

# Tissue repair

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# Tissue repair

*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.

# Tissue repair

## *Definition:*

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

## *Types:*

1. **Healing by regeneration**
2. **Healing by fibrosis and scar formation**

# Tissue repair

*Types of body cell according to power of cell division:*

**Labile cells**

**Continuously dividing cells throughout life under normal conditions**

**Stable cells**

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

**Permanent cells**

**Non-dividing cells. Injured cells heal by fibrosis**

# Tissue repair

## *Types of body cell according to power of cell division:*

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

# Tissue repair

## *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.

# Tissue repair

## *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.

# Tissue repair

## Healing by regeneration

- **Overview:**

- Definition: 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 stimulated and controlled by **growth factors** such as: epidermal growth factor (EGF), fibroblast growth factor (FGF) and platelet-derived growth factor (PDGF)

# Tissue repair

## 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

# Tissue repair

## 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).

# Tissue repair

## Healing by fibrosis

- **Mechanism:**

1- Phase of inflammation:

Acute inflammation at site of injury occurs within 24 hours (infiltration by neutrophils and macrophages)

2- Phase of clearance

Proteolytic enzymes (from neutrophils), lysosomal enzymes (from dead tissues) and macrophages clear necrotic tissue to prepare damaged area for repair process

# Tissue repair

## Healing by fibrosis

### • Mechanism:

3- Formation of granulation tissue:

- Starts after cleaning phase.
- Formation of numerous small new capillary loops
- Proliferation of fibroblasts.
- Grossly; features of granulation tissue are:
  - moist
  - insensitive to touch
  - bleeds easily
  - has red granular surface

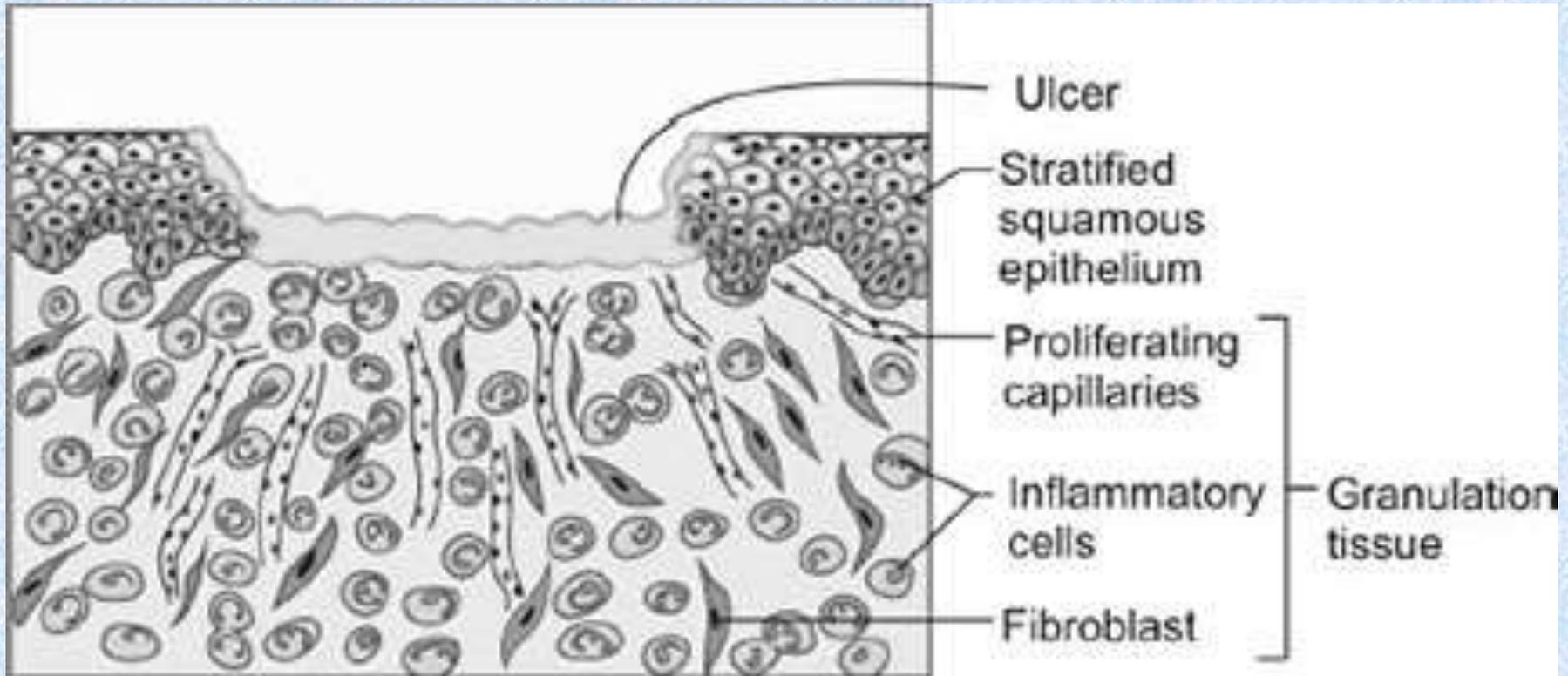
4- Phase of fibrogenesis (fibrosis):

