INFLAMMATION

INFLAMMATION

- Inflammation is a reaction of living vascularized tissues to injury (response of living tissue to injury)
- It involves a well-organized cascade of vascular and cellular changes within living tissue

INFLAMMATION

. **AETIOLIGY:**

1. **Infectious (living) irritants: Bacteria & their toxins, viruses, fungi & parasites.**
2. **Physical irritants as heat, cold and radiation.**
3. **Chemical irritants as acids, alkalies.**
4. **Mechanical irritants as trauma.**
5. **Exposure to antigens leading to hypersensitivity reactions.**

General characteristics of inflammation :

- 1. The inflammatory process is redundant and complex.
- 2. The process is continuous over a period of time. Peracute, acute, subacute, and chronic.
- 3. Inflammation is caused by a stimulus and removal of the stimulus should result in abatement of inflammation. If it doesn't get fixed in the acute period, it becomes chronic.
- 4. Blood is the primary delivery system for inflammatory components.
- 5. Inflammation is on a continuum with the healing process.

Cardinal features:

- **Rubor (redness);**
- **Tumor (swelling);**
- **Calor (heat);**
- **Dolor (pain);**
- **Functio laesa (loss of function)**

INFLAMMATION

FUNCTION:

- **It represents a protective response aiming at:**

1. **Removal of the initial cause of injury (irritants as microbes or toxins).**
2. **Removal of the consequences of such injury (e.g. necrotic cells) (repair).**

ADVERSE EFFECTS:

1. **Pain.**
2. **Thrombosis (not in all condition).**
3. **Perforation of a viscous as in cases of appendicitis (not in all cases).**

Beneficial effects	Harmful effects
• Dilution of toxins • Entry of antibodies • Fibrin formation • Delivery of nutrients and oxygen • Stimulation of immune response	• Persistent cytokine release • Destruction of normal tissues • Swelling • Inappropriate inflammatory response

Systemic Effects of Inflammation

- ***Leukocytosis***
- ***Leukocytosis*** **is a common feature of inflammatory reactions. Leukocytosis means that there is an abnormally high number of circulating white blood cells**
- ***Fever***
- **Fever is coordinated by the hypothalamus and involves a wide range of factors.**
- **Bactereamia , Endotoxemia and Speticeamia**
- **Sepsis is the term used for disease due to toxic bacterial products circulating in the blood.**
- **Endotoxemia specifically refers to circulating gram-negative bacterial toxic products(LPS).**

Inflammatory reaction

- **1- TISSUE INJURY :**
  - **Degeneration and /or**
  - **Necrosis**
- **2. VASCULAR EVENTS**
  - ***Vasodilation***
  - ***And then increased Vascular permeability***
- **3. CELLULAR EVENTS**
  - **Cells move out of the vessels into the area of inflammation using *chemotaxis***
  - **Inflammatory cells become *activated* and then can *phagocytose* offending materials**

INFLAMMATION

TYPES:

1. **Acute inflammation: Rapid onset & short duration (days or weeks).**
2. **Chronic inflammation: Gradual onset & longer duration (several months or years).**
3. **Subacute inflammation: Grades of inflammation between acute and chronic.**

4- **peracute inflammation (no cl.signs)**

ACUTE INFLAMMATION

DEFINITION:

- **It is a type of inflammation characterized by rapid onset and short duration.**

LOCAL CHANGES IN ACUTE INFLAMMATION:

- **The following changes occur in the irritated tissue:**

1. **local tissue damage.**
2. **Release of chemical mediators.**
3. **local vascular changes.**

- I) At the site of injury, there are some degenerated and necrotic cells, accompanied by release of chemical mediators.

II) RELEASE OF CHEMICAL MEDIATORS

1) Definition:

- **Chemical substances that control the inflammatory response.**

2) Types of chemical mediators:

I) Cell-Derived Chemical Mediators:

1- **Vasoactive Amines:**

a) Histamine.

b) Serotonin.

