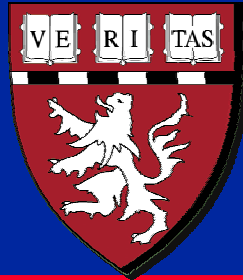


**Massachusetts Institute of Technology  
Harvard Medical School  
Brigham and Women's Hospital  
VA Boston Healthcare System**



**2.79J/3.96J/BE.441/HST522J**

**FORMATION OF SOFT TISSUE AND BONE  
AROUND IMPLANTS:  
The Chronic Response to Implants**

**I.V. Yannas, Ph.D. and M. Spector, Ph.D.**

# RESPONSE TO IMPLANTS: WOUND HEALING

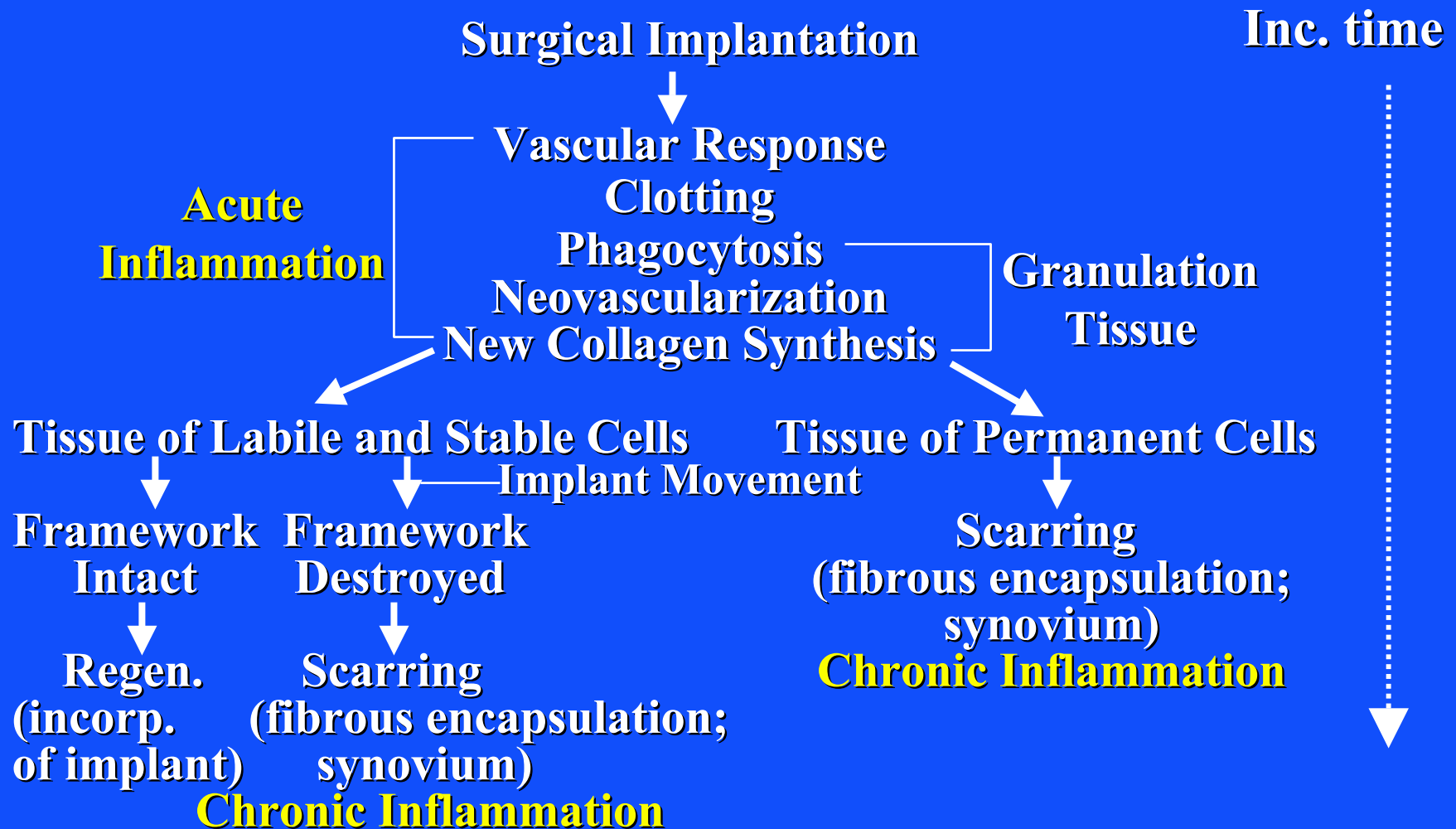


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**I. Metchnikoff**

