

# Johns Hopkins Engineering

## Immunoengineering

**Immune Response to Biomaterials: Inflammation and Wound Healing**

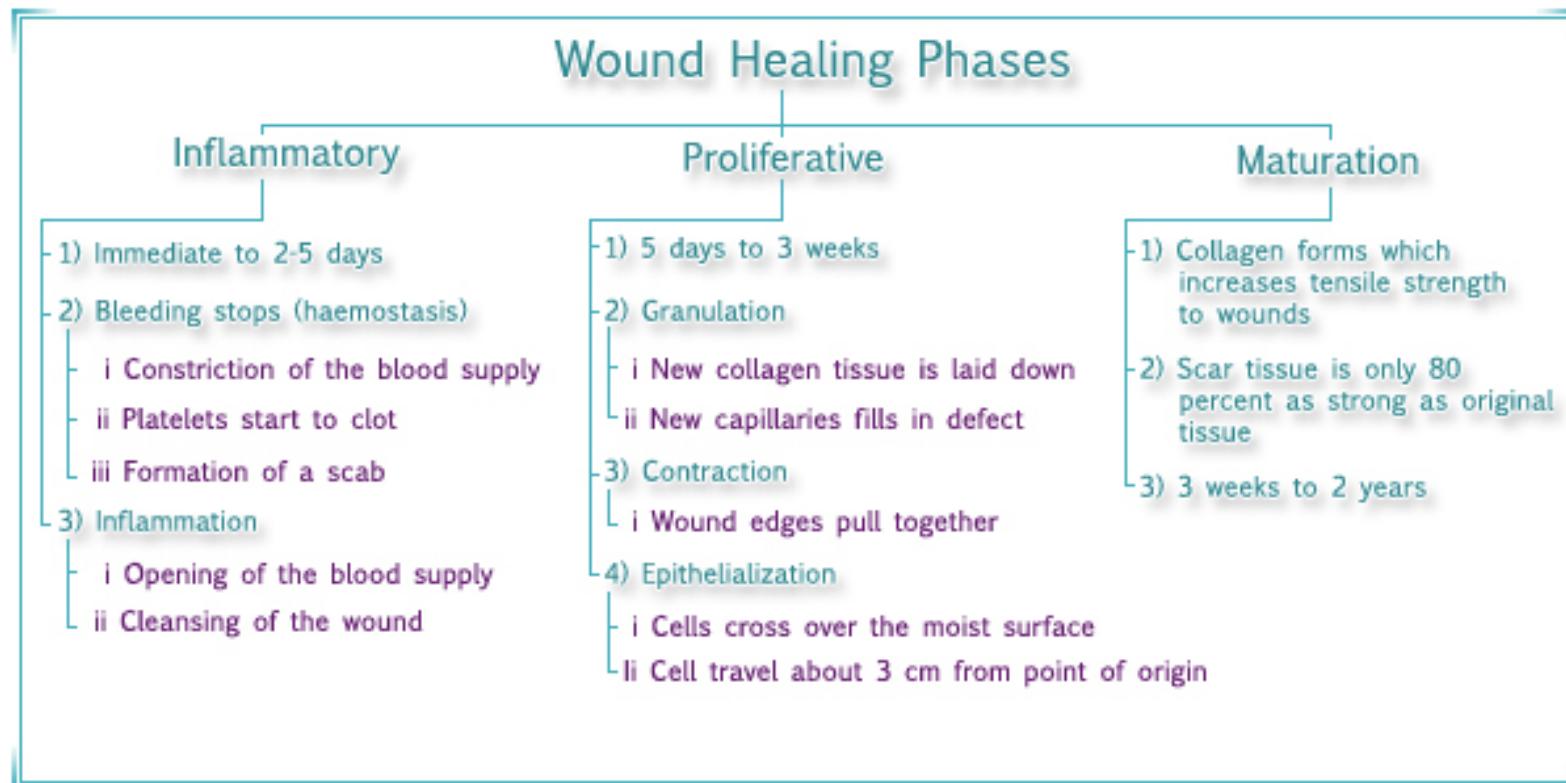


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# Phases of Wound Healing

- Injury
- Hemostasis
- Acute Inflammation
- Chronic Inflammation
- Granulation Tissue Formation
- Extracellular Matrix Formation
- Scar Formation