2- **Arachidonic Acid Metabolites:**

a) Prostaglandins.

b) Leukotrienes.

3- **Cytokines**: 2 types.

a) Lymphokines: derived from lymphocytes (as interleukin-2 (IL-2)

b) Monokines: derived from monocytes as (TNF) and IL-1.

4- **Lysosomal enzymes** derived from neutrophils and macrophages.

5- **Platelet Activating Factor (PAF).**

CHEMICAL MEDIATORS

II)Plasma Factors:

1-Kinins as bradykinin.

2-Complement system, as C3a and C5a components.

III)Bacterial Products.

3) Effect Of Chemical Mediators:

1. **Vasodilatation.**
2. **Increased vascular permeability.**
3. **Chemotaxis.**
4. **Other effects as fever.**

III) LOCAL VASCULAR CHANGES

- **SEQUENCE (STEPS):**

1- Transient Vasoconstriction:

- **Due to irritation of the vessel wall → stimulation of the vasoconstrictor nerves. It lasts for seconds or minutes, followed by vasodilatation.**

2- Vasodilatation:

- **Caused by action of chemical mediators as histamine on vessel walls.**
- **The increased blood flow (hyperemia) → redness & hotness of the inflamed area (the flare phenomenon).**

LOCAL VASCULAR CHANGES

3- Increased Vascular Permeability & Formation of Exudate:

The mechanism includes:

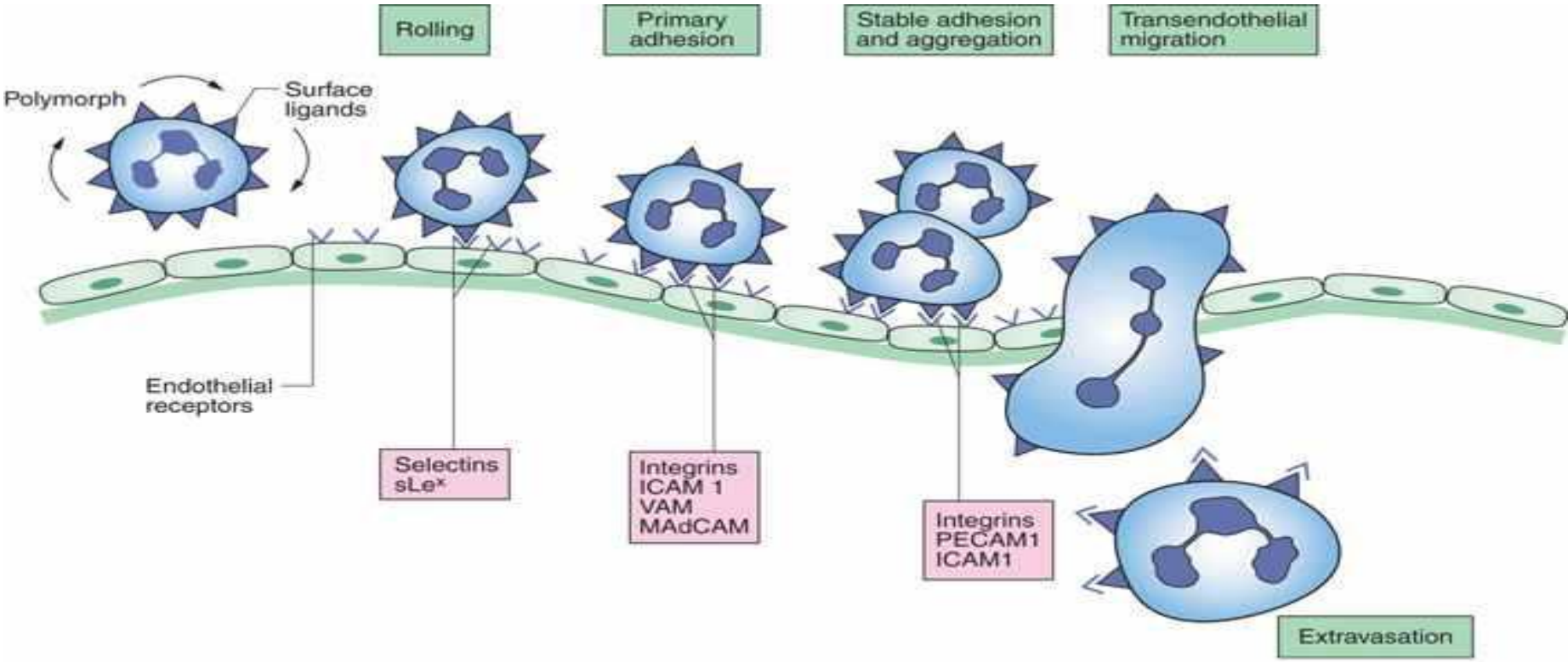
- **Endothelial cell contraction & retraction (be chemical mediators)→ widening of the intercellular junctions creating gaps between the endothelial cells.**
- **It leads to vascular leakage → fluid exudate (followed by cellular exudate).**

