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5th March 2023

By end of this session; you should identify: Definition and types of tissue repair □ Types of cells according to ability of regeneration □ Factors affecting repair Healing by regeneration Healing by fibrosis Common examples of repair: healing of skin wound and healing of bone fracture.

A brief overview of stem cells.

Definition:

- **Tissue repair (<u>healing</u>)** is replacement of damaged tissue by new healthy tissue.
- It is critical to survival of the organism.

Types:

Healing by regeneration Healing by fibrosis and scar formation

Types of body cell according to power of cell division:



Continuously dividing cells throughout life under normal conditions

Stable cells

Limited power of cell division. Cells divide when there is a need



Non-dividing cells. Injured cells heal by fibrosis

Types of body cell according to power of cell division:

Labile cells	Squamous epithelium of skin, mouth, vagina and cervix	
	Columnar epithelium of intestinal tract	
	Transitional epithelium of urinary tract	
	Bone marrow cells	
Stable cells	Liver hepatocytes	
	Alveolar cells of lung	
	Epithelium of kidney tubules	
Permanent cells	Neurons (Nerve cells) Muscle cells as skeletal muscle and heart muscle	

Factors affecting tissue repair

Local factors

- **1. Type of damaged cells:** Labile, Stable, or permanent cells
- 2. Severity and duration of injury: large or severe wound requires long duration for repair
- **3. Blood supply:** poor blood supply delays repair
- 4. Presence of infection or foreign bodies: delays the repair process.

Factors affecting tissue repair

General or systemic factors

- **1. Age:** repair is more rapid in young age
- 2. Nutritional status: repair is impaired in cases of:
 a. Protein deficiency
 b. Deficiency of vitamin C and D.
 c. Deficiency of zinc
- 3. Intake of corticosteroids: delays repair
- **4. Diabetes mellitus:** Increases susceptibility to infection, so delays repair.

Healing by regeneration

• Overview:

- <u>Definition</u>: Replacement of damaged cells by new healthy cells of the same type.
- It restores tissue integrity and the function is preserved

• Mechanism:

- Regeneration occurs by proliferation of neighboring cells
- Cell proliferation is <u>stimulated</u> and <u>controlled</u> by **growth factors** such as: epidermal growth factor (EGF), fibroblast growth factor (FGF) and platelet-derived growth factor (PDGF)

Healing by regeneration

• Examples for healing by regeneration:

Healing by regeneration occurs in injuries of labile and stable cells such as:

- 1. Regeneration of epidermis
- 2. Regeneration of mucous membranes
- 3. Regeneration of liver cells
- 4. Repair of bone fractures

Healing by fibrosis

• Overview:

- Definition: Replacement of damaged cells by fibrous tissue.
- It restores tissue integrity but the function is impaired

• Examples for healing by fibrosis:

Healing by fibrosis occurs in injuries of permanent cells such as healing of muscle and nerve tissue

• Mechanism:

Healing by fibrosis passes through the following steps

- 1. Phase of inflammation
- 2. Phase of clearance
- 3. Phase of granulation tissue formation.
- 4. Phase of fibrogenesis (fibrosis).





- Obliteration of capillaries



Healing by fibrosis

• Morphology of granulation tissue:



Gross: granulation tissue appears - Moist

- Insensitive to touch
- Bleeds easily
- Has red granular surface



Microscopically: granulation tissue is formed of Small capillariesFibroblasts

Examples for healing

1.Healing of skin wound

- Healing of skin wounds provides a good example of combination of healing by regeneration and fibrosis.
- Epidermis heals by regeneration while subcutaneous tissue heals by fibrosis
- Types of skin healing:
 - 1. Healing by primary intention (primary skin union).
 - 2. Healing by secondary intention (secondary skin union).

Examples for healing

1.Healing of skin wound

□ Healing by primary intention (primary skin union).

Occurs in: - Clean incised wounds

- Wounds with minimal tissue damage
- Edges of the wound are approximated (sutured).

Steps of healing:

- Blood clot and mild inflammation at site of wound.
- Surface epithelium: proliferation of basal layer of epidermis across the wound to meet at the center.
- Deeper tissue: formation of granulation tissue that fills wound gap
- After 2 weeks: maturation of granulation tissue to fibrous tissue (scar formation) that shrinks in size.

