BURNS

- **Local effects of burns:**
  - **Vasodilatation and increased vascular permeability leading to edema.**
  - **Inflammation with its cardinal signs:**
    - ✓ *Dolor (pain)*: due to compression of the swelling on nerves.
    - ✓ *Calor (heat):* due to increased blood flow to the affected area.
    - ✓ *Rubor (redness):* due to increased blood flow to the affected area.
    - ✓ *Tumor (swelling):* due to increased vascular permeability leading to edema.
    - ✓ *Function laesa (loss of function).*
  - **There are 3 degrees of burn:**
    - ✓ *First degree*: skin erythema (redness) and local heat.
    - ✓ *Second degree*: epidermal necrosis and formation of blisters (a small bubble on the skin filled with serum).
    - ✓ *Third degree*: epidermal and dermal damage with loss of sensation.
  - **Repair and healing is achieved by:**
    - ✓ *Scar formation (fibrous tissue).*
    - ✓ *Deformities.*
    - ✓ *Keloid*: an area of irregular fibrous tissue formed at the site of a scar or injury.
    - ✓ *Cicatrix (ندبة):* the scar of a healed wound.
  - **Local secondary infection**: due to the exposure of tissue under the skin (there is no presence of the physical barrier).
- **Systemic effects of burns:**
  - Increased vascular permeability and denuded (naked) skin surface will lead to plasma + fluid loss (hypovolemic shock: poor vascular perfusion of tissue). In 3rd degree of burn, 1ml of body water is lost for every $3cm^2$ of burned area/day. This condition can lead to ischemic acute tubular necrosis.
  - Myoglobinuric acute renal failure.
  - Systemic sepsis.
  - Fat embolism.
  - Inhalation injury (ARDS: Acute Respiratory Distress Syndrome).
  - VF in electrical burns.

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CELLS AND TISSUE RENEWAL

- **There are 4 types of cells:**
  - **Stable cells**: they divide at slow rate but retain the capacity to divide if necessary. Examples include: hepatocytes (liver cells) and renal tubules.
  - **Labile cells**: these cells have good capacity to regenerate. Examples include: hematopoietic cells in the bone marrow and surface epithelial cells.
  - **Permanent cells**: they have no ability of effective regeneration. Examples include: nerve cells and striated muscle fibers.
  - **Stem cells:**
    - ✓ They are present in many stable and labile cell populations (ex. Skin, bone marrow and intestine).
    - ✓ *Mitotic division of stem cells produce two daughter cells:*
      - ❖ One which will progress along differentiation.
      - ❖ Other which will retain stem cell characteristics.
    - ✓ *They are vulnerable to radiation and this will result in:*
      - ❖ Cell death and cell loss.
      - ❖ Mutations transmitted to daughter cells and subsequently leading to malignancy.

- **Important terms:**
  - **Regeneration**: replacing dead or injured tissue by functionally identical cells/ tissues.
  - **Repair**: healing with replacement of the lost tissue but not by similar tissue or identical cells.
  - **Organization** (a common consequence of pneumonia and infarction): specialized tissues (lungs, pilosebaceous units, abscess… etc) are repaired by mature fibrovascular tissue through the formation of granulation tissue. Granulation tissue contracts and accumulates collagen to form scar.

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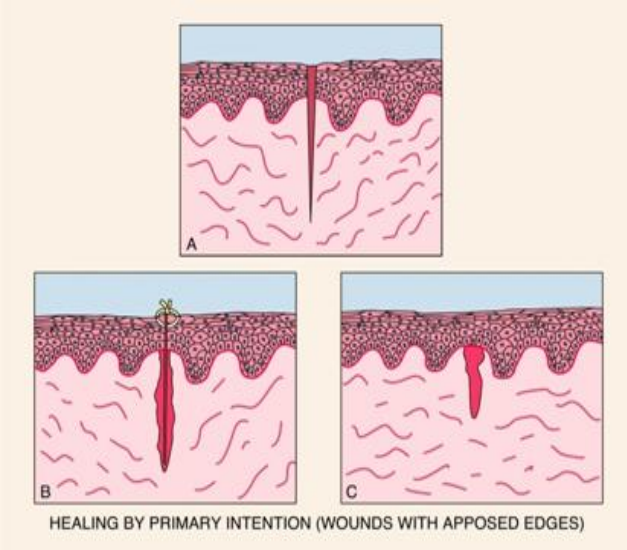
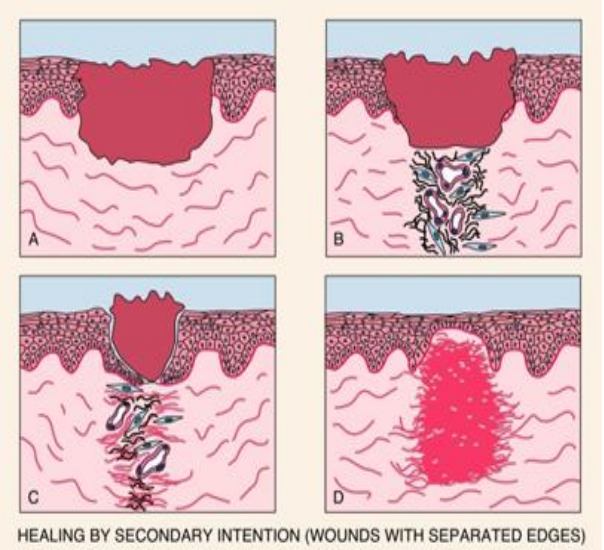
WOUNDS

