



DISTURBANCES OF GROWTH AND DIFFERENTIATION OF TISSUES



APLASIA (AGENESIS)

- Agenesis : congenital disturbance in which the tissue or organ did not develop and there is complete absence of growth of the organ.
- Aplasia: congenital disturbance in which there exists only primitive and usually small structures representative of the organ.
- ✓ Aplasia is commonly seen in paired organs such as the kidneys, gonads and adrenals.
- ✓ If the organ is a single vital organ, the fetus dies.
- ✓ Segmental aplasia is the aplasia of a segment of an organ.
- ✓ e.g. Uterus

APLASIA (AGENESIS)

- Hereditary defects
- Accidental death of a cell at some critical point in the development of the individual
- Diseases like viruses or poisoning during intrauterine life like *Veratrum Californicum*

HYPOPLASIA

- Incomplete development of a tissue or an organ. The organ is congenitally small.
- The major causes of hypoplasia are **genetic defects**, **infectious agents** and certain **poisonous agents** which induce congenital abnormalities in intrauterine life.
- Observed in all organs (vital and paired organs)
- Hypoplasia of the cerebellum is frequently observed in kittens, lambs and calves due to intrauterine viral infections during gestation. e.g.(blue tongue, Panleukopenia,..)

ATROPHY

- Atrophy is the decrease in the mass of a tissue or organ due to decreased size and/or number of cells after it has reached its normal size.
- Decrease in cell size = volumetric atrophy
Decrease in cell number = Numeric atrophy
Decrease in cell size and number = atrophy
- Atrophy can be physiologic and pathologic, systemic and local.
- Physiological atrophy is a function of the growth changes of an organism.

ATROPHY

- ✓ Atrophic cells are smaller than normal. Because the cells are smaller, the microscopic field may appear to be more cellular.
- ✓ Atrophic parenchymal cells, particularly in the heart and liver, may progressively accumulate a yellow, granular, lipid containing pigment (lipofuscin). Lipofuscin is derived from progressive oxidation of lipids. It is found within the cytoplasm of cells.
- ✓ In atrophic organs parenchymal elements may be partially replaced by connective tissue.
- ✓ Microscopically vessels may appear prominent and increased in number but it is actually due to the parenchyma decrease.

PHYSIOLOGICAL ATROPHY

Local physiological atrophy

- Atrophy of the thymus during puberty
- Atrophy of uterus after parturition takes place.

Systemic physiological atrophy

Senile atrophy

- Atrophy of the sex glands, skin, and bones in old people

PATHOLOGICAL ATROPHY

Local pathologic atrophy

- Can be caused by:
 - ✓ Decreased workload (disuse atrophy)
 - ✓ Insufficient supply of blood (e.g., atrophy of the brain cortex during atherosclerosis of the blood vessels of the brain)
 - ✓ Loss of hormonal stimulation (e.g. atrophy of the adrenals due to destruction of pituitary glands)
 - ✓ Denervation (especially in skeletal muscles),
 - ✓ Compression (e.g., neoplasms, or distended body cavities).
 - ✓ Exhaustion (prolonged overwork of an organ may be followed by atrophy)

Systemic pathologic atrophy

- Appears in cases of:
 - ✓ Insufficient nutrition,
 - ✓ Chronic infection or intoxication
 - ✓ Disorders of the endocrine glands or of the central nervous system

Atrophy results

1. **Fibrosis** ; when parenchymal elements are replaced with connective tissue
2. **Pseudotrophy**: when parenchymal elements are replaced with adipose tissue. The organ may look bigger than normal.
3. **Serous atrophy**: fat cells are atrophic and replaced by proteinaceous fluid which converts the fat depots to gelatinous masses.
4. **Brown atrophy**: atrophic parenchymal cells, particularly in the heart and liver, accumulate lipofuscin pigment.

HYPERTROPHY AND HYPERPLASIA

Hypertrophy

- Increase in the size of a tissue or organ by enlargement of the existing cells.