**In 1923 a piece of glass was removed from a patient's back; it had been there for a year. It was surrounded by a minimal amount of fibrous tissue, lined by a glistening synovial sac, containing a few drops of clear yellow fluid.**

Photo removed due to copyright considerations.

**Smith-Peterson**

**J. Bone Jt. Surg.,  
30-B:59 (1948)**

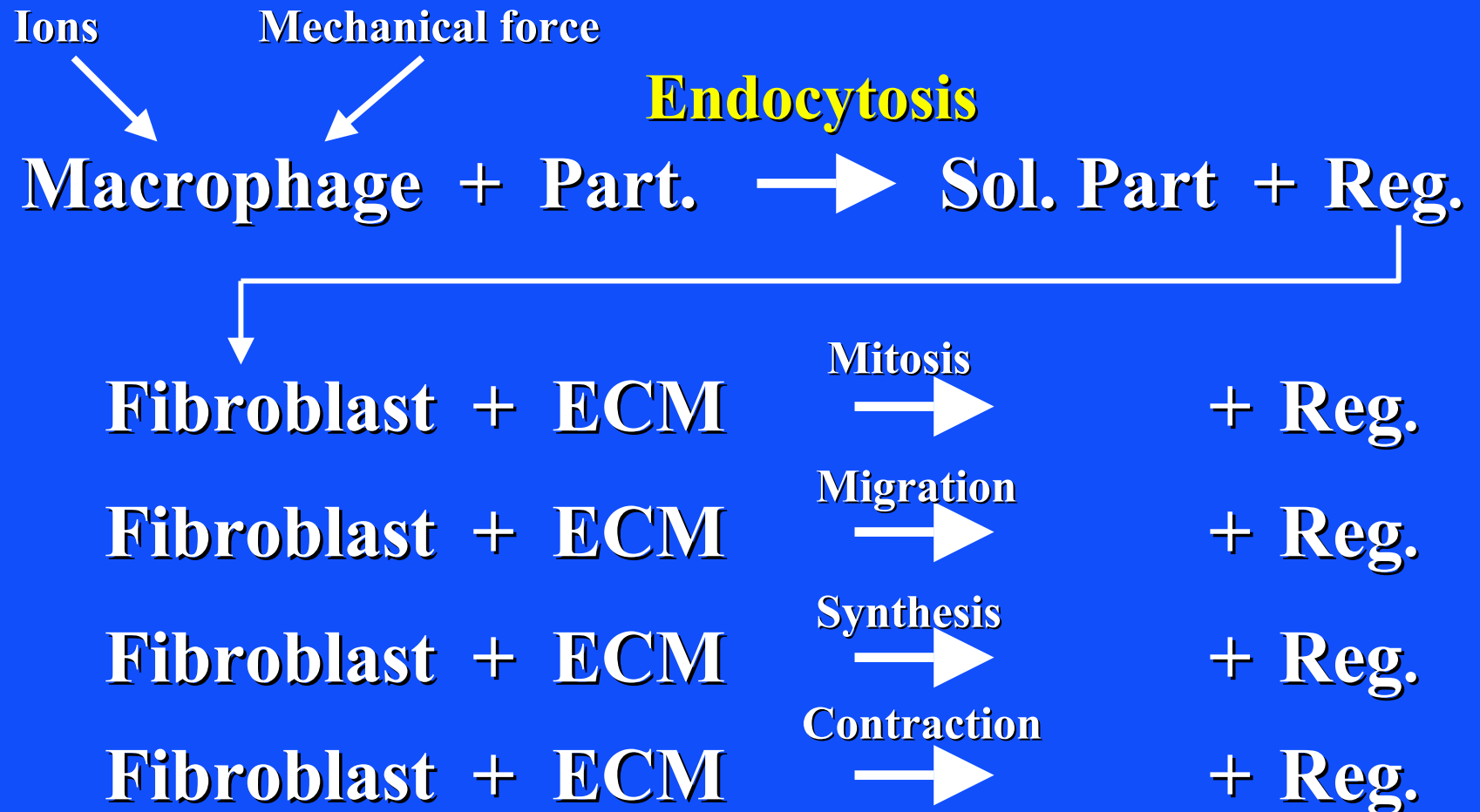
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# CHRONIC RESPONSE TO IMPLANTS

