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Y Drindod Dewi Sant
University of Wales
Trinity Saint David

‘TRANSFORMING EDUCATION, TRANSFORMING LIVES.....’

Daniel Martin
MSc BSc MHCP MCSP MAACP

Learning Outcomes

- Understand basic physical concepts of how injury occurs?
- Identify basic elements of the healing process
- Discuss the role of collagen in restoration and regeneration of tissue



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BASIC CONCEPTS

Elasticity

- Ability of an object to resume its former shape after a deforming force is applied then released. All substances contain some level of elasticity.

Stiffness

- Ability of an object to resist deformation when a stress is applied to it. Related to tensile strength.
Increased length of time under load reduces stiffness.



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Stress and Strain

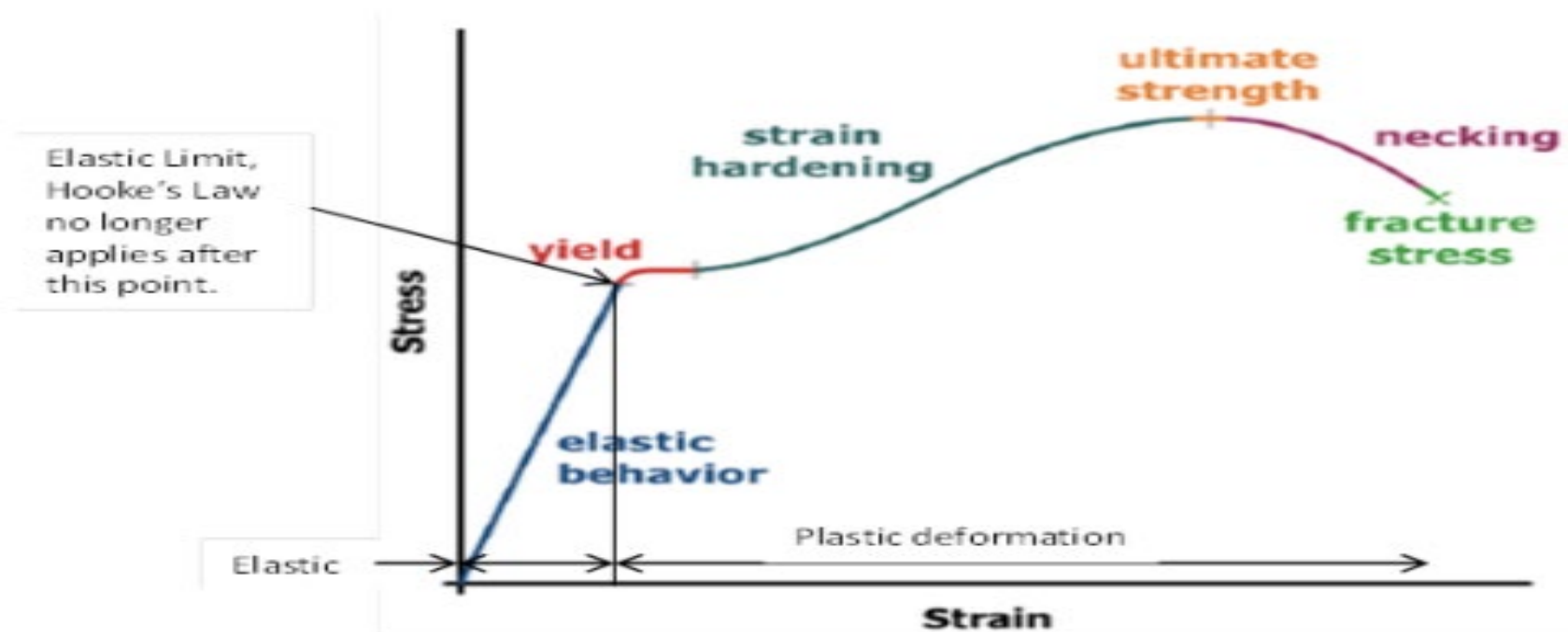
Hooke's Law

Stress = Force/ Cross-sectional Area

Strain = Extension/Original Length

E (Young's Modulus)= Stress/Strain

The greater the E value the stiffer the material



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BASIC CONCEPTS

Structural Fatigue

- This is the point at which the tissue or object can no longer withstand the stress. Can be sudden or produced over a long period.