Hyperplasia

- Increase in the size of a tissue or organ as a result of an abnormal increase in the number of cells.

ETIOLOGY OF HYPERTROPHY AND HYPERPLASIA

Hypertrophy

- Hormonal hypertrophy (e.g. Hypertrophy of the muscles due to the effect of testosterone)
- Compensatory hypertrophy (Increase in the size of an organ or volume of a tissue following loss or malfunction of the paired organ.)

Hyperplasia

- Chronic irritation (e.g. Cutaneous hyperplasia, hyperplasia of the bile ducts in coccidiosis of the rabbit.)
- Chronic infections
- Hormonal hyperplasia; e.g. estrogen-dependent uterine cells undergo hyperplasia and hypertrophy following pregnancy.

METAPLASIA

- The transformation of **fully differentiated** normal adult tissue into another related type of differentiated adult tissue.
- The change occurs only to cell types from the **same germ layers** and is an alteration from a **less specialized** cell type to **more specialized** cell types.
- Metaplasia often occurs in **epithelial** and **connective** tissue.

METAPLASIA

Metaplasia in epithelial tissue

| Tissue | Normal | Metaplasia |
|-----------------|--------------------------------------|---------------------|
| Airways | Pseudostratified columnar epithelium | Squamous epithelium |
| Urinary bladder | Transitional epithelium | Squamous epithelium |
| Esophagus | Columnar epithelium | Squamous epithelium |
| Cervix | Glandular epithelium | Squamous epithelium |

METAPLASIA

Metaplasia in connective tissue



These changes are specially seen in mixed tumours, mammary gland tumours of bitches, tendinitis, etc.

CAUSES OF METAPLASIA

- Vitamin A deficiency (Vitamin A is necessary for normal differentiation of stratified squamous epithelium, deficiency or absence of Vit A leads to Squamous metaplasia of the epithelial lining of the glands and ducts)
- Chronic irritations (e.g. the respiratory epithelium lining the trachea, bronchi and bronchioles replaced by stratified squamous epithelium)
- Hormonal imbalance (e.g. estrogen-induced squamous metaplasia in the prostate gland)
- Chronic inflammation (e.g. mammary ducts in chronic mastitis)
- Function changes (Cells are replaced by more resistant ones. e.g. ossification of cartilage and tendons)

DYSPLASIA

- Dysplasia implies an abnormality in formation of a tissue. For example, renal dysplasia is the abnormal formation of the kidney.
- Refers to a loss of architectural orientation of cells or loss in uniformity of individual cells or both.
- Microscopically, dysplastic epithelial cells have atypical features, such as abnormal variation in size (anisocytosis) and shape (poikilocytosis), hyperchromatic nuclei, increased nuclear size (karyomegaly), and increased number of mitotic figures.
- Dysplasia is associated with chronic irritation and inflammation but may be due to nutritional disorders.



NECROSIS



NECROSIS VS APOPTOSIS

- **Necrosis** is the death of cells or organs within living organism.
- In contrast, **apoptosis** is a naturally occurring **programmed** and targeted cause of cellular death.
- While **apoptosis** often provides **beneficial** effects to the organism, necrosis is almost always **detrimental** and can be **fatal**.

NECROSIS

Causes of necrosis

- Necrosis is caused by :
- ✓ **Chemical substances** such as mineral acids, caustic alkalines and phenol.
- ✓ **Physical influences** such as heat, cold, electricity
- ✓ **Mechanical forces**
- ✓ **Nutrition** (failure of blood to reach the organs because of thrombosis, embolism, volvulus, invagination, tumor, abscess, etc.)
- ✓ **Neural causes** (peripheral nerve destruction)
- ✓ **Infectious causes** (bacterial: necrobacillosis, tuberculosis, pseudotuberculosis. viral: rinderpest, foot and mouth disease. mycotic: aspergillosis, blastomycosis)