LOCAL VASCULAR CHANGES

4- Vascular Slowing (Stasis):

- **It is due to increased blood viscosity due to vascular leakage.**
- **It may have an adverse effect since vascular stasis can lead to thrombosis.**

Formation Of The Inflammatory Cellular Exudate



LOCAL VASCULAR CHANGES

2- Formation Of The Inflammatory Cellular Exudate:

Mechanism of formation:

a- Margination and Pavementing of Leucocytes:

b- Emigration of leucocytes (neutrophils &macrophages):

c- Passive escape of red cells (diapedesis):

d- Chemotaxis:

- **Definition**: It is the directed movement of emigrating leukocytes to the site of injury.
- **Aim:** phagocytosis of foreign particles as bacteria
-

e- Phagocytosis:

- **Definition: Phagocytosis is the process by which the phagocytic cells recognize then engulf abnormal particles such as bacteria, dead cells followed by their degradation.**

- **Mechanism of phagocytosis:**

a) **Recognition & attachment of bacteria (opsonisation):** Bacteria are coated by an opsonin which is an immunoglobulin or complement factor.

b) **Engulfment:** Phagocytic leukocytes surround the opsonised bacteria by pseudopodia. Fusion of pseudopodia → phagocytic vacuole (phagosome).

c) **Degradation:** Killing bacteria may be done through:

i) Oxygen dependent mechanisms: Formation of hydrogen peroxide or superoxide which are bactericidal.

ii) Oxygen-independent mechanisms: Lysosomes→ a powerful bactericidal activity.

LOCAL SIGNS & SYMPTOMS OF ACUTE INFLAMMATION

1- **Redness** due to vasodilatation & opening of capillary bed → increased blood flow.

2-**Hotness** due to increased blood flow. Redness & hotness are called flare.

3- **Swelling** due to accumulation of exudate (edema).

4-**Pain**.

5- **Loss of function**: due to pain and tissue damage.

FATE OF ACUTE INFLAMMATION

1- Resolution: This is return of the tissue to its normal state. It occurs when inflammation is limited and tissue damage is minimal.

2- Regression and healing: Inflammation subsides but there is tissue damage which is gradually repaired.

3- Progression and spread: With weak immunity, bacteria may spread:

- Direct spread.
- Lymphatic spread causing lymphangitis and lymphadenitis.
- Blood spread which may lead to serious effects as septicaemia.

4- Chronicity: This occurs if the injurious agent could not be eliminated completely.

TYPES OF ACUTE INFLAMMATION according to exudate

1- **Suppurative** (purulent, septic or pyogenic) inflammation: Characterized by pus formation.

- Suppurative inflammation may be:

  a) **Localized** as abscess, boil and carbuncle.

  b) **Diffuse** as cellulitis, suppurative appendicitis & diffuse septic peritonitis.