Creep

- Low-level stress applied over a long period, that results in deformation of tissue in its plastic range



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TYPES OF FORCE

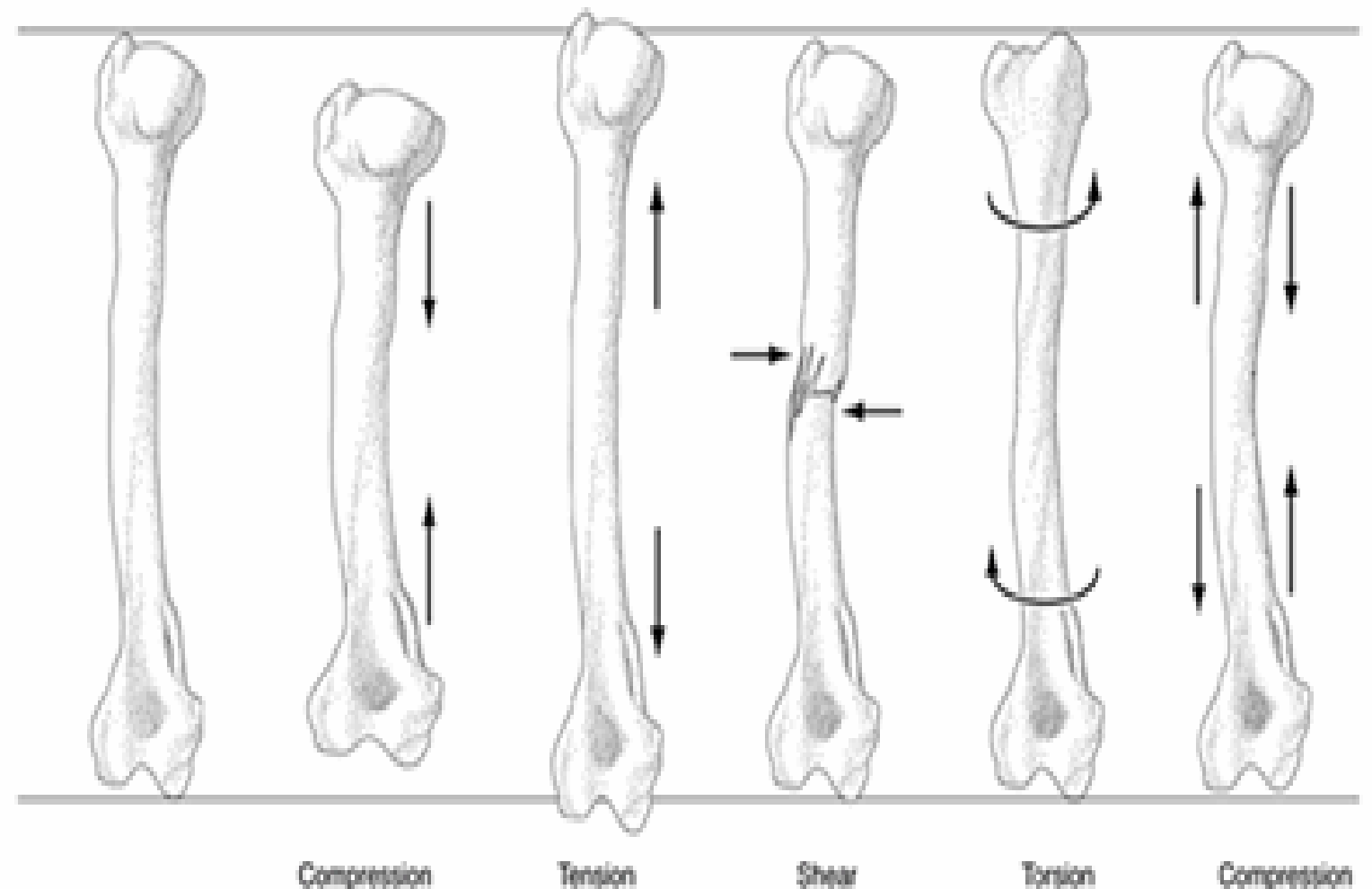
Compression

Tension

Shear

Torsion

Compression
& Bending + Torsion



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HEALING

PRIMARY INTENTION

Healing process is dependent on the extent of the injury and the approximation of the wound's stump ends.

SECONDARY INTENTION

Healing whereby the stump ends cannot be bridged and cells form across the affected area

How would the timescales differ for each healing process?



