SNS COLLEGE OF ALLIED HEALTH SCIENCE

Affiliated to The Tamil Nadu Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIOPULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME : PATHOLOGY

TOPIC : CELLULAR ADAPTATION

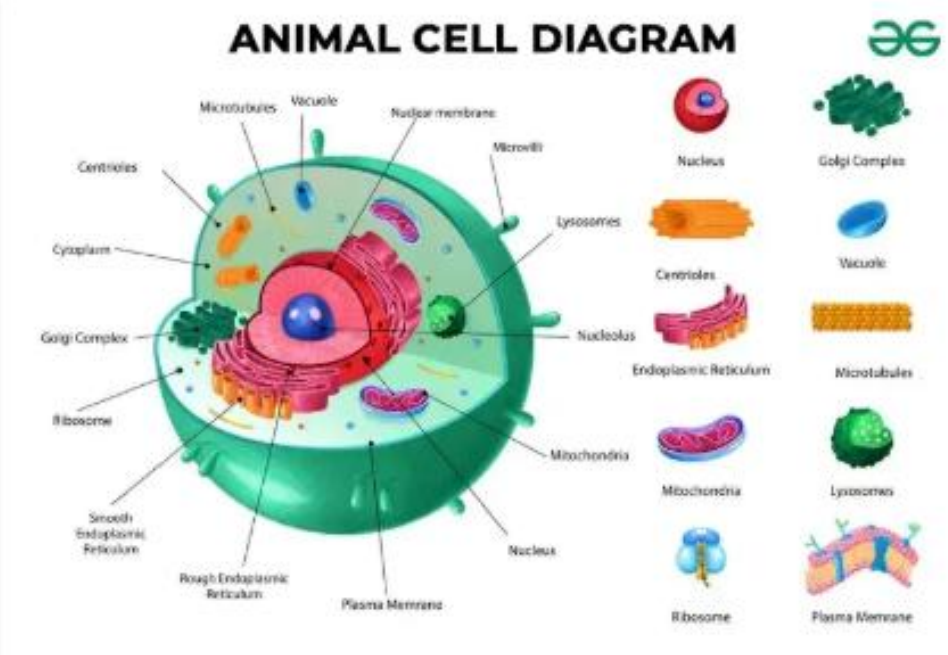
UNIT : 1

FACULTY NAME : Ms. NIVETHA RAJA

INTRODUCTION

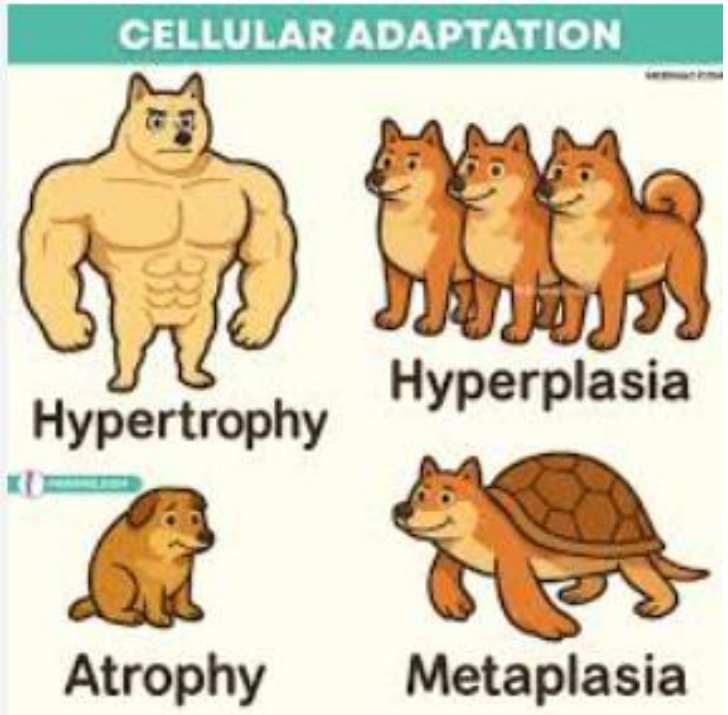
- **DEFINITION { DEFINE STAGE } :**

Cellular adaptation is the reversible functional or structural change that occurs in cells in response to changes in their environment or stress, allowing the cell to survive and maintain homeostasis.