- **Classification of wounds:**
  - **Legal classification:**
    - ✓ Simple.
    - ✓ Dangerous.
    - ✓ Fatal.
  - **Medicolegal classification:**
    - ✓ Abrasions (الخدوش).
    - ✓ Bruises/contusions (الكدمات): a region of injured tissue in which blood capillaries have been ruptured.
    - ✓ Incised (cut).
    - ✓ Stab (طعنة): it is penetrating.
    - ✓ Laceration (التمزّق): deep cut or tear in skin or flesh.
    - ✓ Firearm and blast injuries (الجروح الناتجة عن الأسلحة النارية أو الانفجار).
    - ✓ Thermal injuries.
    - ✓ Fractures (compound fractures in which the bone is penetrating the skin).
- **Wound healing:**
  - **First intention**: healing of surgical (clean) wound.
    - ✓ Healing is achieved by resolution/repair.
  - **Second intention**: healing of infected wound, ulcer or abscess.
    - ✓ Healing is achieved by organization.
  - **Control mechanisms (3 levels):**
    - ✓ *Paracrine*: relating to a hormone that has effect only in the vicinity of the gland secreting it.
    - ✓ *Endocrine*: relating to glands that secrete hormones or other products directly into the blood.
    - ✓ *Autocrine*: in which a cells secretes a hormone that binds to autocrine receptors on that same cell, leading to changes in the cell.
- **Principles of healing:**
  - Hemorrhage, platelets aggregates and thrombus plug defect.
  - Hemorrhage controlled by hemostatic mechanism.
  - Interaction between coagulation and complement initiates chemotaxis to inflammatory cells.
  - **Angiogenesis**: the development of new blood vessels.
- **Granulation tissue and repair:**
  - Angiogenesis.
  - Phagocytosis of debris and blood clot element.
  - Absorption of exudates into vascular system.
  - The fibrin meshwork.
  - Regeneration and migration of specialized cells.
  - Myofibroblasts secrete collagen and other matrix components.
  - Repair and replacement by fibrous tissue.
  - Repair is regulated by low-molecular weight proteins known as growth factors.





VERY IMPORTANT

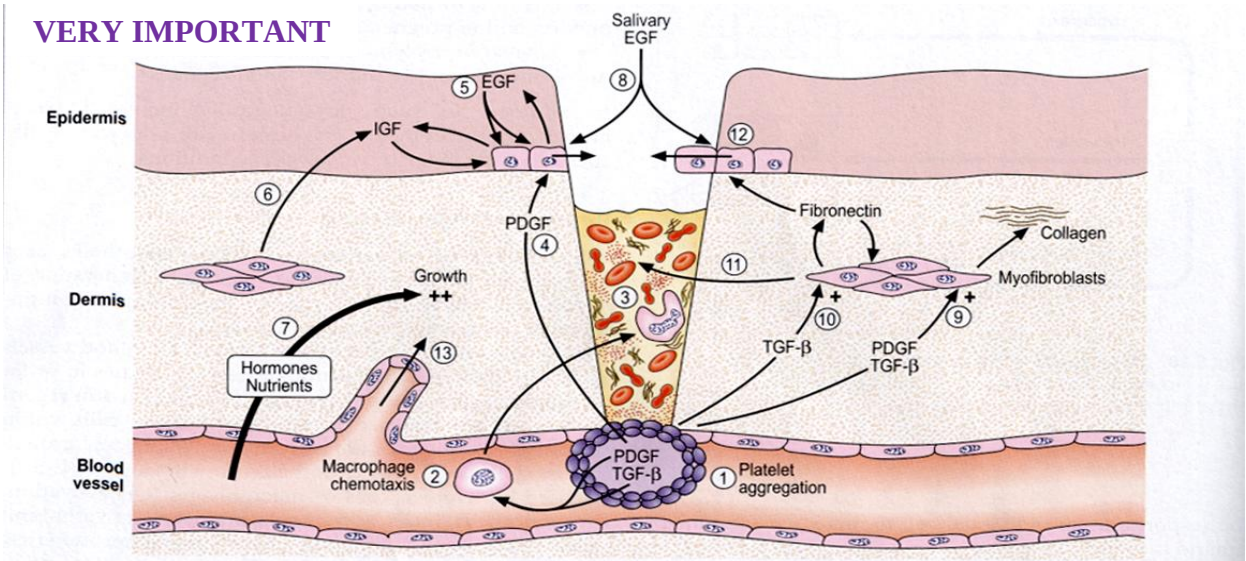
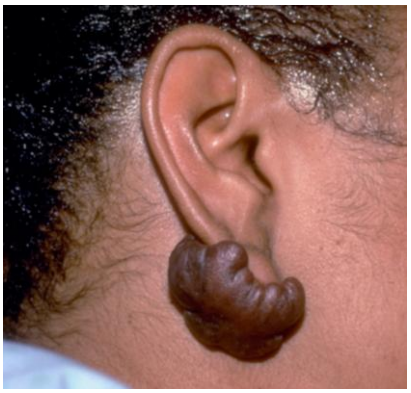