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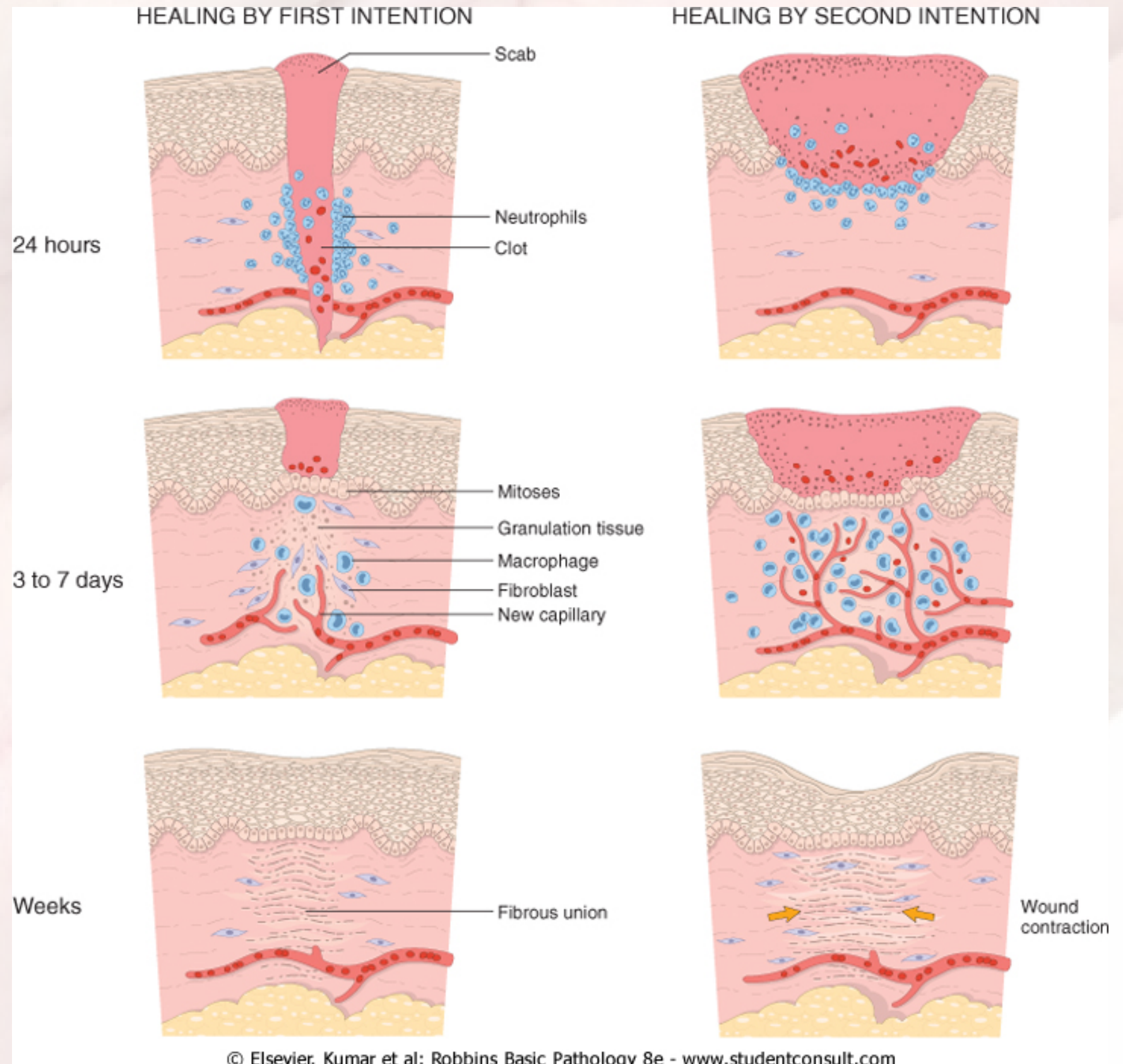
HEALING

By 1st intention:

- “clean” incision
- limited scarring or wound contraction

By 2nd intention:

