



BASIC PATHOLOGY/FIRST COURSE

WOUND HEALING

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قسم تقنيات الاشعة والسونار

. Third Stage

المرحلة الثالثة

محاضرة رقم: 3

الجانب النظري

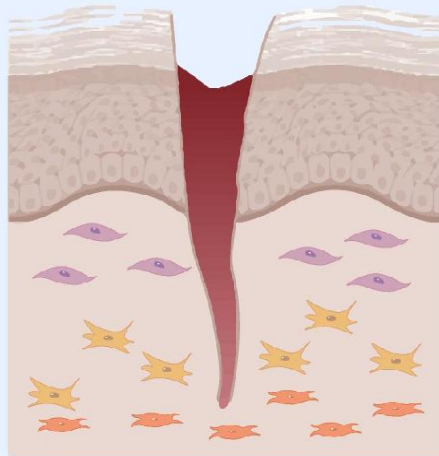
Lecture No. two

Theoretical

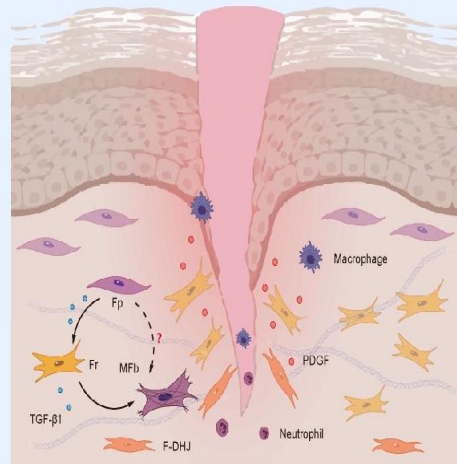
تدريسي المادة : م.م فاضل عوفي عواد

WOUND HEALING AND REGENERATION

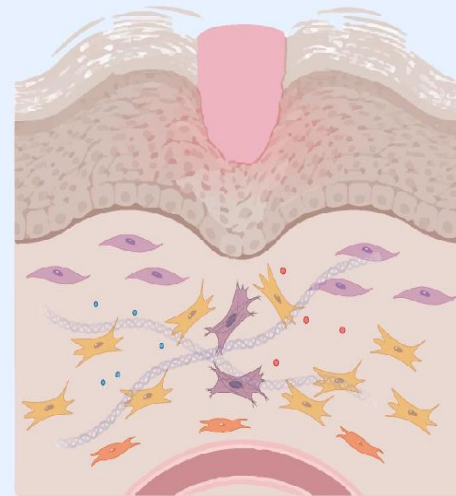
Fibroblast heterogeneity in physiological tissue repair



Injury



Hemostasis and inflammation



Granulation tissue formation



Tissue remodeling

DEFINITION

- Wound healing is the physiological response to tissue injury, aiming to restore skin integrity and function. It is a dynamic and tightly regulated process involving cellular, molecular, and biochemical events.

THE PHASES OF WOUND HEALING

- including homeostasis, inflammation, proliferation, and remodelling,
- are tightly regulated by various growth factors, cytokines, and cell types, such as
- platelets, neutrophils, macrophages and fibroblasts.

PHASES OF WOUND HEALING

1-Hemostasis (Immediate)

a)Blood vessels constrict.

B)Platelets aggregate and form a clot.

c)Release of growth factors like PDGF and TGF- β .

2-Inflammation (Day 1–3)

a) Neutrophils and macrophages infiltrate the wound.

b) Debris and pathogens are cleared.

c) Cytokines like IL-1 and TNF- α are released.

3-Proliferation (Day 3–10)

a) Fibroblasts produce extracellular matrix (ECM).

b) Angiogenesis occurs via VEGF.

c) Keratinocytes migrate to re-epithelialize the wound.

Remodeling (Weeks to Months)

Collagen type III is replaced by type I.

Myofibroblasts contract the wound edges.

Scar tissue forms and strengthens.

KEY CELLULAR PLAYERS

- **Platelets:** Initiate clotting and release growth factors.
- **Neutrophils:** First responders for microbial defense.
- **Macrophages:** Orchestrate inflammation and transition to repair.
- **Fibroblasts:** Synthesize collagen and ECM.
- **Endothelial cells:** Form new blood vessels.
- **Keratinocytes:** Restore epidermal layer.

