

# Wounds and healing surgical wounds

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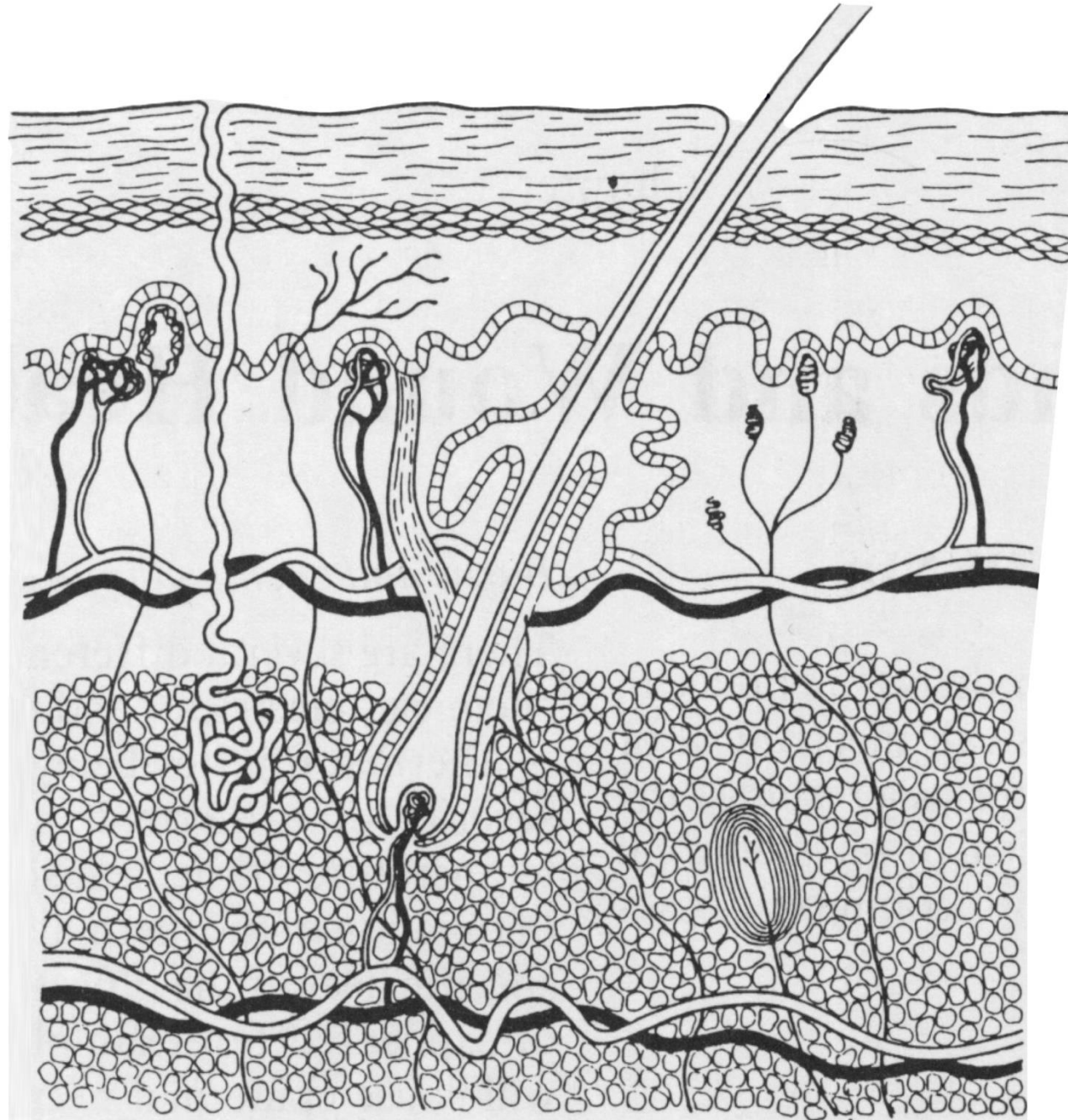
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# Classification of WOUNDS

- **Wound** may be defined as a **defect or break in the skin** that results from physical, mechanical or thermal damage.
- **Healing** is complete when the skin surface has reformed and the skin has regained most of its tensile strength

Deep  
dermal

Superficial  
partial  
thickness



Partial  
thickness

Full  
thickness

# Classification of WOUNDS

- **Mechanical injuries**
  - Abrasions
  - Laceration
  - Penetration
  - Bites
  - **Surgical wound**
- **Burns and chemical injuries**
  - Superficial – I. degree
  - Deep dermal – second degree
  - Full thickness – third degree
- **Chronic ulcerative wounds**
  - Decubitus ulcers
  - Leg ulcers
  - Ulcers ( resulting from radiotherapy, malignant disease..)