- Granulation tissue is transformed to fibrous tissue by:
- Deposition of excess collagen
  - Obliteration of capillaries

# Tissue repair

## Healing by fibrosis

- Mechanism:



# Tissue repair

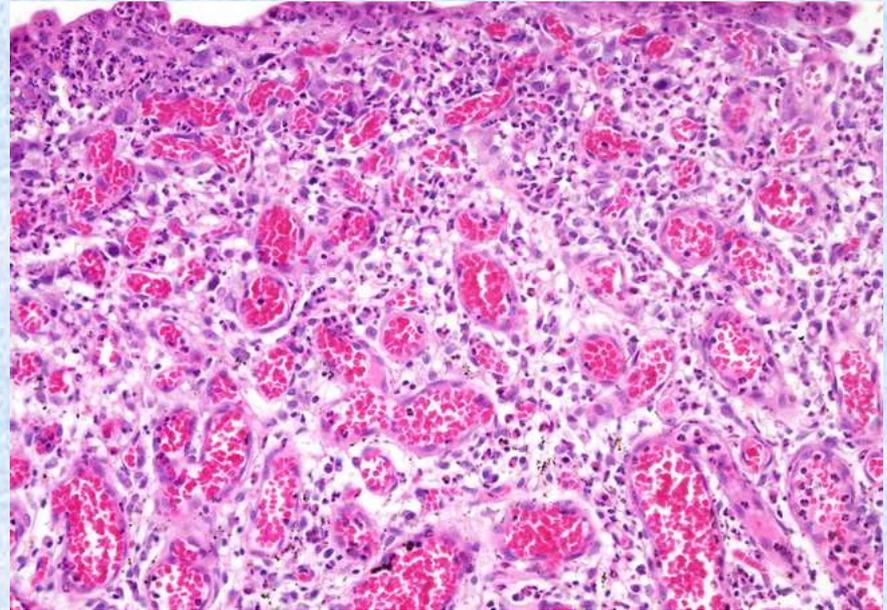
## Healing by fibrosis

- 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 capillaries*
- *Fibroblasts*