FACTORS AFFECTING HEALING

- **Local:** Infection, oxygenation, moisture.
- **Systemic:** Age, diabetes, nutrition, medications.
- **Mechanical:** Pressure, movement, wound size.

REGENERATION IN WOUND HEALING

- **Definition:**

- Regeneration is the biological process by which damaged tissues are replaced with cells of the same type, restoring both structure and function completely. Unlike repair, regeneration does **not** result in scar formation.

KEY FEATURES OF REGENERATION

- **Restores original tissue architecture.**
- **Maintains full functionality.**
- **Requires viable stem or progenitor cells.**
- **Occurs in tissues with high proliferative capacity.**

MECHANISMS OF REGENERATION

- 1.Activation of stem cells or progenitor cells.**
- 2.Proliferation and differentiation into specialized cells.**
- 3.Reconstitution of tissue architecture via signaling pathways (e.g., Wnt, Notch, Hedgehog).**
- 4.Minimal or no fibrosis.**

REPAIR

Repair is the biological process by which damaged tissues restore their integrity after injury. Unlike regeneration, repair does not fully restore the original architecture but instead replaces lost tissue with fibrous scar tissue.

Feature	Repair	Regeneration
Outcome	Scar formation	Restoration of original tissue
Functionality	May be reduced	Fully preserved
Example	Skin after deep cut	Liver after partial resection

CELLULAR MECHANISMS OF REPAIR

- **Fibroblasts:** Synthesize collagen and extracellular matrix (ECM).
- **Endothelial cells:** Promote angiogenesis (formation of new blood vessels).
- **Macrophages:** Clear debris and secrete growth factors like TGF- β and PDGF.

PHASES OF REPAIR

- 1.Inflammation:** Removal of pathogens and dead cells.
- 2.Proliferation:** Fibroblast activation, angiogenesis, and ECM deposition.
- 3.Remodeling:** Collagen reorganization and scar maturation.

TYPES OF REPAIR OUTCOMES

- **Primary intention:** Clean, surgical wounds with minimal scarring.
- **Secondary intention:** Large or infected wounds with significant scar formation.
- **Aberrant repair:** Includes fibrosis, hypertrophic scars, and keloids.

NORMAL VS. ABERRANT WOUND HEALING

- **Definition:** A coordinated biological process that restores tissue integrity after injury, following a predictable sequence of phases.

PHASES

- 1. Hemostasis** – Immediate clot formation to stop bleeding.
- 2. Inflammation** – Recruitment of immune cells to clear debris and pathogens.
- 3. Proliferation** – Fibroblast activation, angiogenesis, and granulation tissue formation.
- 4. Remodeling (Maturation)** – Collagen reorganization and scar formation.

- Features:**

- Timely progression through phases.
- Minimal scarring.
- Restoration of function (partial or complete).
- Regulated by growth factors like TGF- β , VEGF, PDGF.

ABERRANT WOUND HEALING

- **Definition:** A pathological deviation from the normal healing process, leading to delayed, excessive, or defective tissue repair.

TYPES:

- **Delayed Healing / Chronic Wounds:**
 - Examples: Diabetic ulcers, pressure sores.
 - Causes: Persistent inflammation, poor vascularization, infection.
- **Excessive Healing:**
 - **Hypertrophic Scars:** Raised scars within wound boundaries.
 - **Keloids:** Overgrown scars beyond original wound margins.

•**Fibrosis:**

- Excessive ECM deposition leading to tissue stiffness and dysfunction.
- Seen in organs like liver (cirrhosis), lung (pulmonary fibrosis).

•**Mechanisms:**

- Dysregulated cytokine signaling.
- Prolonged inflammation.
- Impaired angiogenesis or fibroblast activity.
- Genetic predisposition (e.g., keloid formation).

SUMMARY

Concept	Definition	Outcome	Key Features
Wound Healing	Biological response to injury	Restoration or scarring	4 phases: hemostasis, inflammation, proliferation, remodeling
Repair	Replacement with scar tissue	Partial function	Fibroblast-driven, ECM deposition
Regeneration	Restoration with original tissue	Full function	Stem cell activation, no scarring
Aberrant Healing	Pathological healing	Dysfunction or disfigurement	Chronic wounds, excessive scarring, fibrosis

QUIZ



Any questions?

*Thank
You*