2- **Nonsuppurative** types:

a) serous **b) fibrinous**

c) serofibrinous **d) catarrhal**

e) granuloamtous **f) hemorrhagic**

g) necrotizing **h) allergic**

I – ACUTE SUPPURATIVE INFLAMMATION
(Septic, Purulent or Pyogenic Inflammation)

Definition:

- Acute inflammation characterized by pus formation.

Caused by:

- Pyogenic organisms as:

-Staphylococcus aureus.

-Streptococcus hemolyticus.

ACUTE SUPPURATIVE INFLAMMATION

Mechanism (Pathogenesis) Of Pus Formation:

- **Pyogenic organisms cause:**

  a) Remarkable tissue necrosis.

  b) Attraction of a huge number of neutrophils.

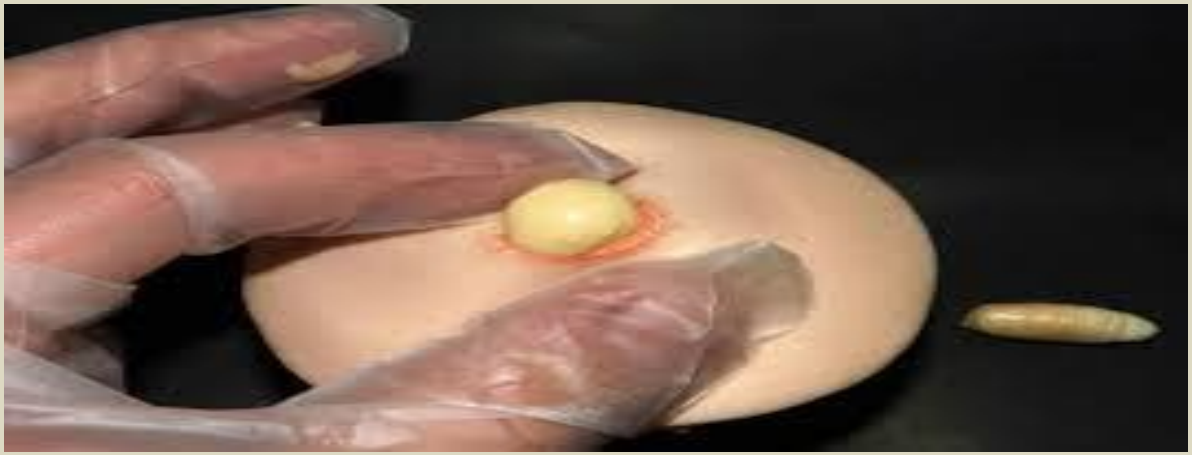
  c) Death of many neutrophils due to high virulence of the bacteria → pus cells

  d) Dead neutrophils (pus cells) release their proteolytic enzymes → liquefaction of necrotic tissue & fibrin.

- **The liquefied necrotic tissue mixed with pus cells & fluid exudate form a turbid creamy fluid called PUS.**

Acute **Suppurative** Inflammation

It is Characterized by pus formation.



ACUTE SUPPURATIVE INFLAMMATION

Types of suppurative inflammation:

1- LOCALIZED

-**Causative organism: Staphylococcus aureus**.

-**Why:** coagulase enzyme → fibrin deposition →localization.

-**Examples**: a) **Abscess.** b**) Boil (furuncle**). c) **Carbuncle.**

2- DIFFUSE

-**Causative organism: Streptococcus haemolyticus**.

-**Why:** hyaluronidase (spreading factor) & streptokinase (fibrinolysin) which dissolves fibrin.

-**Examples:** a) **Cellulitis.**

b) **Suppurative appendicitis.**

c) **Diffuse septic peritonitis**.

ABSCESS

4)Pathological features:

Early: two zones can be recognized:

a) A central zone of necrosis.

b) A peripheral zone of inflammation showing many neutrophils, pus cells, macrophages, dilated capillaries and fibrin.

Later: progressive liquefaction starts at the margin of necrotic tissue→ three zones:

a) A central necrotic core.

b) A mid zone of pus.

c) The peripheral zone of inflammation (now called the pyogenic membrane).