TYPES OF ADAPTATION

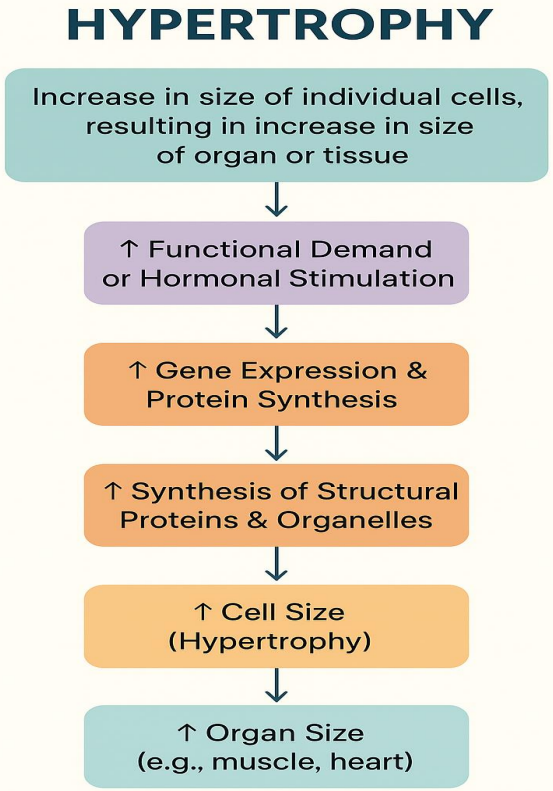
- **Hypertrophy**: ↑ cell size
- **Hyperplasia:** ↑ cell number
- **Atrophy:** ↓ cell size & number
- **Metaplasia:** Change in cell type
- **Mnemonic:** HHAM — Hypertrophy, Hyperplasia, Atrophy, Metaplasia



HYPERTROPHY

- Hypertrophy is the increase in the size of individual cells, resulting in an increase in the size of an organ or tissue — without an increase in cell number.
- It occurs mainly in cells incapable of division (e.g., skeletal muscle, cardiac muscle).

MECHANISM



- **KEY MOLECULAR MECHANISMS :**

Mechanical triggers: Increased workload or stretch

Trophic triggers: Growth factors (e.g., IGF-1), hormones (e.g., estrogen)

Result: Increased synthesis of proteins, mitochondria, myofilaments → larger cell size

- **EXAMPLES :**

Type	Example	Description
Physiological Hypertrophy	Skeletal muscle in athletes	Due to increased workload during exercise → increased actin & myosin synthesis
Pathological Hypertrophy	Left ventricular hypertrophy (LVH)	Due to chronic hypertension → increased workload on heart → thickened myocardium

HYPERPLASIA

Hyperplasia is the increase in the number of individual cells, resulting in an increase in the size of an organ or tissue.