# Tissue repair

## 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).

# Tissue repair

## 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:**

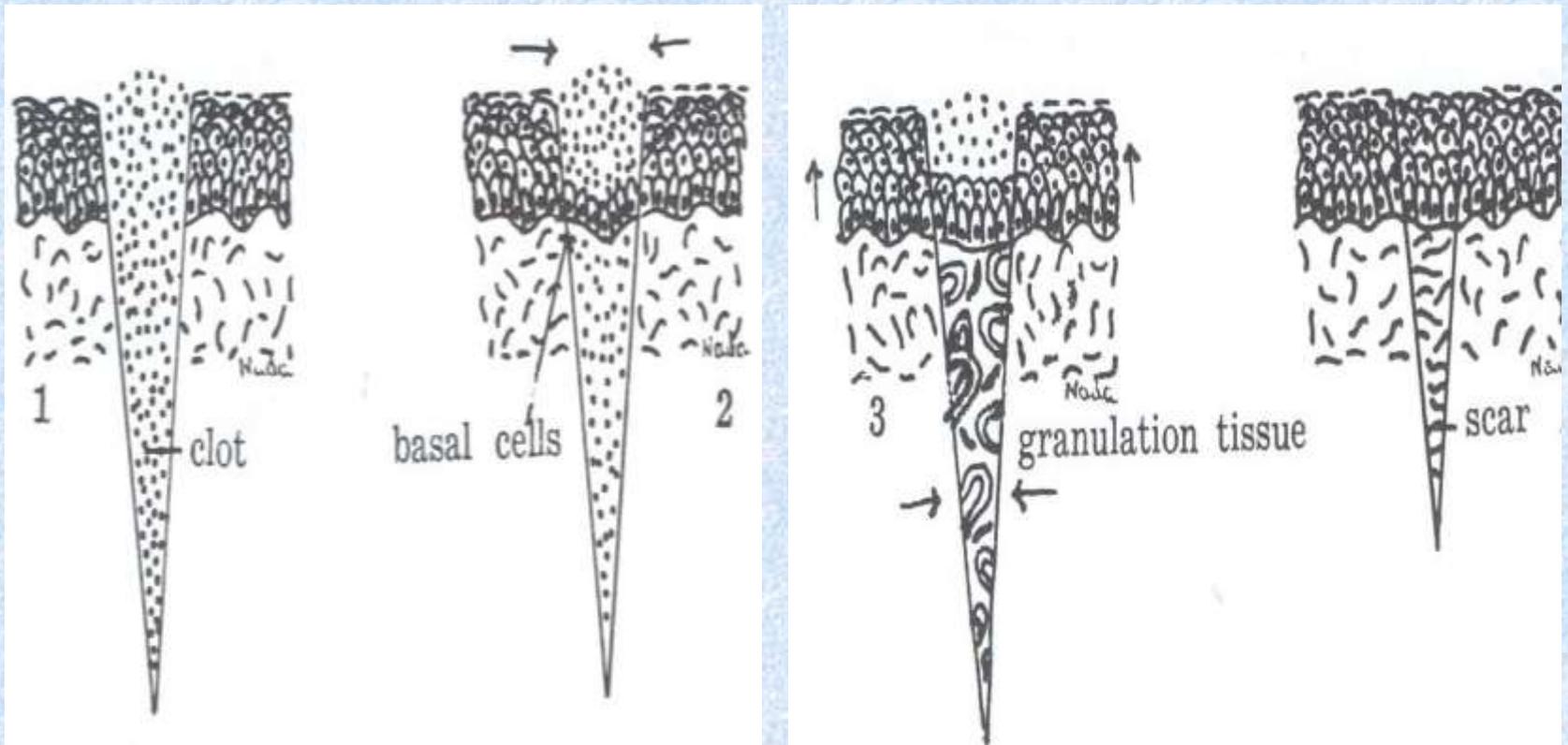
- Blood clot and mild inflammation at site of wound.
- Surface epithelium: proliferation of basal layer of epidermis across the wound to meet at the center.
- Deeper tissue: formation of granulation tissue that fills wound gap
- After 2 weeks: maturation of granulation tissue to fibrous tissue (scar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

# Tissue repair

## Examples for healing

### 1. Healing of skin wound

- Healing by primary intention (primary skin union).