- ulcers or lacerations
- often scarring and wound contraction

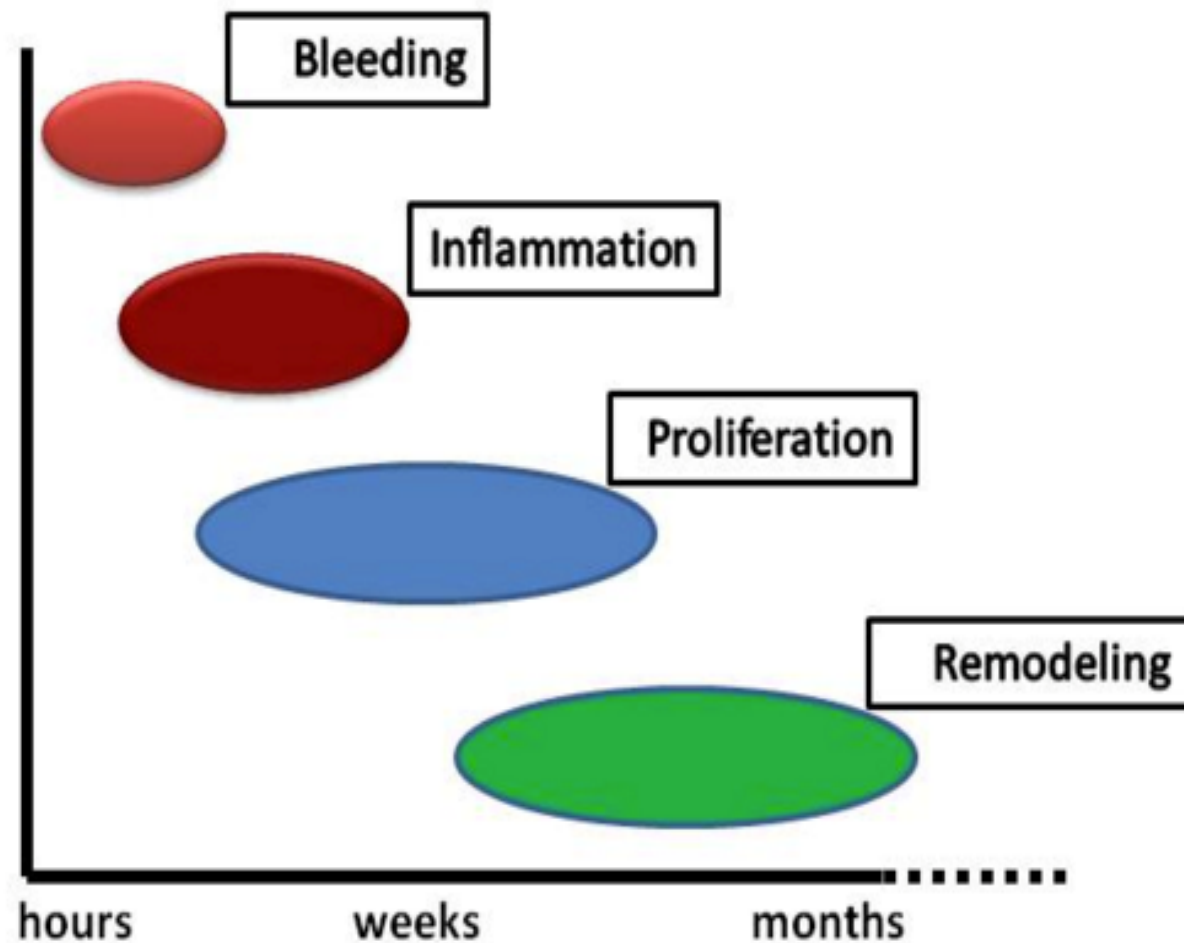


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HEALING PHASES

Phases of tissue healing



Overlap

Non Linear

Interdependent

Interact



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HEALING PHASES

Bleeding Phase

- Short lived
- Occurs following trauma
- Tissue dependent timescale for ceasation
- 4-6 hours is often quoted
- Crush injuries can take up to 24hrs or longer
- Initial phase of vasoconstriction
- Followed by vasodilation involving influx of Blood, Serum proteins, Clotting factors and Platelets



HEALING PHASES

Inflammatory Phase

- Essential component to healing
- Rapid onset (few hours), reaching maximal magnitude (1-3/7)
- Vascular tissues start and resolve quicker
- Split into vascular/ chemical and cellular effects



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HEALING PHASES

Vascular/ Chemical Effects

- Vasodilation
- Increased vascular permeability to allow important healing substances that are normally restricted to blood stream
- Initially histamine is released by platelets, Neutrophils/ granular leukocytes and mast cells
- Serotonin and other cytokines maintain the increased permeability, and are followed by Prostaglandins (PGE).
- PGEs attract leukocytes into the area and further the healing process