Mechanism of Hyperplasia

↓

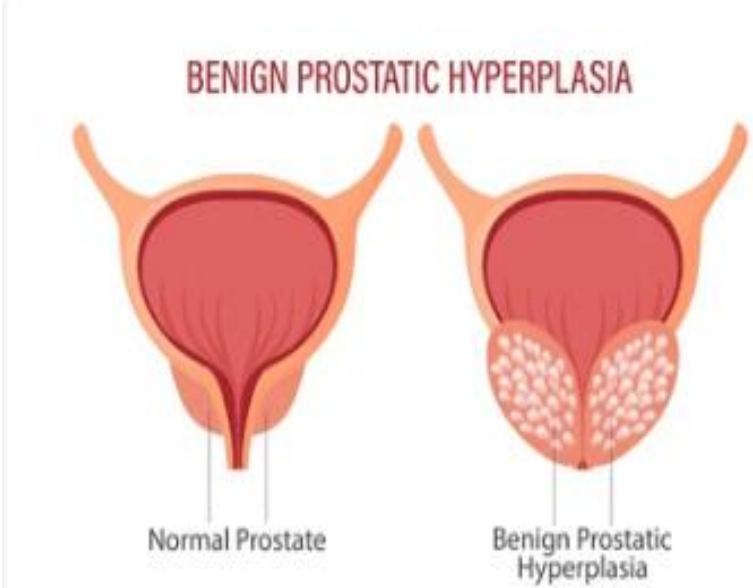
↑ Stimulus

↓

Activation of Signal Transduction Pathways

↓

↑ Cell Proliferation



Examples

Physiological

Breast tissue growth during pregnancy

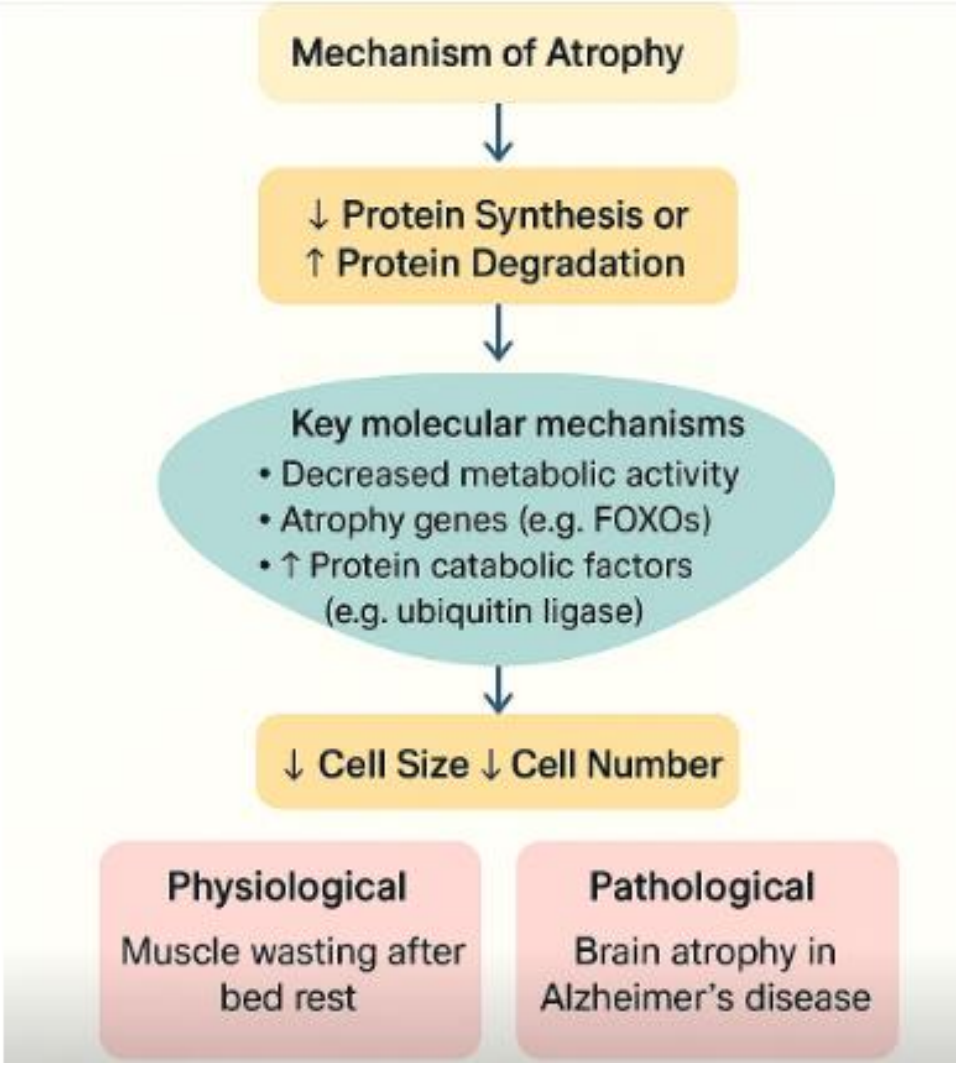
Pathological

Prostate enlargement in benign prostatic hyperplasia (BPH)