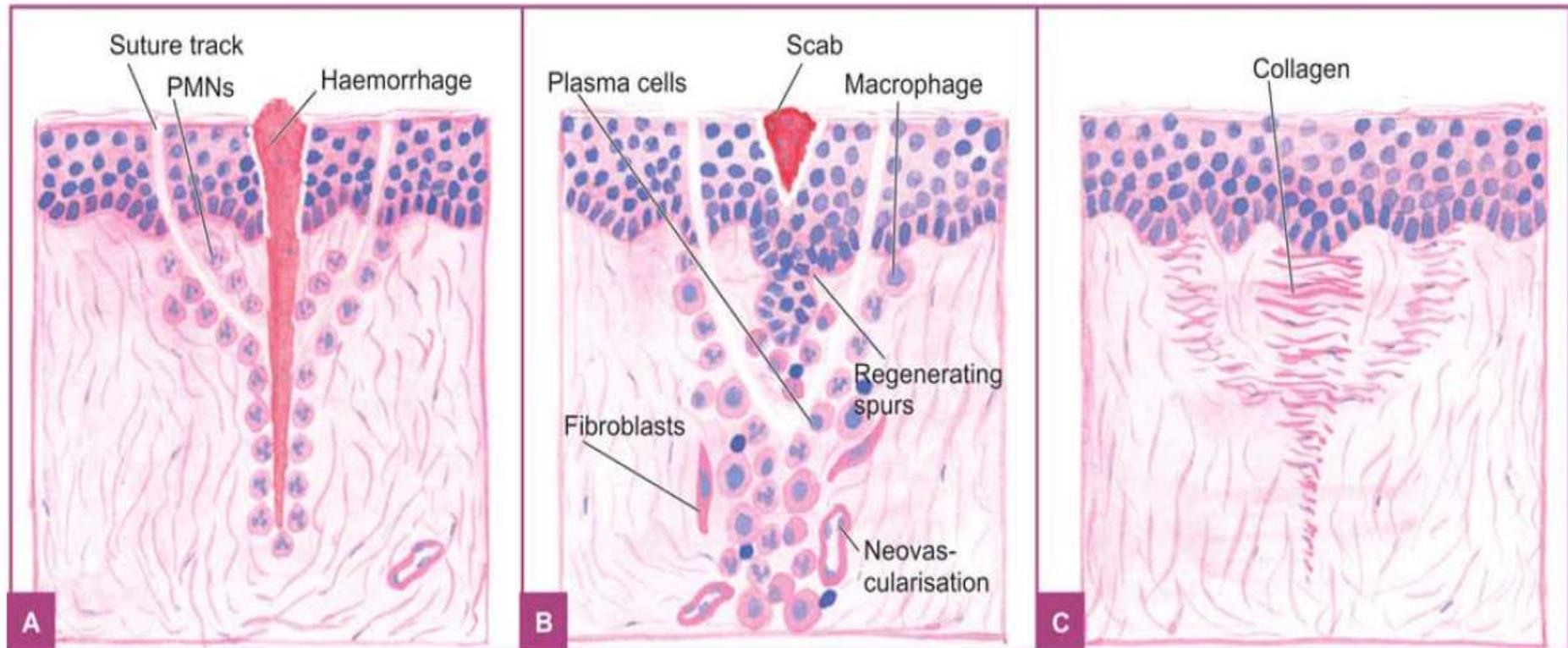


# Tissue repair

## Examples for healing

### 1. Healing of skin wound

□ Healing by primary intention (primary skin union).