ABSCESS

Finally:

- The central necrotic core may disappear by further liquefaction and the abscess may enlarge if the bacteria cause further necrosis and liquefaction.

5-Fate of abscess:

a) **Small abscess**: Pus may be absorbed, followed by healing.

b) **Large abscess**: if not surgically incised → pointing & rupture (spontaneous evacuation) → healing.

ABSCESS

6)Complications of abscess:

1-Spread of infection:

a)**Direct spread** leads to abscess enlargement.

b)**Lymphatic spread** leads to lymphangitis and lymphadenitis.

c)**Blood spread** may lead to:

-**Toxaemia**: Bacterial toxins circulating in the blood.

-**Septicemia**: large numbers of virulent bacteria & their toxins circulating in blood. Commonly fatal.

-**Pyaemia**: Septic venous thrombi (septic thrombophlebitis) may develop close to the abscess. If these thrombi become fragmented → circulating septic emboli → multiple small abscesses in distant organs. These small abscesses are called pyemic abscesses and the whole process is called pyemia.

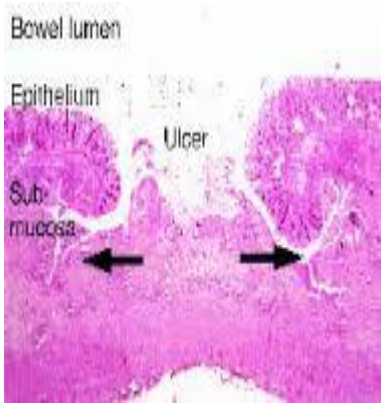
ABSCESS

2- Complications Of Evacuation And Healing:

a) Ulcer: It is a local defect within a surface (skin, mucosa...). It is due to separation of inflammatory necrotic tissue.

b) Sinus: It is a blind ended tract between a deep abscess and the surface.

c) Fistula: A tract communicating between two surfaces or hollow organs.



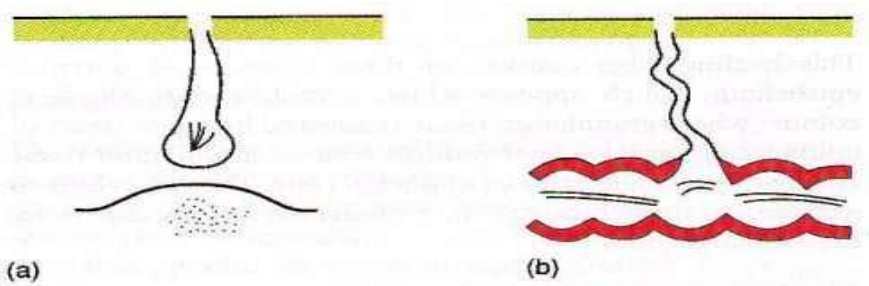
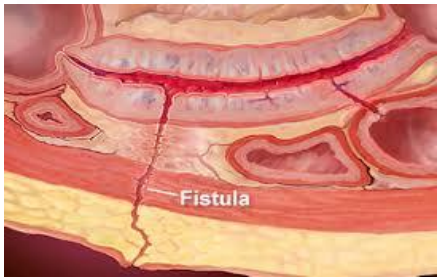


Fig. 12.18 (a) A sinus, and (b) a fistula. Both usually arise from a preceding abscess. (a) This shows that a sinus is a blind track, in this case a pilonidal sinus with its hairs; (b) this shows that a fistula is a track connecting two (epithelial) lined surfaces, in this case a colocutaneous fistula.



FURUNCLE (BOIL)

Definition:

- **Staphylococcal infection of the hair follicles (folliculitis).**

CARBUNCLE

Definition: A special type of localized suppurative inflammation characterized by multiple communicating deep subcutaneous abscesses, opening on skin by multiple sinuses.

ACUTE DIFFUSE SUPPURATIVE INFLAMMATION

CELLULITIS

1-Definition:

- Cellulitis is an acute diffuse suppurative inflammation.