# Wound closure

- **Closure by first intention**

- **Primary intention** : When the wound is closed at the time of surgery.
- Primary closure is used in the majority of elective surgical cases and clean trauma wounds.

- **Delayed primary closure**: When a wound is contaminated or devitalized tissues have been débrided, it is left open and packed with suitable dressings, such as Jelonet or proflavine-soaked gauze. Wound closure is undertaken 2–3 days later, providing the wound is clean.

- **Closure by second intention**

- **Secondary intention** – Larger tissue losses, contraction occurs and eventually the wound re-epithelialises. This healing by secondary intention requires considerable time
- If a wound is left alone to heal, granulation tissue forms and healing is said to be by second intention. Grossly contaminated or infected wounds are débrided and left to heal in this manner. Pilonidal disease and hidradenitis are also often treated in this way.

# Principles of wound treatment

- Initiate healing as quickly as possible
- Identify the cause of the wound and try to remove it by all means available
- Suppress the activity of the sympathetic nerves
- Correct the blood volume
- Treat pain
- Prevent hypothermy

# The phases of *wound healing*

- **Coagulation** (immediate)
- **Inflammation** (0–4 days)
- **Fibroplasia** (4 days to 3 weeks)
- **Remodelling** (3 weeks to 18 months)
- Maximal wound tensile strength at about day 60

# Normal Wound-healing Process

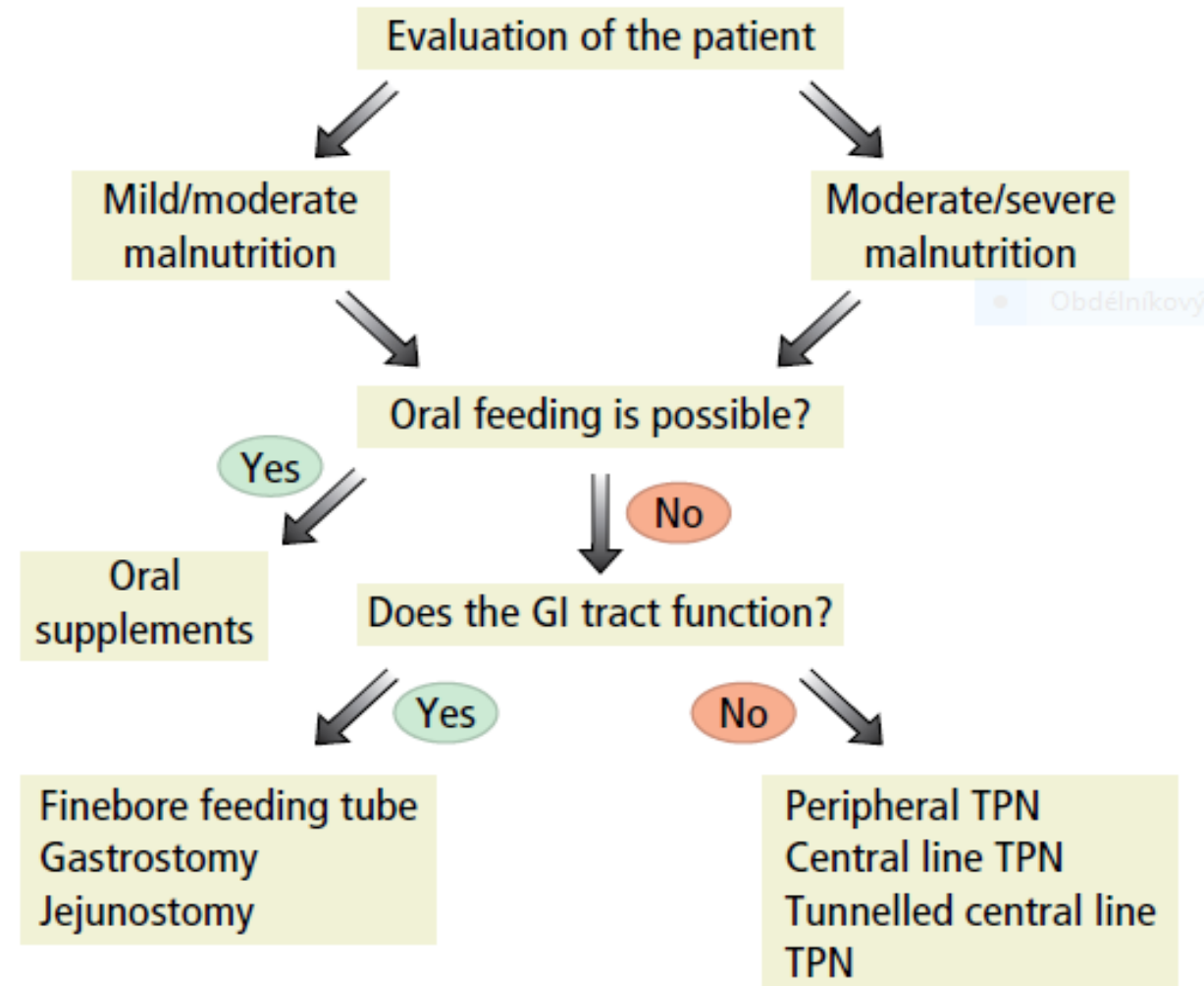
Phase	Cellular and Bio-physiologic Events
<b>Hemostasis</b>	vascular constriction platelet aggregation, degranulation, and fibrin formation (thrombus)
<b>Inflammation</b>	neutrophil infiltration monocyte infiltration and differentiation to macrophage lymphocyte infiltration
<b>Proliferation</b>	re-epithelialization angiogenesis collagen synthesis ECM formation
<b>Remodeling</b>	collagen remodeling vascular maturation and regression



