# Healing of injuries

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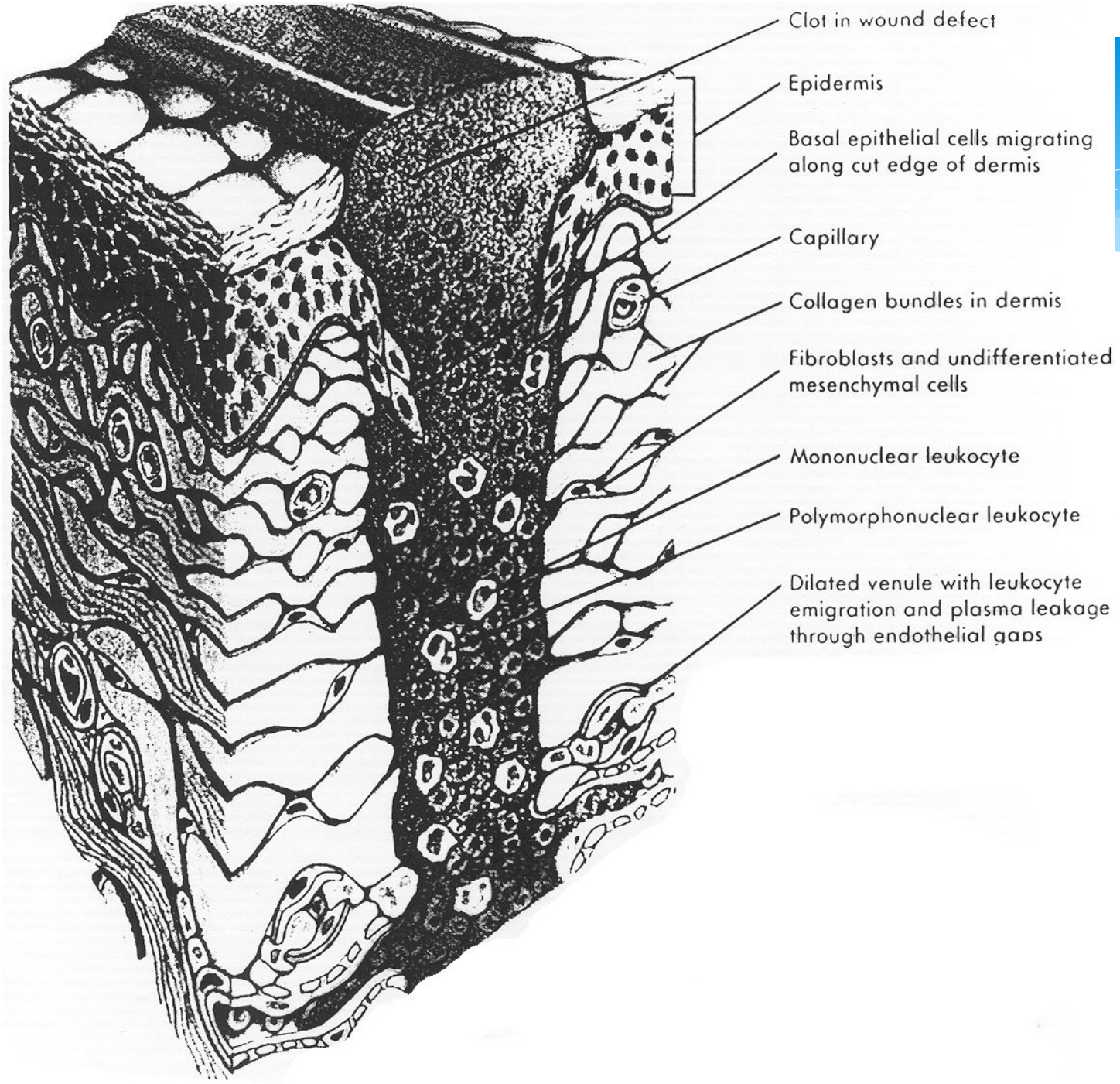
# Healing of Lacerations, Abrasions & Punctures