# Tissue repair

## 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:**

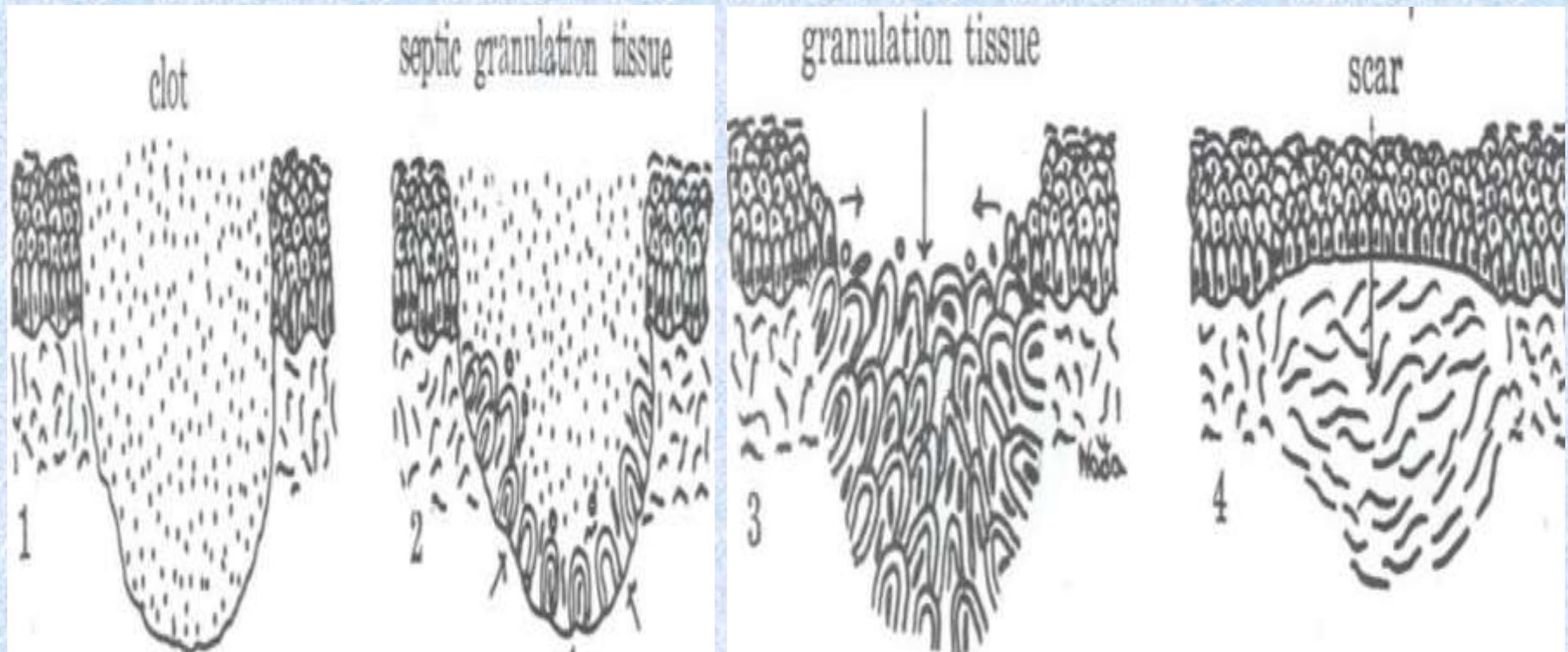
- Large blood clot and more inflammation at site of wound.
- Surface epithelium: proliferation of basal layer of epidermis, but can not cover gap of the wound.
- 3<sup>rd</sup> to 5<sup>th</sup> day:
  - Granulation tissue fills the wound gap.
  - Basal cells proliferate to cross over granulation tissue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

# Tissue repair

## Examples for healing

### 1. Healing of skin wound

□ Healing by secondary intention (secondary skin union).