# Factors Affecting Wound Healing

Local Factors	Systemic Factors
<ul style="list-style-type: none"><li>• <b>Oxygenation</b></li><li>• <b>Infection</b></li><li>• <b>Foreign body</b></li><li>• <b>Venous sufficiency</b></li></ul>	<ul style="list-style-type: none"><li>• Age and gender</li><li>• Sex hormones</li><li>• Stress</li><li>• Ischemia</li><li>• Diseases: diabetes, keloids, fibrosis, hereditary healing disorders, jaundice, uremia</li><li>• Obesity</li><li>• Medications: glucocorticoid steroids, non-steroidal anti-inflammatory drugs, chemotherapy</li><li>• Alcoholism and smoking</li><li>• Immunocompromised conditions: cancer, radiation therapy, AIDS</li><li>• Nutrition</li></ul>

# Nutritional assessment of the surgical patient



# *Inflammation*

- ***There are five signs if inflammation***
  - Heat
  - Redness
  - Pain
  - Swelling
  - Loss of function
- This may make clinical detection of an early wound infection more difficult.

# Inflammatory exudate

- Wound inflammation leads to production of inflammatory exudate, an important part of the wound's defence system.
- A wound produces exudate until epithelisation is complete. Seen as a yellow stain on any dressing, it is a ***normal part of healing process***.
- Exudate is kept in contact with the wound by occlusive dressing. Researchers have recently proposed that growth promoting substances in exudate lead to ***enhanced healing in chronic wounds***
- ***The more effective the exudation the higher the quality of GRANULATION***

# Debridement - definition

- The removal of foreign material and dead or contaminated tissue from a traumatic or infected lesion in order to expose healthy tissue

## Wound debridement phases:

- **Initial phase**
  - Removing burden of necrotic tissue ( surgery, maggots etc.)
- **Maintenance phase**
  - Keep the wound free of necrotic tissue (dressing, enzymes,etc.)

