1. Sickle cell anemia (Base substitution)
2. Several inherited metabolic disorders.
3. Down syndrome (trisomy 21, extra chromosome addition)
4. 5p-Deletion syndrome (cri du chat syndrome)

G. Nutritional Imbalances.

- Nutritional deficiencies remain a major cause of cell injury specially in developing countries.

- Examples include.

1. Protein calorie malnutrition
- Kwashiorkor and marasmus
2. Vitamin deficiencies found throughout the world.

- On other hand excess nutrition is also a cause of injury
- obesity $\rightarrow\rightarrow$ diabetes mellitus and cancer.
- Diets rich in animal fat can be a cause of atherosclerosis.

H. **Ageing:**

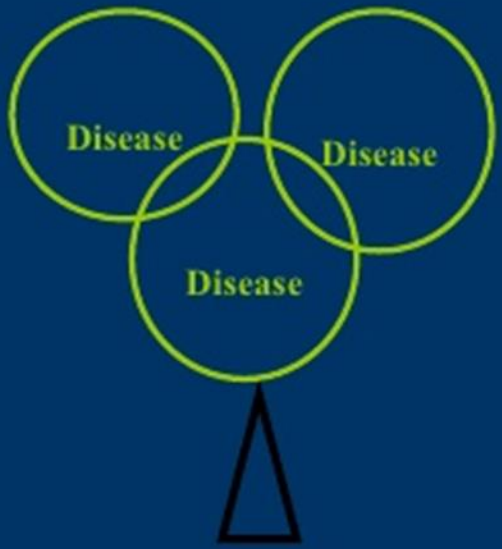
- Individuals age because their cells age.
- Cellular aging is the result of a decline in the proliferative capacity and life span of cells.
- It is also the result of effects of continuous exposure to external factors that cause cellular and molecular damage.
- The process of aging is regulated by genes.

Etiology

- One etiologic agent

→ - one disease, as Malaria.

- Several etiologic agents → one disease, as diabetes .



- One etiologic agent → several diseases, as smoking.

1. Robbins and Cotran Pathologic basis of disease, 9th edition
2. Robbins Basic Pathology 10th edition
3. Pathology secrets 3rd edition


Jazakallah