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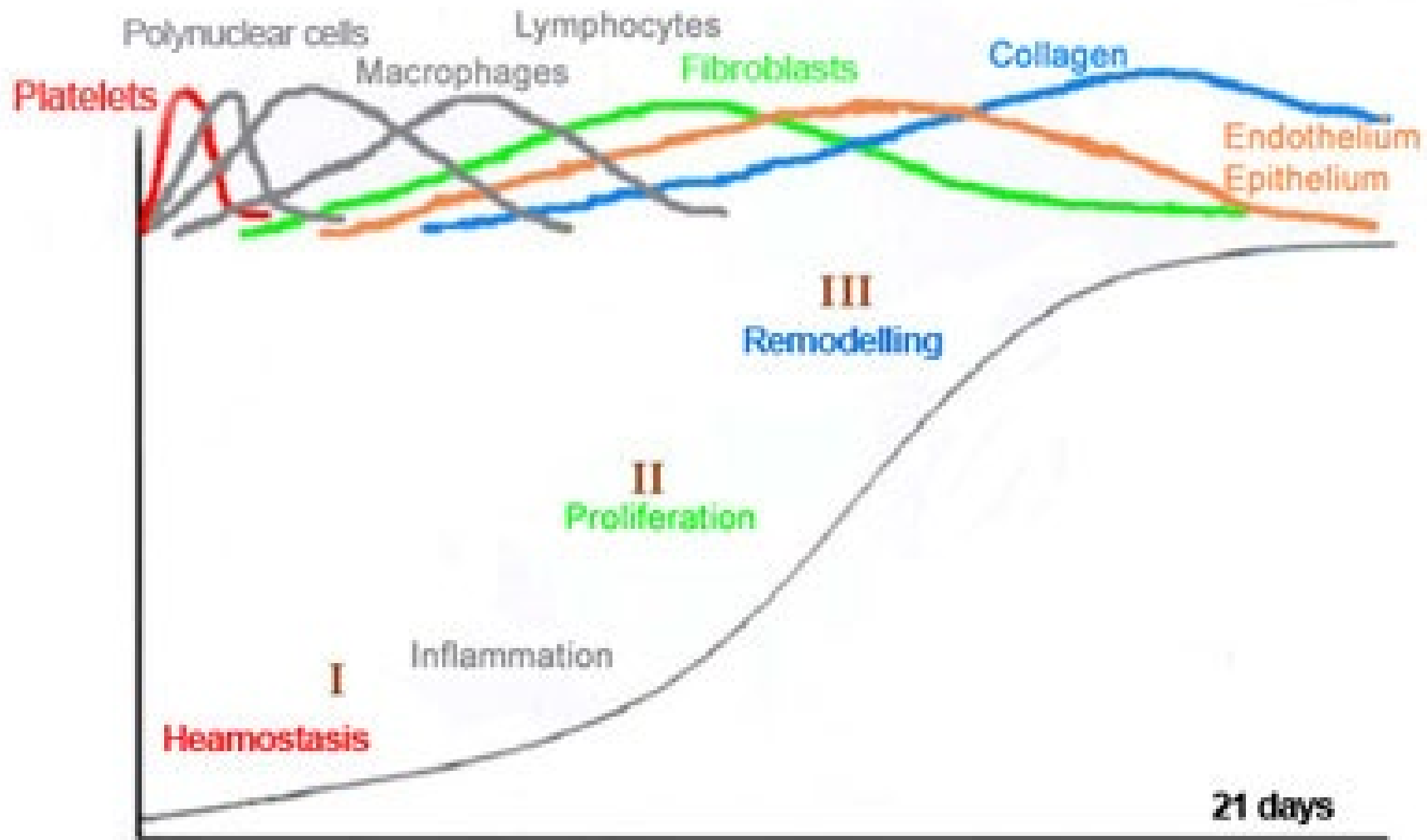
HEALING PHASES

Cellular Effects

- Platelets bind to the fibre stumps and start to form a lattice-like complex that acts like a plug (low strength)
- Normally lymph channels remove extracellular fluid but because of the plugs it can't until another enzyme comes into to facilitate draining of the oedema
- Neutrophils attempt to remove debris (5-6h)
- Neutrophils are replaced by monocytes and Macrophages and continue the clean up (24-48h)
- Macrophages are essential for clearing up waste and excess fluid, as well as releasing growth factors upon resolution of the healing process



HEALING PHASES



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HEALING PHASES

Proliferation Phase

- Macrophages removed debris
- Growth of new blood vessels
- Formation of granulation tissue

Fibroplasia

- Technical name for scar formation
- Growth factors released during inflammatory phase promote proliferation of endothelial cells & fibroblasts
- Characterized by increased number of fibroblasts and reduced number of Neutrophils.
- Fibroplasia is dependent on bodies ability to produce angiogenesis quickly.