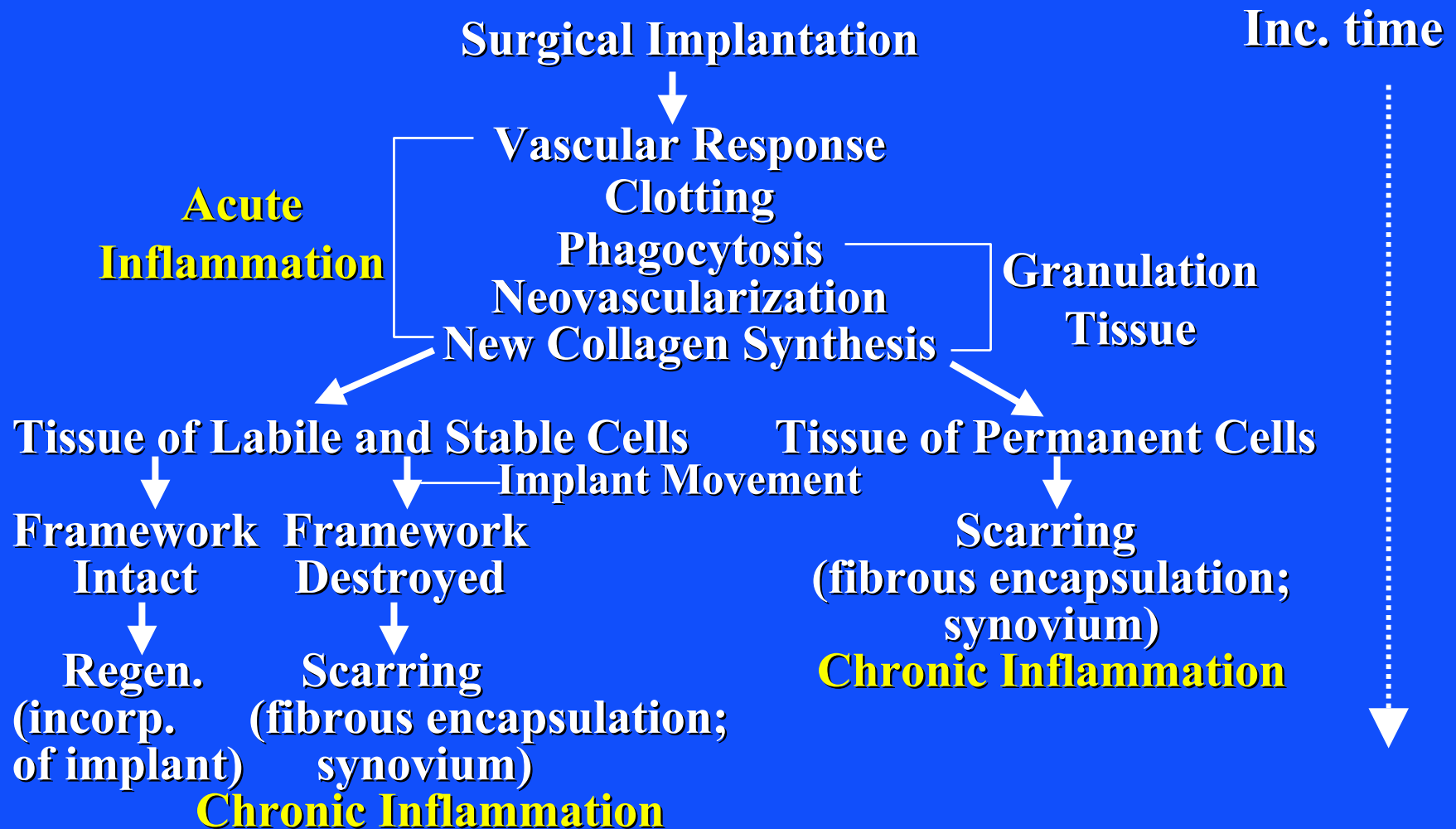
- Persistence of macrophages\* at the implant surface
- Presence of fibroblasts\*
- Proliferation and increased matrix synthesis of fibroblasts can result from mechanical perturbation by the implant or by agents released by the implant, leading to an increase in the thickness and density of the scar tissue.
- Fibroblast contraction can result in scar contracture.