# Granulation tissue

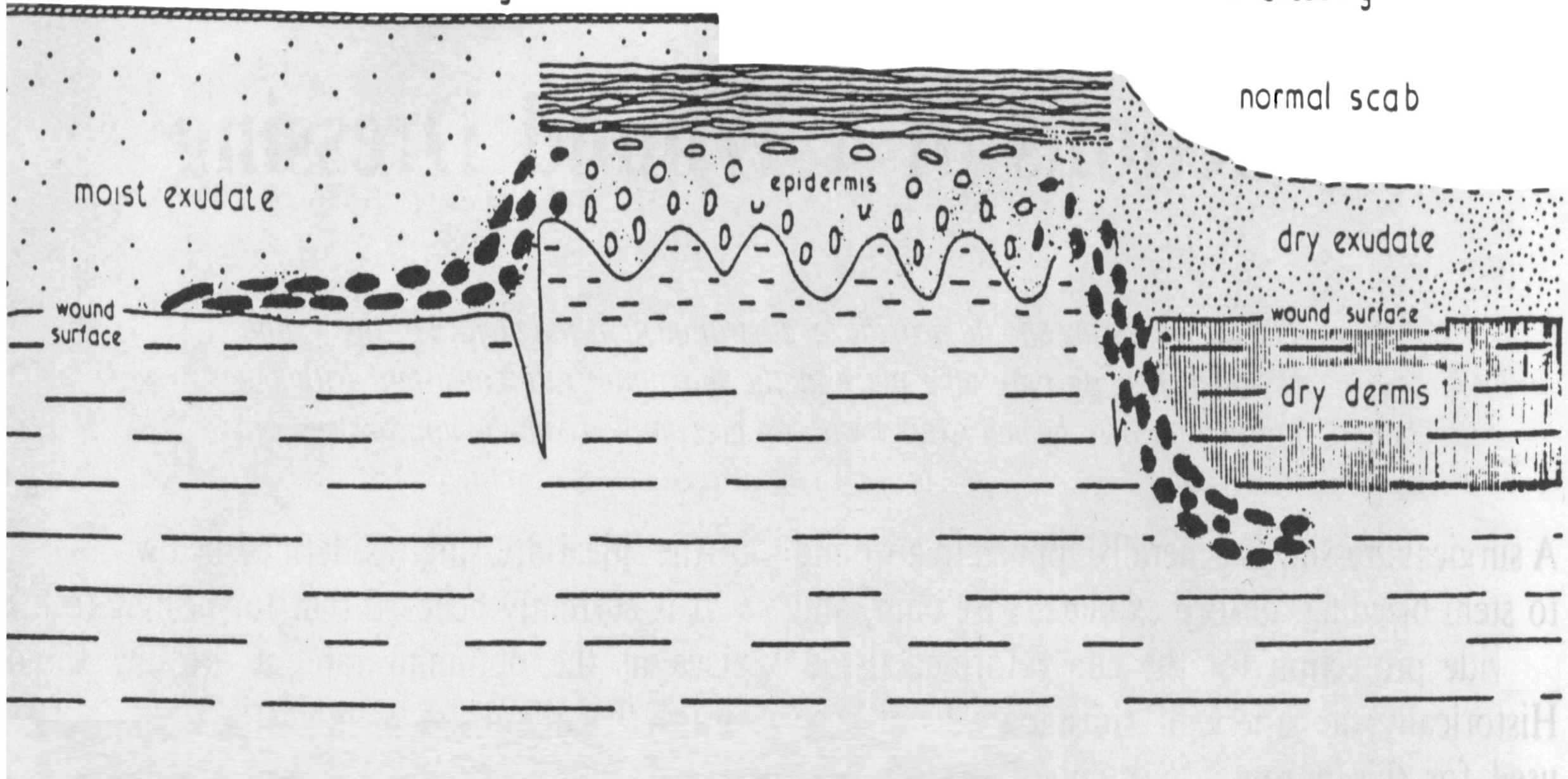
- Granulation leads to the formation of a network of new blood vessels (angiogenesis) in a collagen rich matrix.
- Granulation tissue formation begins approximately five days after injury.
- **The higher the quality of GRANULATION the less frequent occurrence of infection.**

# Epithelisation

- Epithelisation resurfaces the wound.  
In a full thickness wound, regeneration occurs from epithelial cell in the wound margins.
- Research shows that rate of epithelisation may be enhanced by a moist local environment maintained for instance, by occlusive dressing.
- Epithelisation is delayed by foreign material, desiccation and infection.