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HEALING PHASES

Proliferation Phase

- Fibroblasts produce collagen that is a component of the extra-cellular matrix (ECM) along with elastin and reticulin (Fibrous elements). Ground substance (Glyco-amino glycans, proteoglycans) are non-fibrous elements of the ECM.

Angiogenesis

- New blood vessel growth produced by endothelial Cells.
- Important for collagen production (no O₂, no collagen)
- Strength of the scar is directly related to amount, type and arrangement of collagen.



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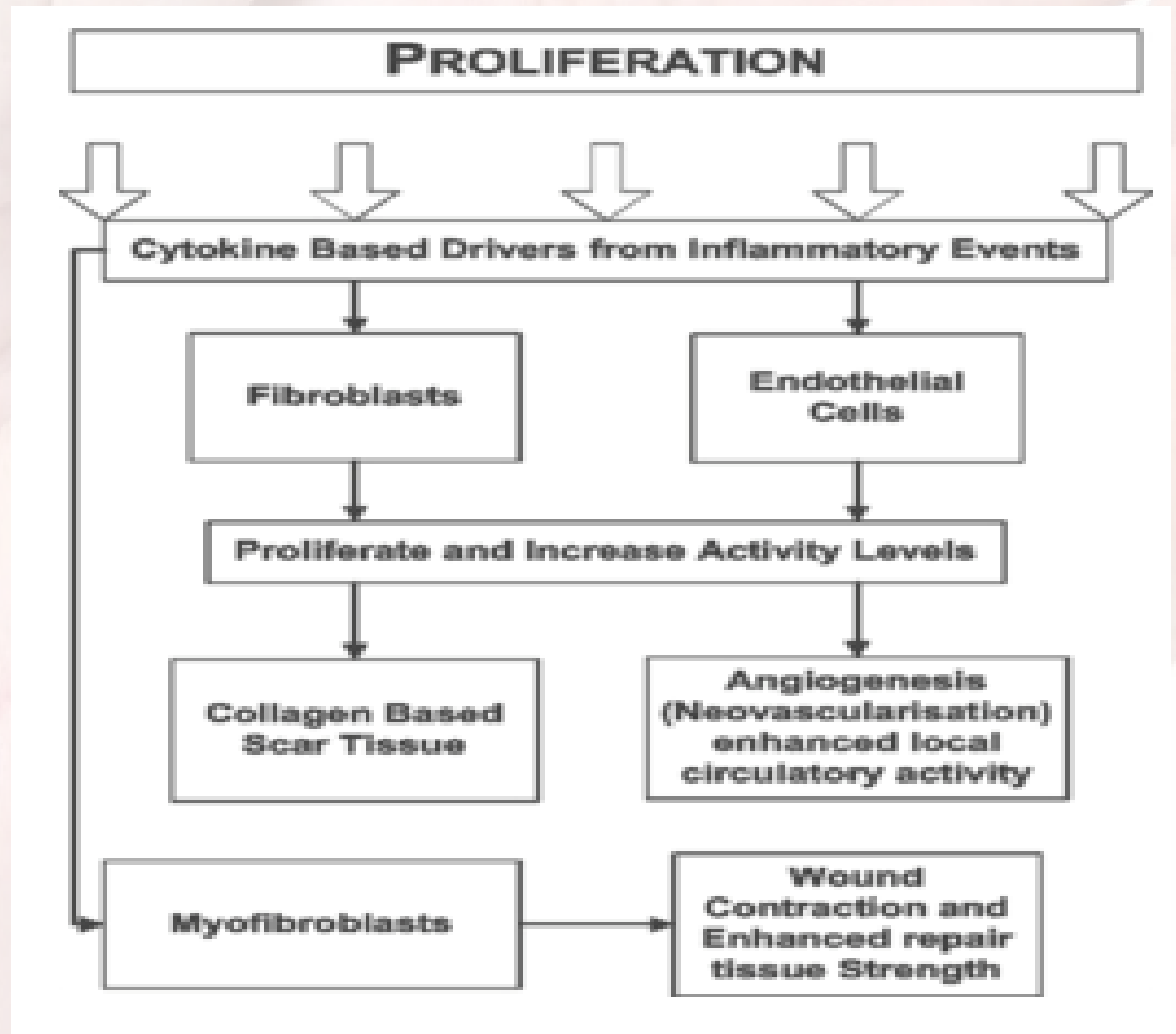
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HEALING PHASES