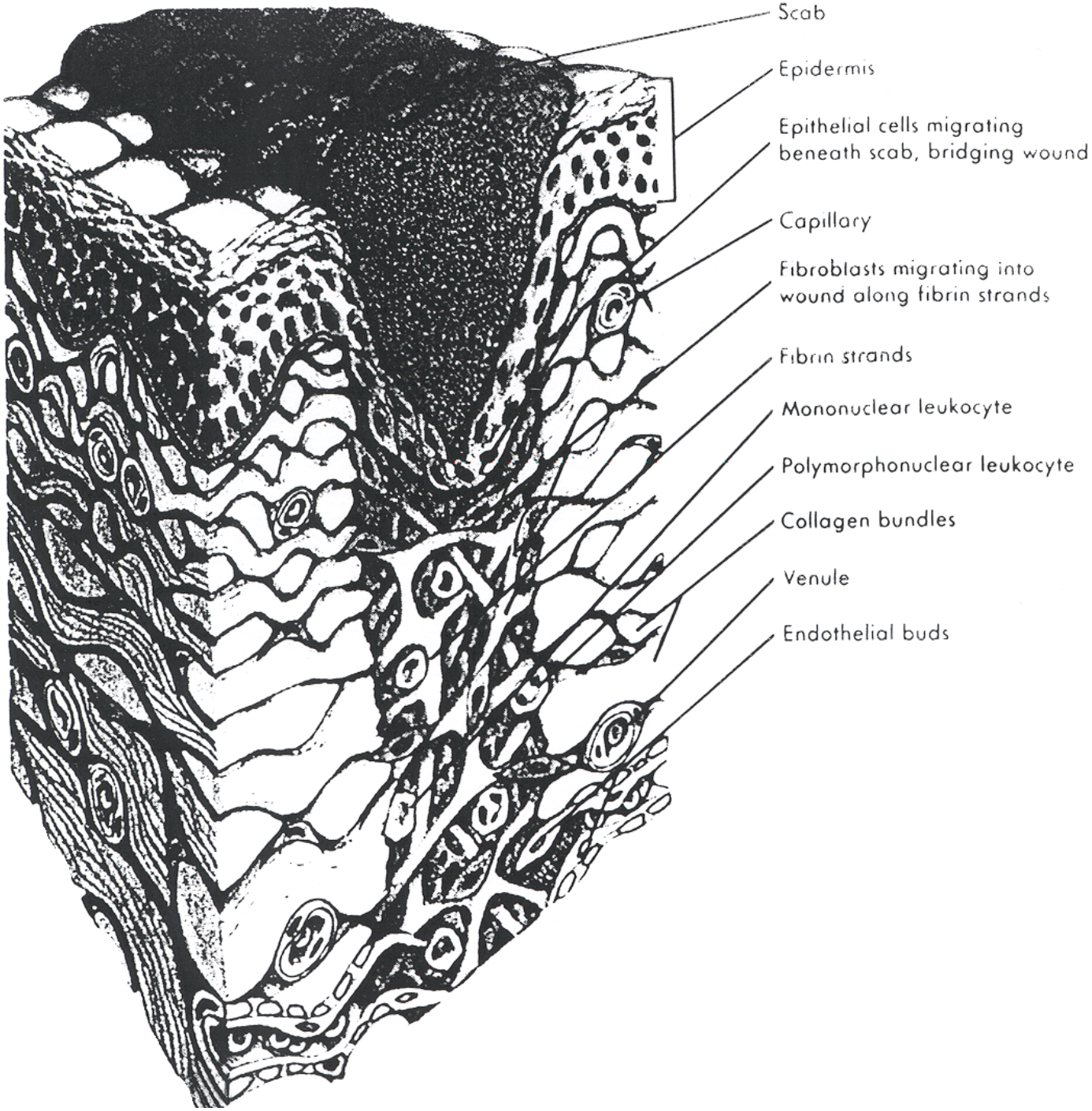
- **Inflammatory Phase: inflammation, bleeding/clotting (0-48 hrs)**
  - **Hageman factor (clotting factor 12) causes:**
    - **platelet plug formation and coagulation system activation (Factor X)**
    - **activation of compliment system**
      - **attraction of phagocytotic cells & inflammatory mediators (chemotaxis)**
      - **arachadonic acid cascade r u prostaglandins, thromboxanes, & leukotrienes**
      - **mast cells & basophils release histamine r u vascular permeability**
    - **platelets release serotonin r u vascular permeability**
    - **Kalikrein (inactive form of bradykinin) r u bradykinin r vasodilation**
  - **In extracellular matrix, hyaluronic acid combines with fibronectin**
    - **fibronectin + hyalruonic acid r "framework" for cell migration**
      - **fibronectin - adhesive glycoprotein located in blood & cell membranes**
    - **initial wound tensile strength provided by:**
      - **fibronectin - hyaluronic acid "framework"**
      - **crosslinking of fibronectin & collagen**
  - **Coagulation completed - granulation tissue begins to form**
    - **granulation tissue: capillary buds, fibroblasts, macrophages**
      - **scar forming tissue**