NUCLEAR CHANGES IN NECROSIS

- Four types of nuclear changes may occur:
- ✓ **Pyknosis** : condensation of nuclear chromatin into a dark round, homogeneous mass smaller than in a normal nucleus.
- ✓ **Karyorrhexis** : breaking up of the nucleus into numerous pieces.
- ✓ **Karyolysis** : dissolution of nuclear chromatin, leaving a ghost form of the nucleus
- ✓ And finally : **complete absence of the nucleus.**

TYPES OF NECROSIS

- Coagulative necrosis
- Caseous necrosis
- Liquefactive necrosis
- Gangrene

COAGULATIVE NECROSIS

- The **denaturation** of cytoplasmic **proteins**, which at the histologic level imparts an opaque and **intense cytoplasmic eosinophilia** to necrotic cells.
- Coagulative necrosis is a typical early response to hypoxia, ischemia, or toxic injury.
- Occurs in **infarcts** of the kidney, spleen and myocardium.
- **Grossly**, the area of necrotic tissue is yellowish grey or pale yellow in color and is depressed below the surface of the surrounding tissue.
- **Microscopically**, the architectural outline of the tissue is preserved but the cellular detail is lost.

CASEOUS NECROSIS

- **Caseous**, from the Latin word for **cheese**, refers to the curdled or cheese like gross appearance of this form of necrosis.
- Characterized by the loss of **both architectural and cellular detail**.
- **Macroscopically**, caseation may appear as crumbled, granular, or laminated yellow-white exudate in the center of a granuloma or a chronic abscess.
- **Histologically**, the lysis of leukocytes and parenchymal cells converts the necrotic tissue into a granular to amorphous eosinophilic substance with basophilic nuclear debris.
- This type of necrosis is characteristic of the lesions of **tuberculosis**.

LIQUEFACTIVE NECROSIS

- Liquefactive necrosis is typical of organs in which the tissues have a lot of lipid .
- Its often seen in brain and spinal cord and the term for the macroscopic (gross) appearance of necrosis in the brain and spinal cord is malacia.
- In liquefactive necrosis, cells are lysed, and the necrotic tissue is converted to a fluid phase.
- Grossly, the dead tissue is in a liquid form and sometimes has a creamy or pasty consistency.
- Microscopically, empty spaces are seen since the liquefied material are lost during the processing of the tissue. A pinkish staining protein material may remain or may not as a precipitate from the liquid.

GANGRENE

- Gangrene denotes a type of necrosis that tends to develop at the distal aspect of extremities, such as the limbs, tail, or pinnae, or in dependent portions of organs, such as the mammary glands or lung lobes.
- Gangrene can be designated as wet or dry.
- **Wet gangrene** occurs if the necrotic tissue is infected by certain bacteria.
- ✓ Hydrogen sulfide is produced
- ✓ As a result of hydrogen sulfide binding with blood pigments, the tissues become greenish-black in color.
- ✓ Septic ulcers of the uterus, gangrenous pneumonia

GANGRENE

- If those bacteria are gas forming (e.g., *Clostridium* spp.), then wet gangrene becomes **gas gangrene**.
- ✓ Blackleg and malignant edema.
- **Dry gangrene** is the result of decreased vascular perfusion and/or loss of blood supply.
- ✓ It is a form of infarction resulting in coagulative necrosis that imparts a dry, leathery texture to the necrotic tissue, providing that it remains **free of putrefactive bacteria**.
- ✓ Necrosis in case of tearing of the umbilical cord after birth.
- ✓ Dry dying fetus in utero.

RESULTS OF NECROSIS

- Dissolution and resorption of necrotic tissue.
- Abscess formation
- Sloughing and desquamation of the necrotic tissue
- Encapsulation without liquefaction ; a containing wall of leukocytes and connective tissue is formed around the mass and the area become encapsulated.
- Organisation of necrotic tissue: occurs when necrotic tissue is invaded with capillaries, connective tissue and leucocytes. The necrotic tissue is digested by leukocytes then the areas are infiltrated with connective tissue leaving a scar.
- Calcification of necrotic material
- Gangrene
- Atrophy
- Regeneration