\* Constituents of synovium

# MACROPHAGE AND FIBROBLAST INTERACTIONS IN SYNOVIUM



# RESPONSE TO IMPLANTS: WOUND HEALING





# **IMPLANT MATERIALS/BIOMATERIALS TISSUE RESPONSE**

## **Soft Tissue (that does not regenerate)**

- **Fibrous capsule (scar)**

**Synovium: fibrous tissue interspersed with  
macrophages**

**Wound healing response of repair (scar formation)  
coupled with macrophage accretion at the “dead  
space” - chronic inflammation**

## **Bone**

- **Tissue integration and tissue bonding**

# TISSUE INTEGRATION

## TISSUE BONDING

- **Tissue Integration (Osseointegration)**

Apposition of tissue (bone) to the implant (contact of bone with the surface but not necessarily bonding);  
no macrophage layer?

Regeneration of tissue up to the surface of the implant

- **Tissue Bonding (Bone Bonding)**

Chemical bonding of tissue (*viz.*, bone) to the surface

Protein adsorption and cell adhesion

Biomaterials: calcium phosphates and titanium (?)

# Dental Implant Designs and Materials

**Carbon**

**Titanium**

**Alumina**

Images removed due to copyright considerations.

**Carbon**

**Alumina**

**Alumina**

# Blade Implant

Photos removed due to copyright considerations.

**“Commercially pure”  
Titanium**

**Two-Stage Design;  
to shield the artificial  
root from loading  
during the initial  
stage of healing**

Images removed due to copyright considerations.

# Osseointegration

Images removed due to copyright considerations.

**T. Albrektsson, *et al.*, Ann. Biomed. Engr., 11:1 (1983)**  
**T. Albrektsson, CRC Crit. Rev. Biocompat., 1:53 (1984)**

# Osseointegration: Control of Surgical Trauma

Image removed due to copyright considerations.

**T. Albrektsson, CRC Crit. Rev.  
Biocompat., 1:53 (1984)**

# Implants with Porous Coatings in Bone

**Metal stem**

**Bone**

Image removed  
due to copyright  
considerations.

Image removed  
due to copyright  
considerations.

**Beaded porous coating**

Image removed  
due to copyright  
considerations.

**Bone**



# Hydroxyapatite-Coated Implants

Images removed due to copyright considerations.

**Plasma-sprayed  
HA coating, 40  $\mu\text{m}$  thick**

**3 hr**



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copyright considerations.

Image removed due to  
copyright considerations.

**Cylindrical  
implant in canine  
prox. femur**

**6 da**

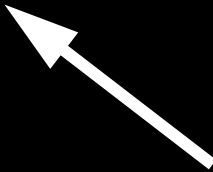
# **Plasma-Sprayed Hydroxyapatite Coating**

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copyright considerations.

**14 da**

Image removed due to  
copyright considerations.

**Bone regeneration in the gap  
between the implant surface  
and surrounding bone.**



# **Plasma-Sprayed Hydroxyapatite Coating**

## **14 days**

Photo removed due to copyright considerations.