- **Fibroplastic phase - begins during inflammatory phase**
  - **macrophages & granulocytes remove cell debris**
  - **tissue hypoxia r formation of fragile capillary "buds"**
    - **happens within 24 hours of injury**
    - **Angiogenesis: buds proliferate & grow new circuits & also connect with existing capillaries**
  - **fibroblast (golgi apparatus) produce collagen fibers that span wound**
    - **vitamin C & oxygen needed for collagen synthesis**
  - **epithelium regenerates and proliferates beneath the clot**
  - **wound contraction occurs**
    - **myofibroblasts located in wound margins have high actin content**
    - **myofibroblasts move toward the center of the wound & contract**
    - **ends of damaged tissue are pulled closer together**
- **Maturation phase - mostly complete in 3 weeks to 6 months**
  - **breakdown & resynthesis of collagen parallel to tensile forces**
  - **may go on for years**

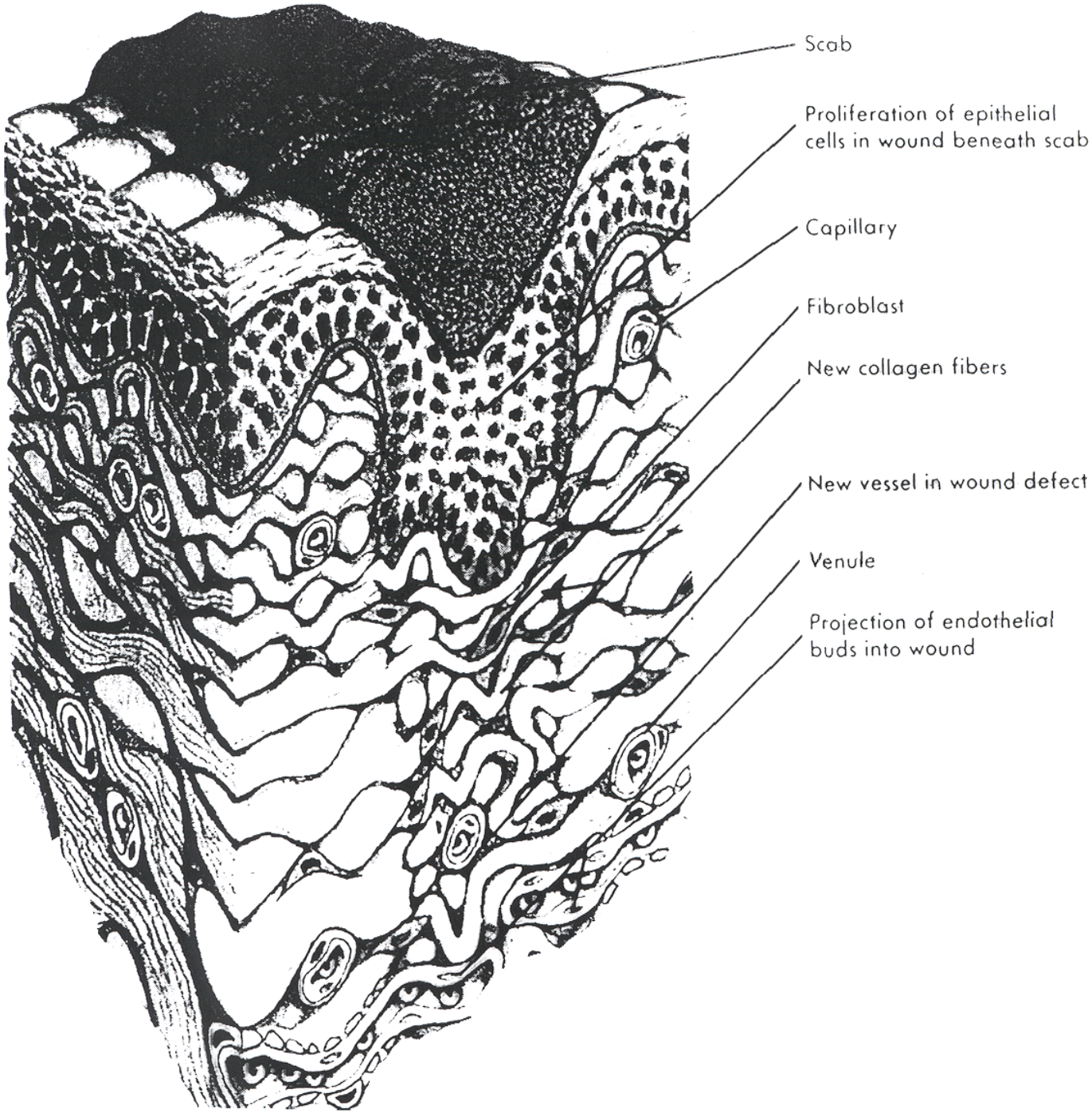
# Cutaneous Wound Healing Inflammatory Phase