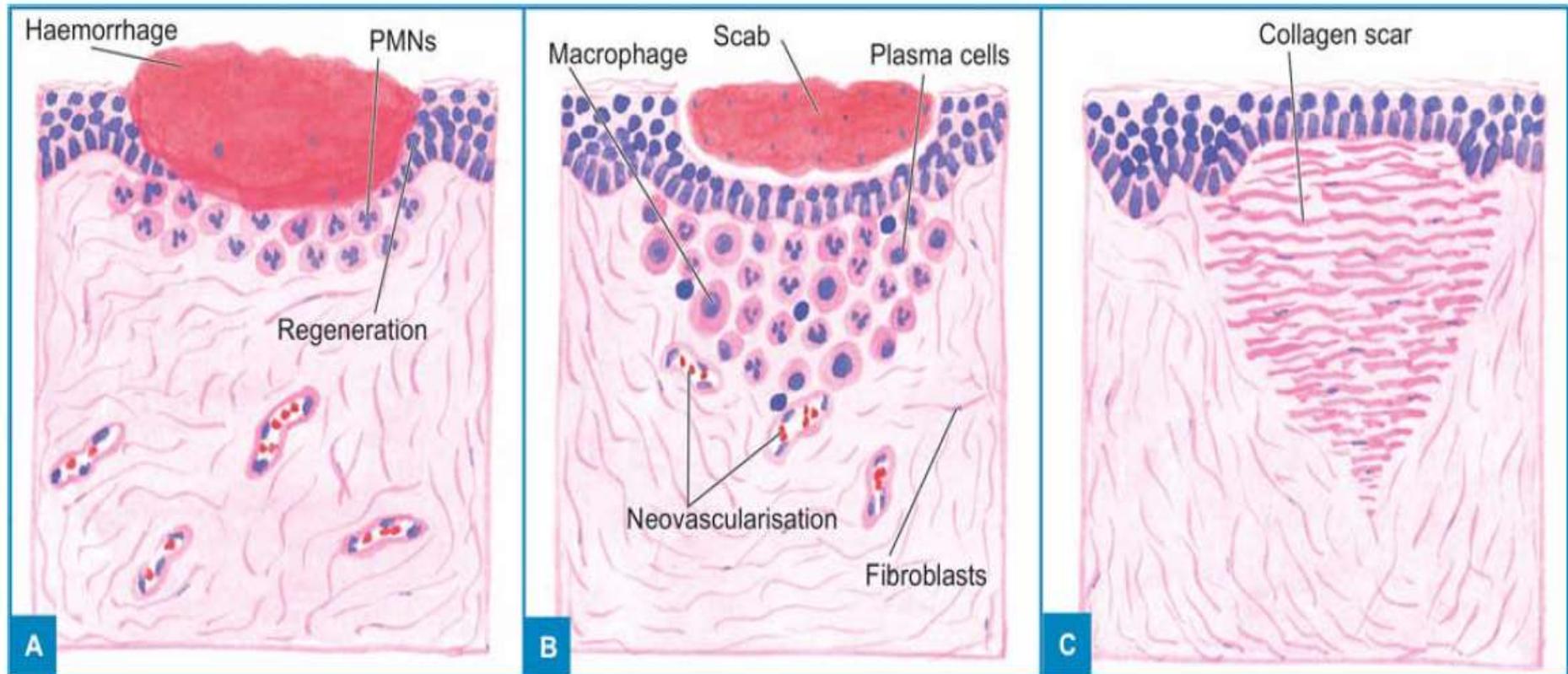


# Tissue repair

## Examples for healing

### 1. Healing of skin wound

□ Healing by secondary intention (secondary skin union).