ATROPHY

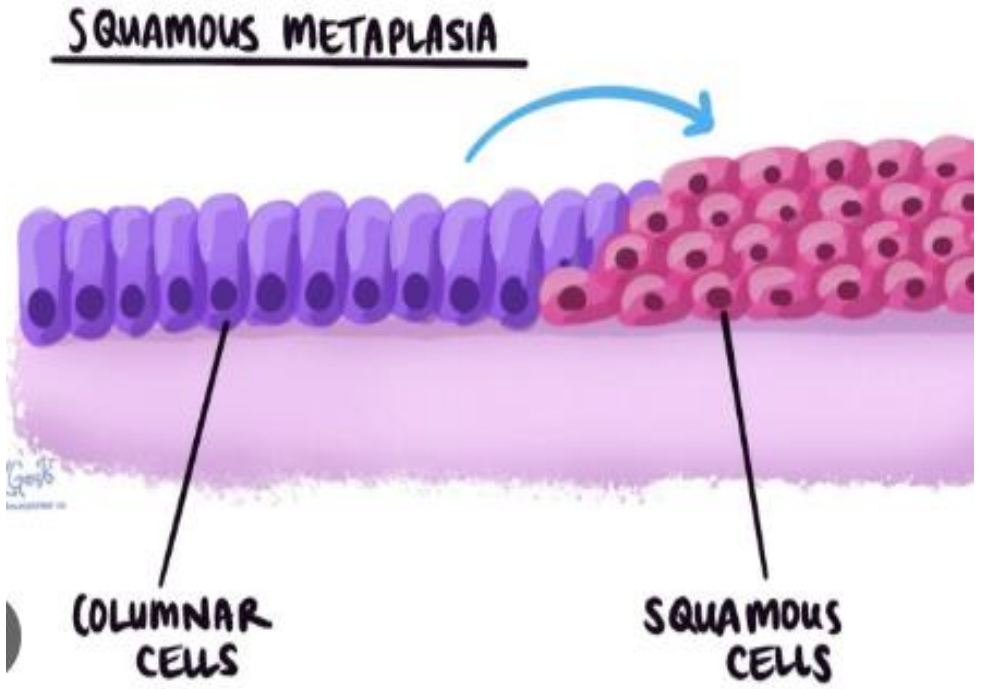
Atrophy is the decrease in the size of individual cells,

resulting in an decrease in the size of an organ or tissue .

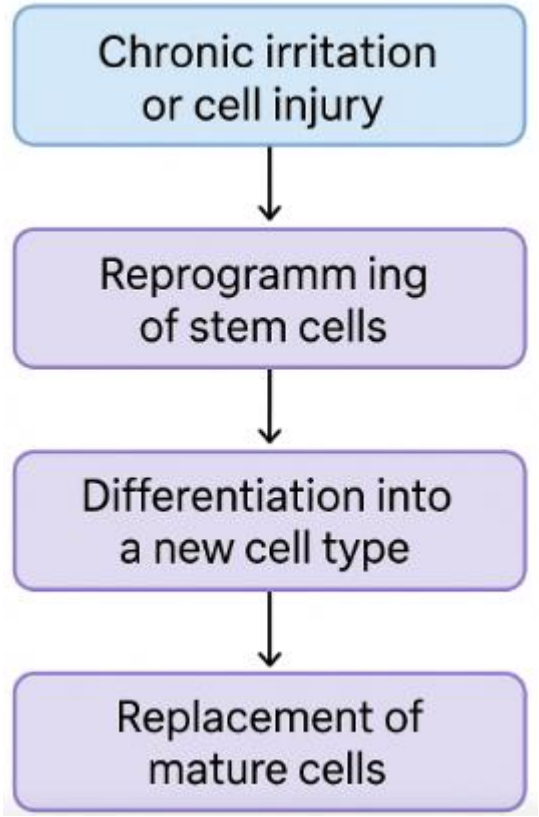


METAPLASIA

- Metaplasia is a reversible change in which one differentiated (mature)
- cell type is replaced by another differentiated cell type that is better able to withstand the adverse environmental conditions.
- **If the stimulus persists, metaplasia can progress to dysplasia (precancerous change).**



MECHANISM OF METAPLASIA



Type	Example	Explanation
Glandular Metaplasia	Barrett's esophagus	Squamous epithelium → columnar epithelium due to acid reflux
Epithelial Metaplasia	Squamous metaplasia in the bronchi of smokers	Normal ciliated columnar epithelium → stratified squamous epithelium

INCLASS ASSESSMENTS

- CASE ：
- A 60-year-old smoker develops chronic cough. Biopsy shows squamous metaplasia in bronchial mucosa.