# Cutaneous Wound Healing Fibroplastic Phase



# Cutaneous Wound Healing Late Fibroplastic and Early Remodeling Phase



# Healing by First & Second Intention

- **Healing by first intention – edges close together or wound edges brought together by sutures**
  - **loss of parenchymal (structural) tissue = amount of scar tissue**
  - **healing occurs faster**
  - **less change of infection**
- **Healing by second intention - wound not closed / unable to be closed**
  - **examples: decubitus ulcers (bed sores), burns**
  - **significant loss of parenchymal tissue r u amount of scar tissue**
  - **healing occurs slower**
  - **greater chance of infection**

# Granulation Tissue or Scar Tissue

- Scar tissue is not as vascularized as original tissue
- Scar tissues is not as flexible, elastic, or strong as original tissue
- Scar tissue formed in a muscular organ may inhibit function
  - Examples: heart, bladder
- Scar tissue may form adhesions which connect adjacent organs
  - may cause loss of function (ligaments, bones, tendons)
- Scar tissue may form contractures
  - may form within a joint: loss of mobility & ROM
  - may form in skin or muscle fascia r loss of mobility & elasticity

# Abrasions

* ***Minor skin injuries***
* ***Caused by a shear force***
* ***Skin is scraped with sufficient force, usually in one direction, against a rough surface***
* ***The greater the applied force, the more layers of skin that are scraped away***

# Blisters

* ***Minor skin injuries***
* ***Caused by repeated application of shear in one or more directions***
* ***Occurs when a shoe rubs back and forth against foot***
* ***Result is the formation of a pocket of fluid between the multiple layers of skin***

# Skin Bruises

* ***Contusion***
* ***Injuries resulting from compression sustained during a blow***
* ***Damage of the underlying capillaries***
* ***Causes the accumulation of blood within the skin***

# Incision and Laceration

* ***Incision***
  * ***Clean cut***
  * ***Produced by the application of a tensile force to the skin as it is stretched along a sharp edge***
* ***Laceration***
  * ***Irregular tear in the skin***
  * ***Typically results from a combination of tension and shear***

# Puncture Wound

* ***Formed when a sharp object penetrates the skin and underlying tissues with tensile loading***
* ***Puncture wound can come from:***
  * ***Shoe spike***
  * ***Nail***

# *Abrasions*

* **Fresh –**
  - **Bleeding → Bright red**
* **12 -24 hrs**
  - **Blood dries up, bright scab**
* **2 -3 days**
  - **Reddish brown scab**
* **4 -7 days**
  - **Epithelal growth beneath the scab**
* **After 7 days**
  - **Scab darkens, retract falls off leaving initially pink area later which becomes pale/whitish**

## *Contusions (Bruises)*

* ***Fresh – Red***
* ***Few hours to 3 days – blue***
* ***4$^{th}$ day – bluish black to brown***
* ***5-6 days – greenish***
* ***7 – 12 days – yellow***
* ***2 weeks - normal skin***

# Bone Injury Healing

* Three Phases Process
  * Acute Phase
  * Repair and Regeneration
  * Remodeling Phase

# Acute Phase

* Last approximately 4 days
* Hematoma is formed
* Vasodilatation occurs
* Edema
* Tissue chemical changes

# Repair and Regeneration Phase

* Osteoclasts come to the area of injury to reabsorb damaged bone tissue
* Osteoblasts build new bone
* A callus is forms between the fractured bone ends
  * A callus is a fibrous vascularized tissue containing immature bone
  * Strengthens with time through remodeling phase
* Fixation devices are only implanted when it appears unlikely that the fracture will not heal properly

# Remodeling Phase

* Osteoblasts and Osteoclasts activity continues until normal shape and strength has restored
* Time is the largest requirement for proper none union to take place
* Complete remodeling may take many years