# Tissue repair

## Examples for healing

### 1. Healing of skin wound

#### □ Complications of skin wound healing

1- Chronic ulcer: Persistent loss of continuity of the skin



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



# Tissue repair

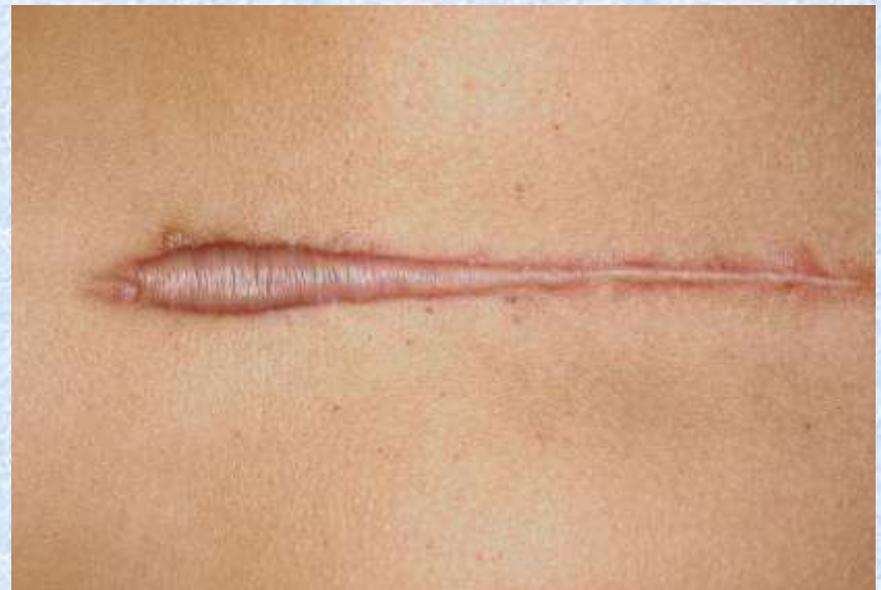
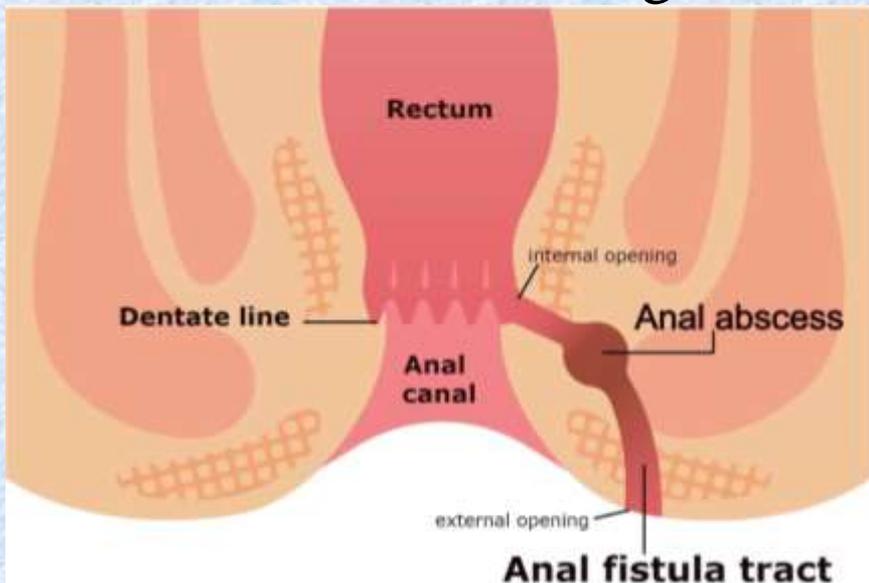
## Examples for healing

### 1. Healing of skin wound

#### □ Complications of skin wound healing

3- Fistula: A tract between abscess cavity and a hollow organ or between two hollow organs