occlusive dressing

no dressing





# Healing is a natural process

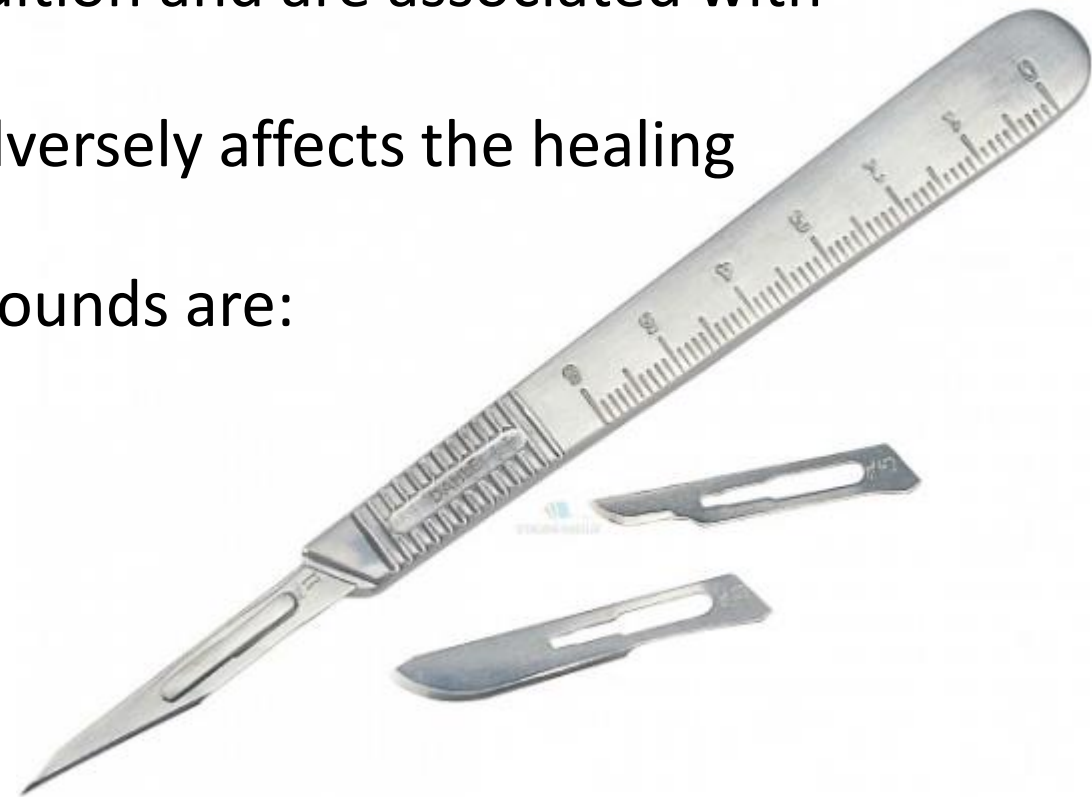
- Under certain preconditions, but.....
- **Worsened perfusion and oxygenation**
- **Vasoconstriction**
- **Corticosteroids,chemotherapeutics, immunosuppressants..**
- **In the case of gram negative infections of aseptic shock granulated tissue is not necessarily formed or it dissolves.**
- **In the case of malnutrition the reproduction of all cells is slowed down.**

# *Surgical Wounds*

A common cause of acute wounds is the surgeon's scalpel

These incisions are made under aseptic condition and are associated with minimal surrounding tissue damage.

- Wound complication is any event which adversely affects the healing process.
- Common complication affecting surgical wounds are:
- ***Infection***
- ***Haematoma***
- ***Wound dehiscence***
- ***Necrosis***