- Identify the adaptation.

- Is it reversible or irreversible?

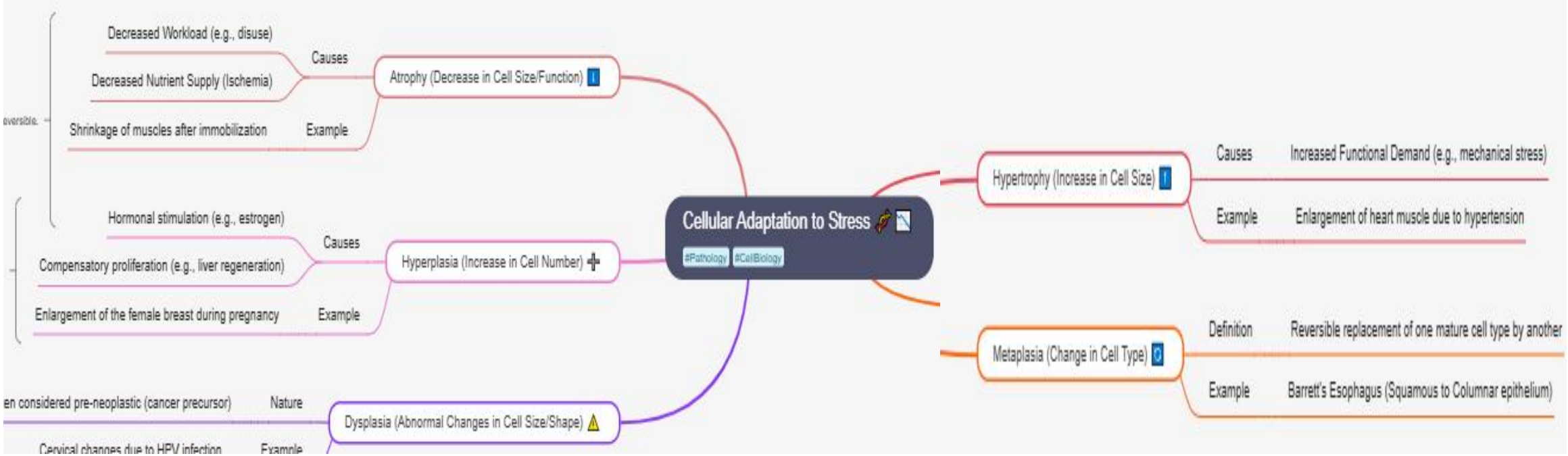
- What if the stimulus continues?
- (Expected: Metaplasia → reversible → may progress to dysplasia/cancer)

- CASE 2 :
- A weightlifter shows increased muscle bulk in arms and legs.

- Identify the type of adaptation.

- Mechanism involved?
- (Expected: Hypertrophy due to increased workload → increased protein synthesis.)

SUMMARY


Cellular Adaptation to Stress
#Pathology
#CellBiology
Atrophy (Decrease in Cell Size/Function)
Causes
Decreased Workload (e.g., disuse)
Decreased Nutrient Supply (Ischemia)
Example
Shrinkage of muscles after immobilization
Hyperplasia (Increase in Cell Number)
Causes
Hormonal stimulation (e.g., estrogen)
Compensatory proliferation (e.g., liver regeneration)
Example
Enlargement of the female breast during pregnancy
Dysplasia (Abnormal Changes in Cell Size/Shape)
Nature
Example
Hypertrophy (Increase in Cell Size)
Causes
Increased Functional Demand (e.g., mechanical stress)
Example
Enlargement of heart muscle due to hypertension
Metaplasia (Change in Cell Type)
Definition
Reversible replacement of one mature cell type by another
Example
Barrett's Esophagus (Squamous to Columnar epithelium)

REFERENCES

- Tortora, G. J., & Derrickson, B. (2021). Principles of Anatomy and Physiology. Wiley.
- Kumar, V., Abbas, A. K., & Aster, J. C. (2021). Robbins & Cotran Pathologic Basis of Disease (10th ed.). Elsevier.
- Taber's Cyclopedic Medical Dictionary (24th ed., 2022).
- MedlinePlus Medical Dictionary — https://medlineplus.gov/

THANKYOU