4- Keloid: Large scar projecting on the surface



# Tissue repair

## Examples for healing

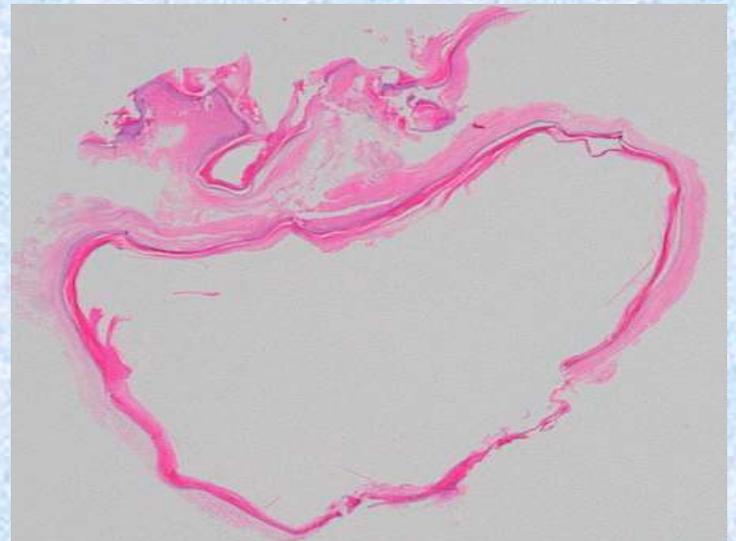
### 1. Healing of skin wound

#### □ Complications of skin wound healing

**5- Contracture:** A scar on a flexure may interfere with movement



**6- Epidermoid cyst:** Epithelial cells trapped in the wound may proliferate and form a cyst



# Tissue repair

## Examples for healing

### 1. Healing of skin wound

#### □ Complications of skin wound healing

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

# Tissue repair

## 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

# Tissue repair

## 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.

# Tissue repair

## Examples for healing

### 2. Healing of bone fracture

#### □ Steps

- 1<sup>st</sup> week: Hematoma formation & mild inflammation.
- 2<sup>nd</sup> week: Formation of soft callus (granulation tissue)
- 3<sup>rd</sup> -4<sup>th</sup> 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.

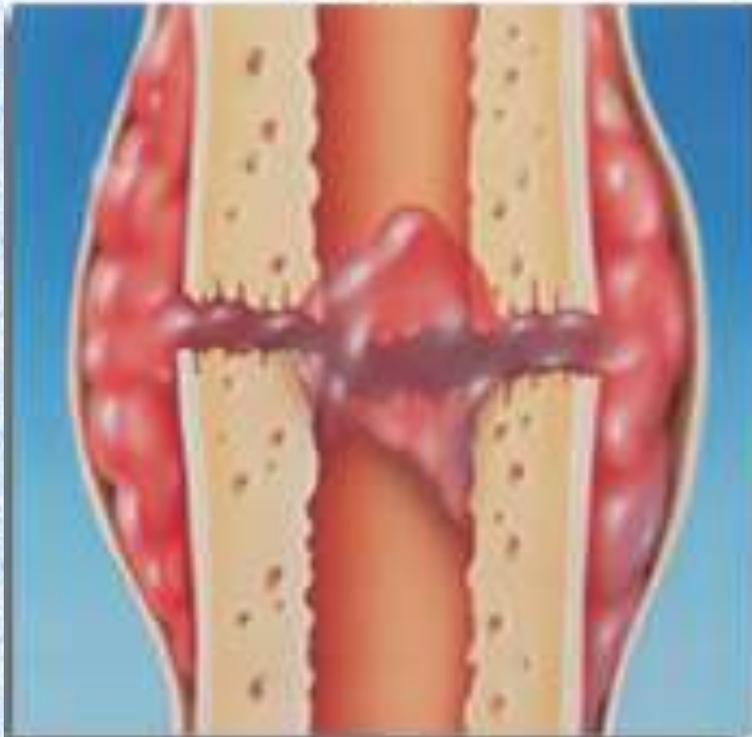
# Tissue repair

## Examples for healing

### 2. Healing of bone fracture

#### □ Steps

Week 1



Hematoma (or Inflammation)

Weeks 2-3



Soft Callus

# Tissue repair

## Examples for healing

### 2. Healing of bone fracture

#### □ Steps

Weeks 4-16



Hard Callus

Weeks 17 & Beyond



Remodeling

# Tissue repair

## 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 capacity of differentiation to cells of same organ.
    - Normally; they are essential to replace aging cells during natural cell turnover and in healing process

# Tissue repair

## 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

# Tissue repair

## □ 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

***GOOD LUCK***