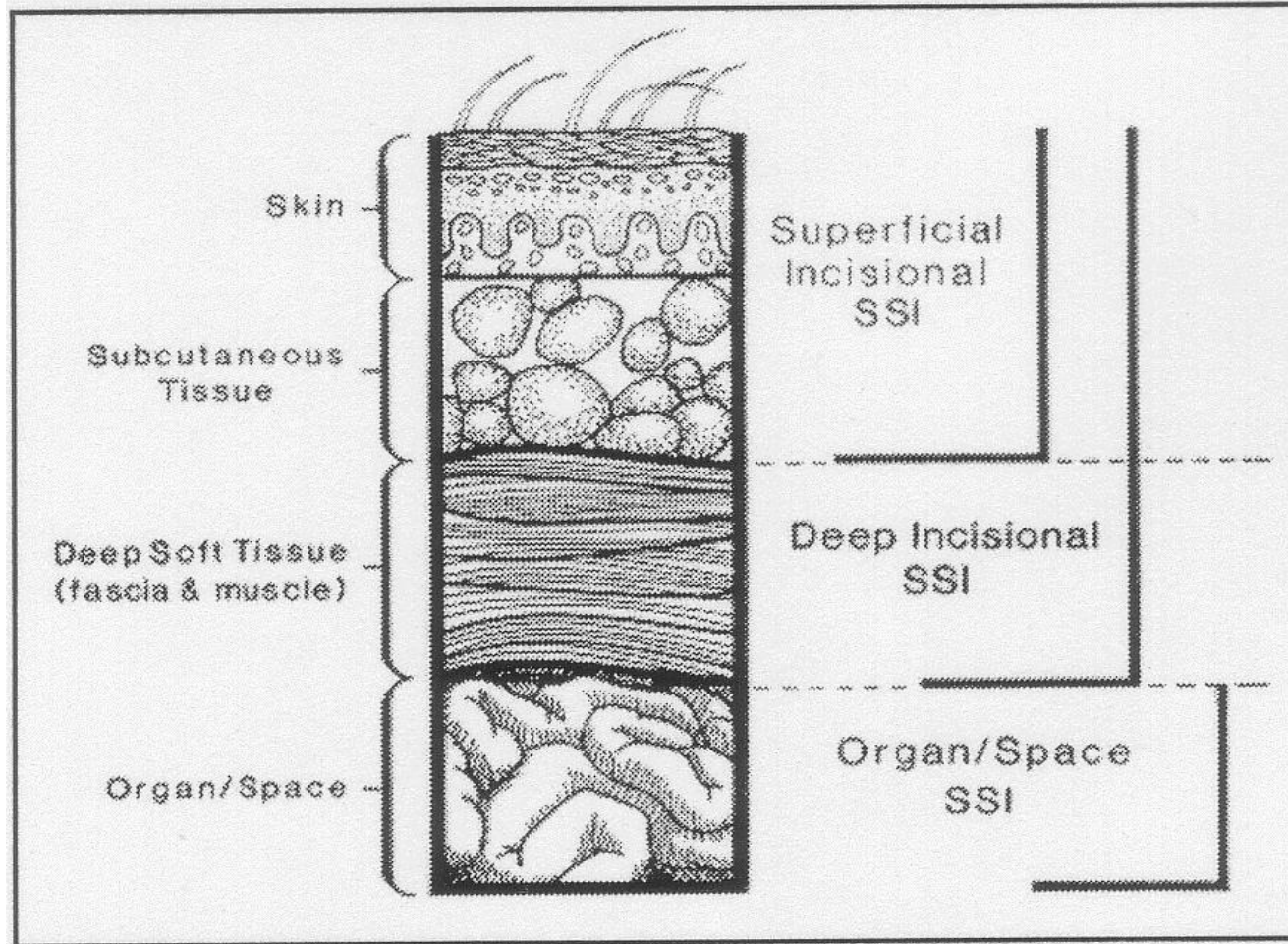
# Definitions -Surgical infection

- **Infection:** the process whereby organisms (e.g. bacteria, viruses, fungi) capable of causing disease gain access and cause injury or damage to the body or its tissues
- **Pus:** a yellow/green foul-smelling viscous fluid containing dead leukocytes, bacteria, tissue and protein
- **Abscess:** localized collection of pus, usually surrounded by an intense inflammatory reaction
- **Cellulitis:** a spreading infection of subcutaneous tissue

# Wound infections

- A wound infection is defined by the US Centre for Disease Control and Prevention (CDC) as surgical site infection (**SSI**). This is further defined as:
- **Superficial incisional SSI** – infection involves only skin and subcutaneous tissue of incision.
- **Deep incisional SSI** – infection involves deep tissues, such as facial and muscle layers.
- **Organ/space SSI** – infection involves any part of the anatomy in organs and spaces other than the incision, which was opened or manipulated during the operation.

# SSI



- Superficial
- Deep
- Organ/space

# What defines a surgical wound infection?

- A surgical wound/site infection is defined by the following criteria:
- **Infection must occur within 30 days** of the surgical operation.
- **And at least one of the following is present:**
  - Purulent discharge from the surgical site
  - Purulent discharge from wound or drain placed in wound
  - Organisms isolated from aseptically obtained wound culture
  - Must be at least one of the signs and symptoms of infection – pain or tenderness, localised swelling, or redness/heat.

Other factors that play a role in wound infection are shown in the table below.

- **General patient characteristics**
  - Age, obesity, malnutrition
  - Endocrine and metabolic disorders
  - Hypoxia, anaemia
  - Malignant disease
  - Immunosuppression
- **Wound characteristics**
  - Nonviable tissue in wound
  - Foreign bodies
  - Tissue ischaemia
  - Haematoma formation
- **Operative characteristics**
  - Poor surgical technique, Long operation time (>2 hours)
  - Intraoperative contamination, Prolonged preoperative stay
  - Hypothermia

# What is the risk of wound infection?

Classification	Description	Infective Risk %
Clean	Uninfected operative wound No acute inflammation No entry to internal organs No break in aseptic technique E.g. hernia repair	<2
Clean contaminated	Opening to internal organ but minimal or no spillage of contents No evidence of infection or major break in aseptic technique E.g. appendectomy	<10
Dirty	Purulent inflammation present Intraperitoneal abscess formation or visceral perforation	40