# Phases of Wound Healing



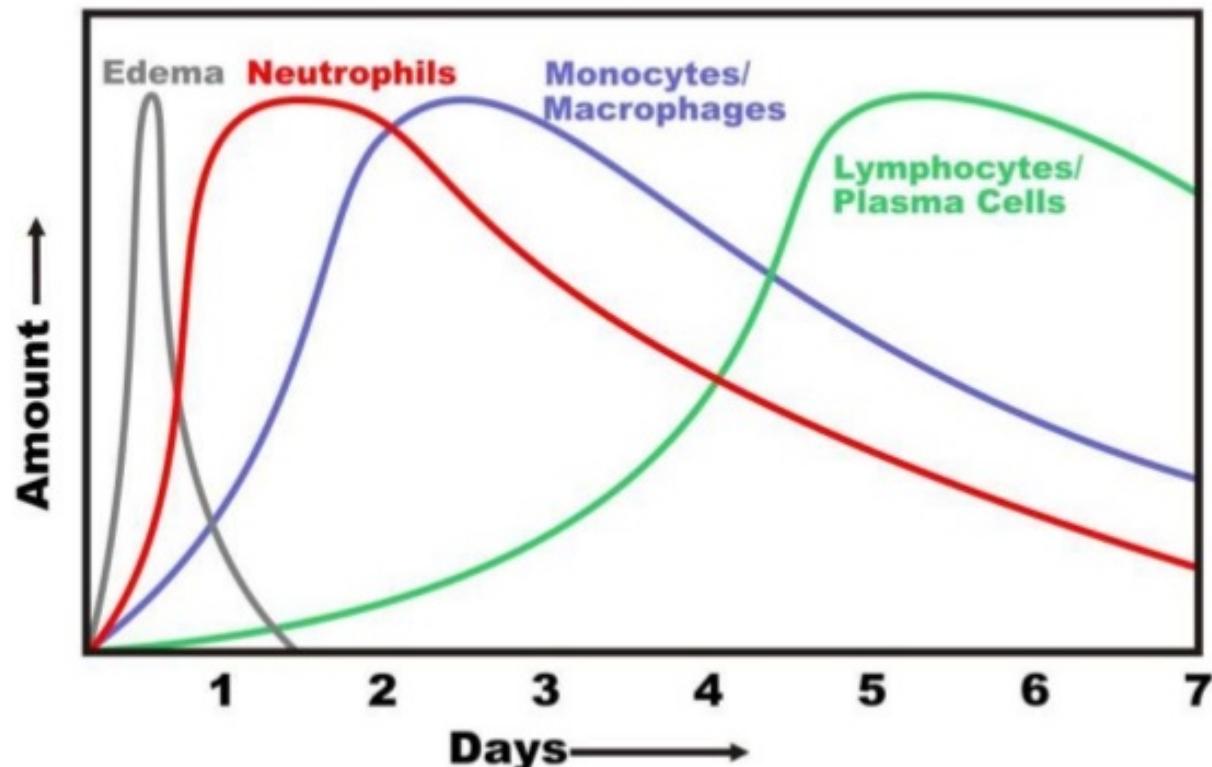
# Signs of Acute Inflammation

- Rubor – redness
- Dolor – pain
- Calor – heat
- Tumor – swelling

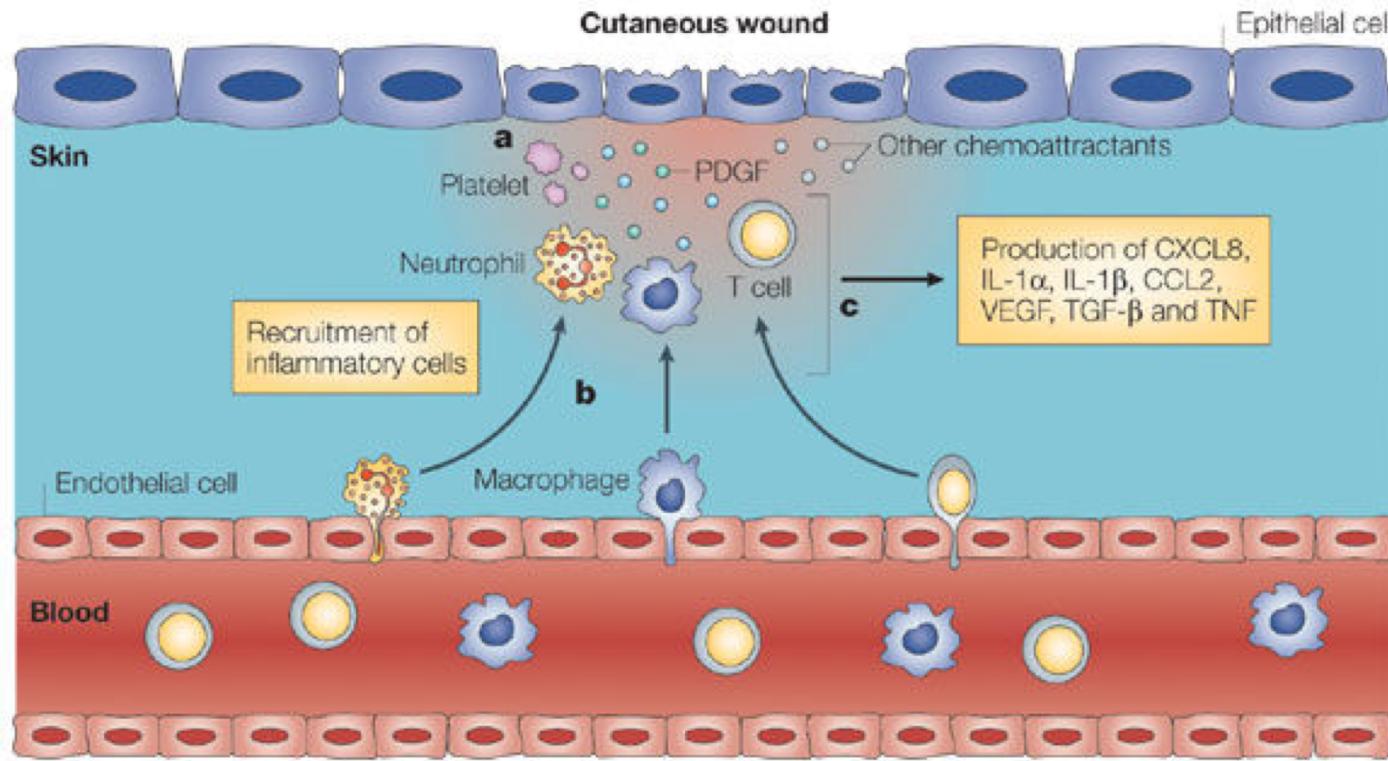
# Acute vs Chronic Inflammation

Feature	Acute	Chronic
Onset	Fast: minutes to hours	Slow: days
Cellular infiltration	Mainly neutrophils	Monocytes/macrophages and lymphocytes
Tissue Injury	Mild and self-limited	Severe and progressive, may include fibrosis
Local and systemic signs	Prominent	Less