Fig. 5.11 Factors mediating wound healing. A wound is shown penetrating the skin and entering a blood vessel. **(1)** Blood coagulation and platelet degranulation, releasing platelet-derived growth factor (PDGF) and transforming growth factor beta (TGF-β). **(2)** PDGF and TGF-β are chemotactic for macrophages, which migrate into the wound to phagocytose bacteria and necrotic debris **(3)**. *In the epidermis*: **(4)** the released PDGF activates epidermal basal epithelial cells, which are also under autocrine and paracrine stimulation by epidermal growth factor (EGF) and insulin-like growth factors (IGF) **(5)**, some derived from dermal myofibroblasts **(6)**. Nutrients and oxygen **(7)** and circulating hormones and growth factors diffusing from blood vessels (including insulin, thyroxine, IGF-1 and IGF-2), and EGF **(8)** from saliva (if the wound is licked) all contribute to epidermal growth. *In the dermis*: **(9)** PDGF and TGF-β stimulate cell division in myofibroblasts, and **(10)** TGF-β stimulates these cells to produce collagen and fibronectin. Fibronectin stimulates migration of dermal myofibroblasts **(11)** and epidermal epithelial cells **(12)**. Angiogenic growth factors (not shown) stimulate the proliferation and migration of new blood vessels into the area of the wound **(13)**.

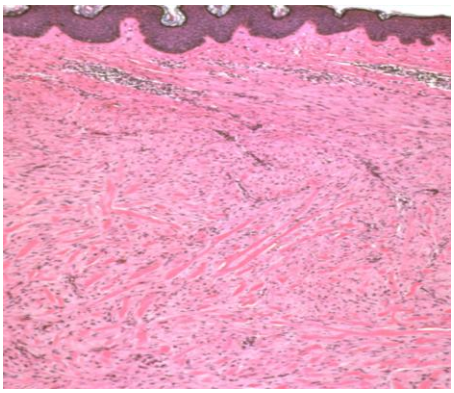
Table 10.4 Growth factors involved in healing and repair associated with inflammation

Growth factor	Abbreviation	Function
Epidermal growth factor	EGF	Regeneration of epithelial cells
Transforming growth factor α	TGFα	Regeneration of epithelial cells
Transforming growth factor β	TGFβ	Stimulates fibroblast proliferation and collagen synthesis Controls epithelial regeneration
Platelet-derived growth factor	PDGF	Mitogenic and chemotactic for fibroblasts and smooth muscle cells
Fibroblast growth factor	FGF	Stimulates fibroblast proliferation, angiogenesis and epithelial cell regeneration
Insulin-like growth factor-1	IGF-1	Synergistic effect with other growth factors
Tumour necrosis factor	TNF	Stimulates angiogenesis

- **Paracrine:**
  - Platelets Derived Growth Factor (PDGF) and Transforming Growth Factor-β (TGF-β) are produced by platelet degranulation and they are chemotactic to inflammatory cells (including macrophages) which are required to clear necrotic debris and blood clot.
  - PDGF also activates epidermal basal cells.
  - Insulin-like Growth Factor (IGF) which is produced from dermal fibroblasts also act on epidermal basal cells.
  - PDGF and TGF-β stimulate the dermal myofibroblasts to secrete collagen and fibronectin. Fibronectin will aid in the migration of epidermal epithelial cells and dermal myofibroblasts.
- **Autocrine:**
  - Represented by Epidermal Growth Factor (EGF) which aids in regeneration of epithelial cells.
- **Endocrine-represented by:**
  - Insulin-Like Growth Factor-1 (IGF-1) and Insulin-Like Growth Factor-2 (IGF-2).
  - Thyroxine, insulin, glucose, nutrients, oxygen… etc.
  - Saliva EGF.
  - Angiogenic Growth Factor.
- **Outcome of wound healing:**
  - Organization of granulation tissue → repair by fibrous tissue.
  - Scar formation if small.
  - Contractures and limitation of movement.
  - Adhesions.
  - Keloid formation.
- **Factors affecting cell renewal/tissue repair:**
  - Age of patient.
  - Vascularity of the tissue.
  - Impairment of lymph drainage.
  - Early movement of affected part.
  - Fixation to underlying tissue.
  - Presence of foreign body or irritant substances.
  - Infection.
  - State of immunity.
  - Denervation.
  - Constitutional factors including: diabetes, anemia, hypoproteinemia, vitamin/mineral deficiencies, deficiency of sulphar-containing amino acids and excessive adrenal glucocorticoid hormone.



Keloid



Scar tissue- type 3 collagen- usually in African-Americans