# Management of surgical infection

## *Preventive measures*

- Short operations
- Skin cleansing with antibacterial chemicals and detergents (patient's, surgeons's and nurse's skin)
- Filtering of air in operating theatre
- Occlusive surgical masks and gowns

## **Prophylactic antibiotics:**

- Should be bacteriocidal
- Should have high tissue levels at time of contamination
- One preoperative dose given 1 h prior to surgery
- Should be given to patients with implanted prosthetic materials, e.g. heart valves, vascular grafts, joint prostheses

# Management of established infection

- **Diagnosis**
  - Made by culture of appropriate specimens (pus, urine, sputum, blood, CSF, stool)
- **Antibiotics**
  - Prescribe on basis of culture results and 'most likely organism' while waiting for results
  - Certain antibiotics are reserved for serious infections
  - Therapeutic monitoring of drug levels may be required, e.g. with aminoglycosides
  - Synergistic combinations may be required in some infections, e.g. aminoglycoside, cephalosporin and metronidazole for faecal peritonitis
  - In serious infections seek advice from clinical bacteriologist
  - Barrier nursing and isolation of patients with methicillin-resistant *Staphylococcus aureus* or vancomycin-resistant enterococcus
- **Drainage** Surgical or radiological drainage is the most important treatment modality for an abscess

# Bacterial Virulence Factors

- **Exotoxins**

- Usually secreted by either Gram positive or Gram negative bacteria during growth phase
- Cause nonspecific death of many cell types

- **Endotoxins**

- Associated strictly with Gram <sup>-</sup> bacteria
- Released when the bacteria are lysed

- **Bacterial Proteases**

- Collagenases, elastase

# Bacterial Virulence Factors: Impact on Wound Healing

- Role in generalized tissue necrosis
- Role in stimulation of inflammatory mediators (TNF $\alpha$ , IL-1, IL-6)
  - with subsequent stimulation of MMP production by cells
  - and effects on growth factor and GF receptor expression
- Role in decreasing collagen deposition by fibroblasts
- Role in decreasing cell proliferation



# Summary

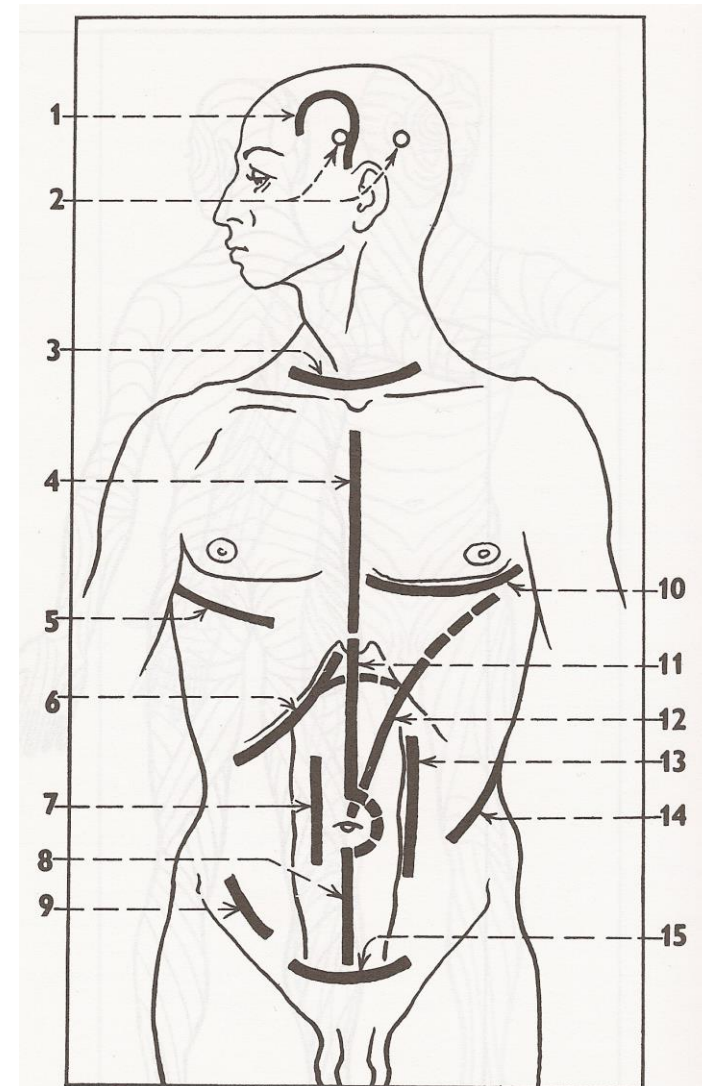
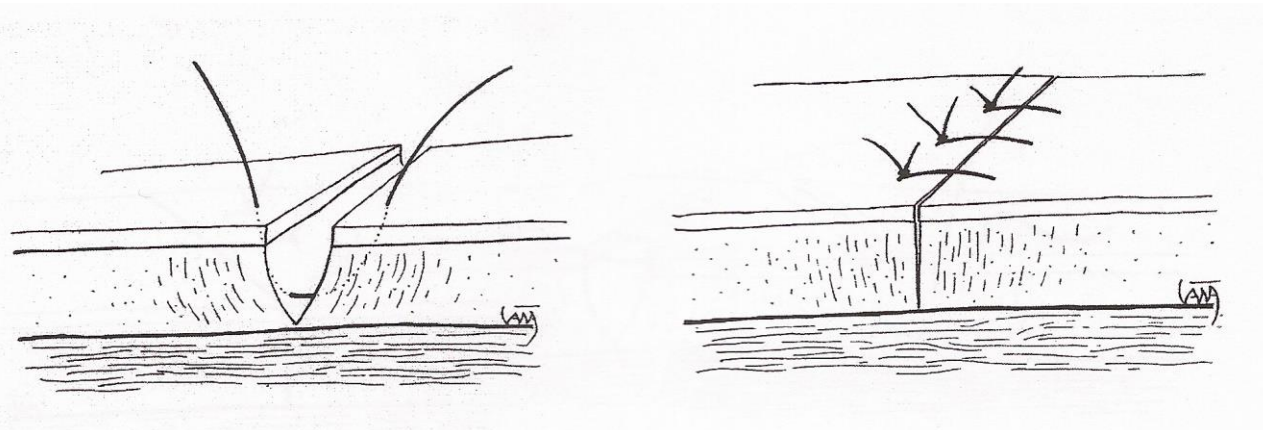
- **Bacteria can create a burden (negative effects) on wound healing even at low levels**
- **Clinical signs of increased bioburden are more subtle**
- **Topical antimicrobials have improved and have a place in wound management**
- **Silver is an effective topical antimicrobial agent and is not expected to cause resistance in the wound environment**