ACUTE NON-SUPPURATIVE INFLAMMATION

Defintion:

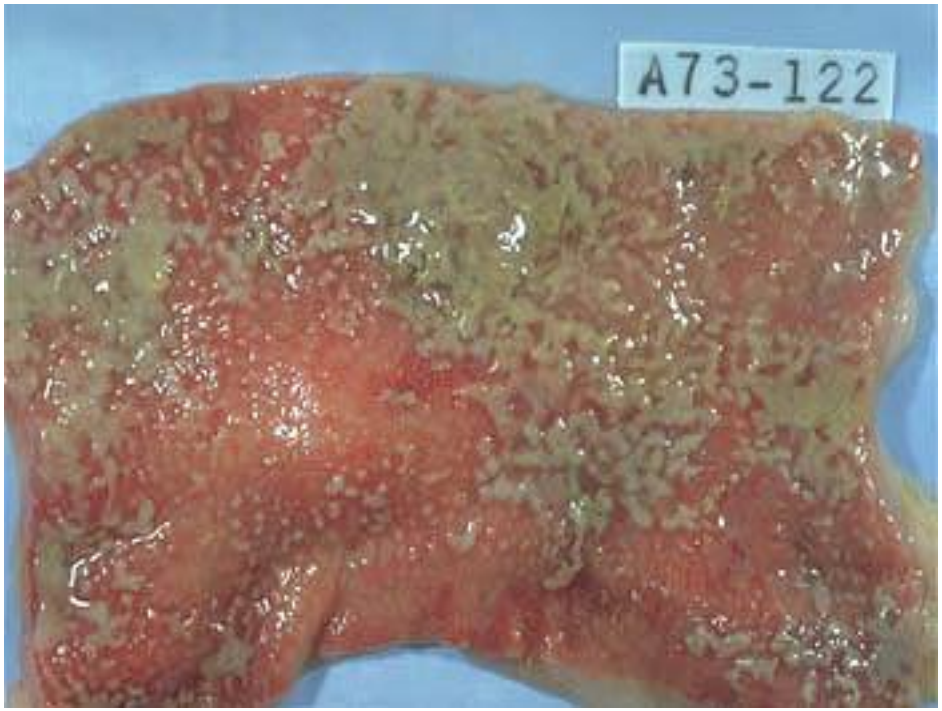
- **it is a type of acute inflammation NOT associated with pus formation.**

Types:

1. **Serous**
2. **Fibrinous**
3. **Serofibrinous**
4. **Catarrhal**
5. **Granulomatous**
6. **Hemorrhagic**
7. **Necrotizing**
8. **Allergic**