Examples for healing

1.Healing of skin wound

□ Healing by primary intention (primary skin union).



Examples for healing

1.Healing of skin wound

□ Healing by primary intention (primary skin union).



Examples for healing

1.Healing of skin wound

□ Healing by secondary intention (secondary skin union).

Occurs in: - Gapped wound

- Wounds with excessive tissue damage
- Infected wound and abscess

Steps of healing:

- Large blood clot and more inflammation at site of wound.
- Surface epithelium: proliferation of basal layer of epidermis, but can not cover gap of the wound.
- 3rd to 5th day: Granulation tissue fills the wound gap.
 - Basal cells proliferate to cross over granulation tissue
 - Granulation tissue matures to fibrous tissue.

- Next weeks formation of scar tissue and contraction of the wound.

Examples for healing

1.Healing of skin wound

□ Healing by secondary intention (secondary skin union).

septic granulation tissue

granulation tissue

Examples for healing

1.Healing of skin wound

□ Healing by secondary intention (secondary skin union).



Examples for healing

1.Healing of skin wound

Complications of skin would healing

<u>1- Chronic ulcer</u>: Persistent loss of continuity of the skin



<u>2- Sinus:</u> A blind ended tract between skin surface and depth of a wound or abscess cavity.



Examples for healing

1.Healing of skin wound

Complications of skin would healing

<u>**3- Fistula:</u>** A tract between abscess cavity and a hollow organ or between two hollow organs</u>



<u>4- Keloid:</u> Large scar projecting on the surface



Examples for healing

1.Healing of skin wound

Complications of skin would healing

<u>5- Contracture</u>: A scar on a flexure **<u>6- Epidermoid cyst</u>**: Epithelial may interfere with movement



cells trapped in the wound may proliferate and form a cyst



Examples for healing

1.Healing of skin wound

Complications of skin would healing

7- Malignant change: Rarely scar may be a site for development of carcinoma (e.g. squamous cell carcinoma)

Examples for healing

1.Healing of skin wound

Feature	Primary healing	Secondary healing
Cleanness	Clean	Unclean
Infection	Generally uninfected	May be infected
Margins	Surgically clean	Irregular
Healing	Scanty granulation tissue	Granulation tissue fill the gap
Healing period	Short	long
Healing direction	Direct healing	From the bottom to the edge
Outcome	Neat linear scar	Contracted irregular wound

Examples for healing

- 2. Healing of bone fracture
 - **Types**
 - Primary bone union:
 - Less common
 - Occurs when ends of fracture are approximated surgically by application of metal plates or nails.
 - Secondary bone union:
 - Is more common
 - Occurs when fracture site is fixed by plaster casts.

Examples for healing

2.Healing of bone fracture

□ Steps

- 1st week: Hematoma formation & mild inflammation.
- 2nd week: Formation of soft callus (granulation tissue)
- 3rd -4th week: Formation of provisional callus (woven bone and cartilage)
- After 1 month: Formation of bony callus (bone trabeculae that is weight bearing)
- Remodeling of bone callus and formation of lamellar bone
- Regeneration of bone marrow.





Stem cells

Definition: Cells characterized by ability to self-renewal and differentiation

□ Clinical importance: Stem cells are essential for healing of injured tissue, treatment of diseases and tissue transplantation.

Types:

1. Embryonic stem cells:

- Exist in embryo
- Have ability to differentiate to any type of cells.
- 2. Adult (somatic) stem cells:
 - Exist in adult tissues in different organs.
 - Have restricted capacities of differentiation to cells of same organ.
 - Normally; they are essential to replace aging cells during natural cell turnover and in healing process

Homework:

-Choose the correct answer:

- One of the following is an example for permanent cells

- a. Epidermal cells
- b. Transitional epithelial cells
- c. Neural cells
- d. Liver cells

- Which of the following imply loss of continuity of surface epithelium?

- a. Ulcer
- b. Sinus
- c. Fistula
- d. Keloid

Homework:

-Answer the following questions:

- 1. Classify cells according to power of regeneration
- 2. Mention factors affecting process of healing
- 3. Compare between healing by primary and secondary intention
- 4. Describe steps of healing by fibrosis
- 5. Mention complications of wound healing
- 6. Mention steps of bone healing