# Killing Bacteria in Wounds

- Topical Antimicrobials
  - Topical Antibiotics
  - Topical Antiseptics
- Systemic Antimicrobials
  - YES or NOT

# When the suture remove

- Head and face: 3–5 days
- Arms and hands: 7–10 days
- Chest: 7–10 days
- Abdomen: 7–10 days
- Lower limb/feet: 10–14 days



# Abdominal wound dehiscence

- Abdominal wound dehiscence is associated with substantial **morbidity and mortality**, especially in elderly or malnourished patients.
- Burst abdomen is a complication of abdominal surgery whose incidence has not changed appreciably over the past century.
- Predisposing, contributing and causative factors have long been recognized. In the majority of cases, lack of compliance with suture protocols, with inadequate knot and suture technique, are causative.



# Skin scarring

- Skin scarring is the normal endpoint of tissue repair, and scars generally develop after dermal injury.
- Individuals vary considerably in their potential for scarring.
- Scars may be **normal fine lines** or **abnormal scars**, which may be categorized as widespread (stretched), atrophic, hypertrophic, and keloid.
- Keloid (Greek κελοιδ, crab claw) scar formation is a complication of wound healing caused by excessive deposition of extracellular matrix at the wound site.
- Histologically, there is excessive production of collagen, fibroblasts and capillaries in the healing wound

# Surgical infection

- Despite ongoing prevention efforts, surgical site infections (SSIs) account for approximately 40% of hospital-acquired infections among surgical patients.
- Approximately 3% of surgical patients develop an infection postoperatively.
- These infections increase length of hospital stay and associated costs, significantly increase risk of ICU admission, and double the risk of mortality compared with surgical patients who do not develop an infection.
- SSI is a key surgical outcome indicator.

# Conclusion

- **Wound healing is a complex biological process that consists of hemostasis, inflammation, proliferation, and remodeling**
- **Large numbers of cell types**—including neutrophils, macrophages, lymphocytes, keratinocytes, fibroblasts, and endothelial cells—**are involved in this process.**
- **Multiple factors** can cause **impaired wound healing** by affecting one or more phases of the process and are categorized into local and systemic factors.
- The influences of these factors are not mutually exclusive. **Single or multiple factors may play a role in any one or more individual phases, contributing to the overall outcome of the healing process.**