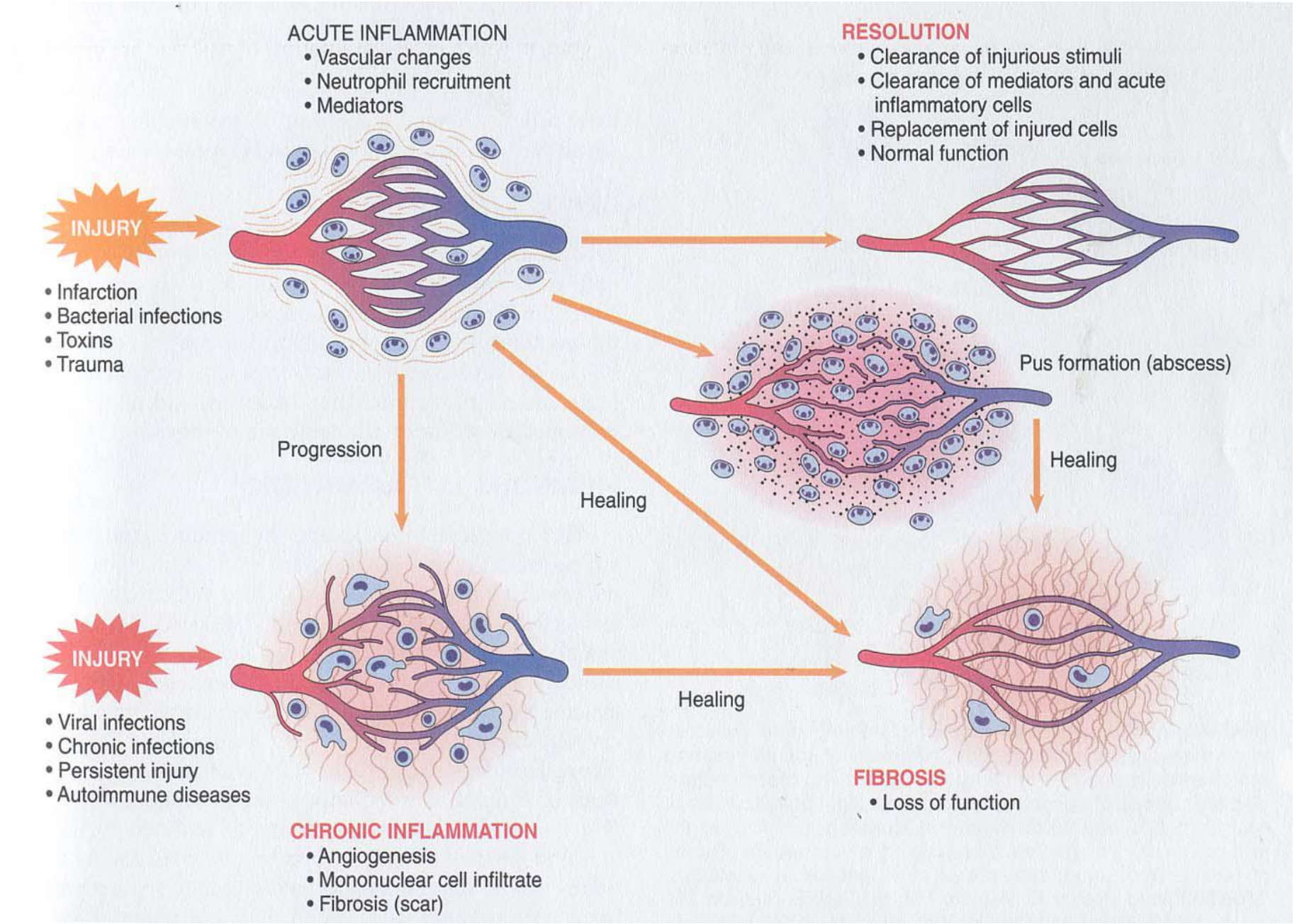
PSEUDOMEMBRANOUS INFLAMMATION

Fibrinous inflammation



Chronic inflammation

- Host response to an inciting stimulus that goes on for weeks or months
- ***Characteristics:***
  - Not usually red or hot (unlike acute inflammation)
  - Do not "ooze"
  - Productive or proliferative
  - Often present in infections with higher order organisms (mycobacteria, fungi, metazoan parasites) and in many autoimmune diseases
- ***Histologic appearance:***
- Primarily **mononuclear** cells involved
- **Fibroblasts** and new blood vessels, together called "**granulation tissue**"
- ***Granulomatous inflammation***
- Is always chronic
- Is composed predominantly of macrophages
- May have multinucleate giant cells – macrophages fuse


ACUTE INFLAMMATION
• Vascular changes
• Neutrophil recruitment
• Mediators
RESOLUTION
• Clearance of injurious stimuli
• Clearance of mediators and acute inflammatory cells
• Replacement of injured cells
• Normal function
INJURY
• Infarction
• Bacterial infections
• Toxins
• Trauma
Pus formation (abscess)
Progression
Healing
Healing
INJURY
• Viral infections
• Chronic infections
• Persistent injury
• Autoimmune diseases
Healing
FIBROSIS
• Loss of function
CHRONIC INFLAMMATION
• Angiogenesis
• Mononuclear cell infiltrate
• Fibrosis (scar)


THANK
YOU