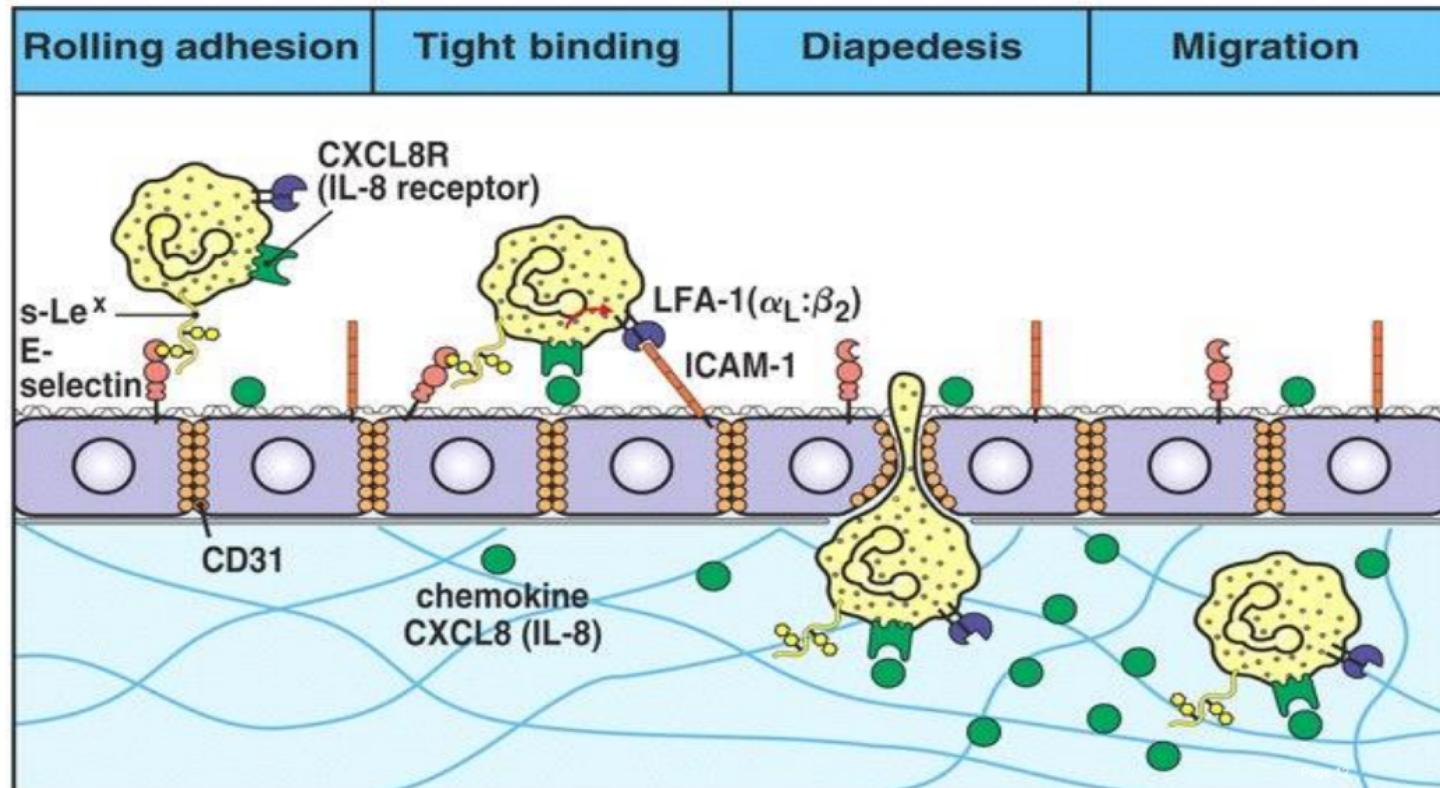
# Time Course of Cellular Responses



# Acute Inflammation



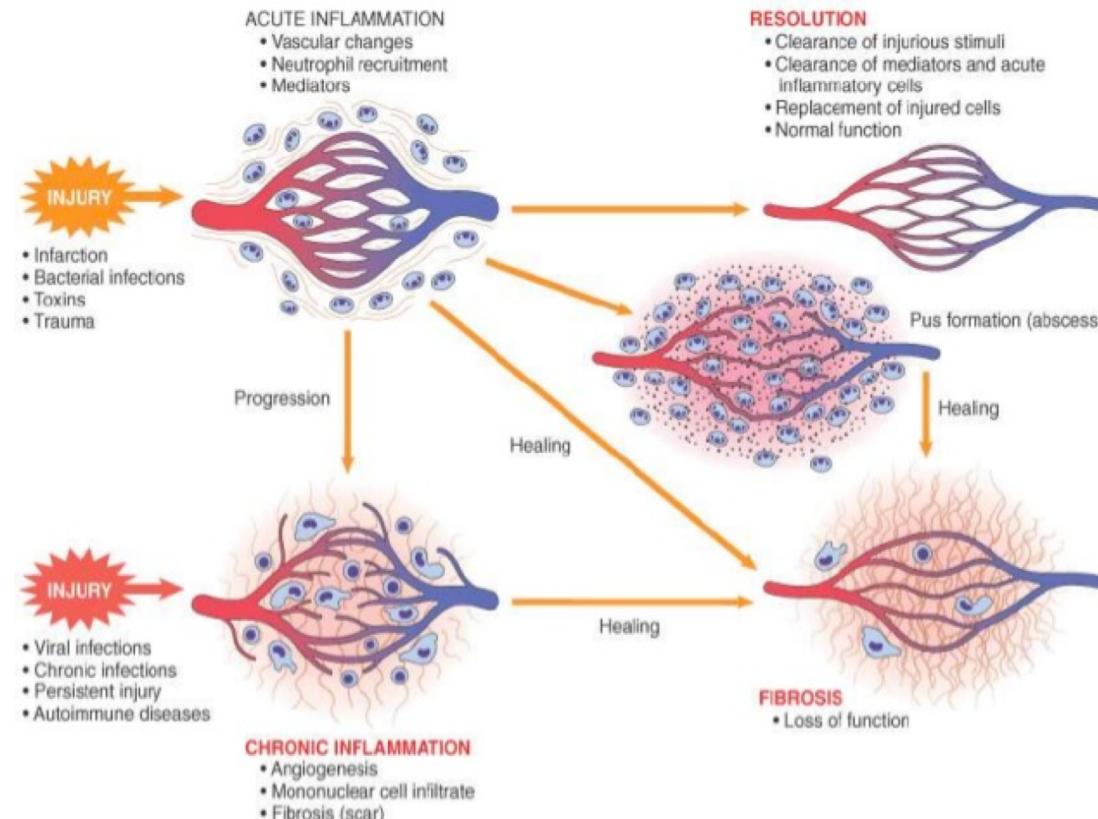
# Leukocyte Extravasation



# Chemical Mediators of Inflammation

Mediators	Examples
Vasoactive agents	Histamines, serotonin, adenosine, endothelial-derived relaxing factor (EDRF), prostacyclin, endothelin, thromboxane $\alpha_2$
Plasma proteases	
Kinin system	Bradykinin, kallikrein
Complement system	C3a, C5a, C3b, C5b-C9
Coagulation/fibrinolytic system	Fibrin degradation products, activated Hageman factor (FXIIA), tissue plasminogen activator (tPA)
Leukotrienes	Leukotriene B <sub>4</sub> (LTB <sub>4</sub> ), hydroxyeicosatetraenoic acid (HETE)
Lysosomal proteases	Collagenase, elastase
Oxygen-derived free radicals	H <sub>2</sub> O <sub>2</sub> , superoxide anion
Platelet activating factors	Cell membrane lipids
Cytokines	Interleukin 1 (IL-1), tumor necrosis factor (TNF)
Growth factors	Platelet-derived growth factor (PDGF), fibroblast growth factor (FGF), transforming growth factor TGF- $\alpha$ or (TGF- $\beta$ ), epithelial growth factor (EGF)

# Resolution of Inflammation





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