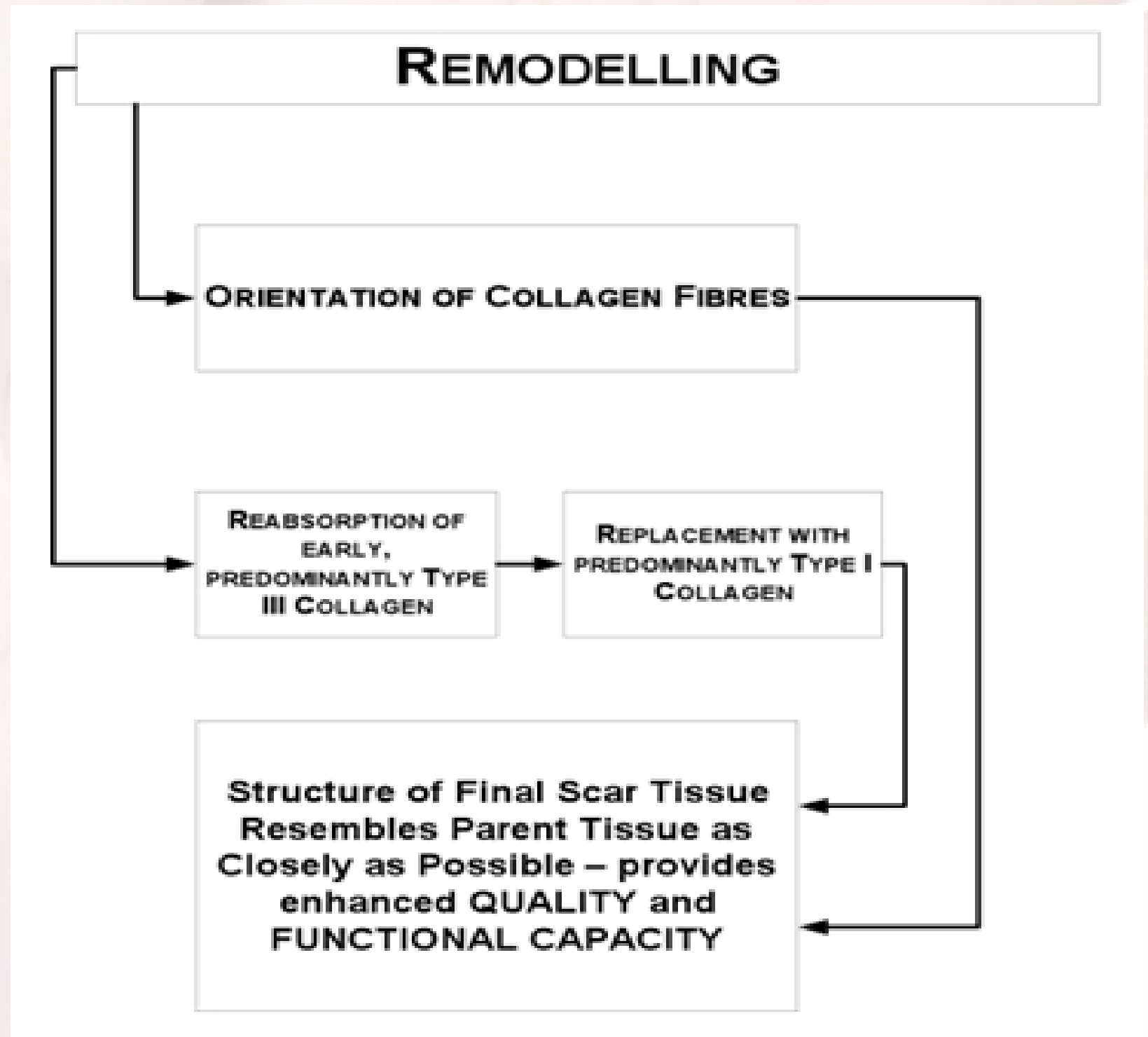
HEALING PHASES

Remodelling Phase

- Myofibroblasts continue the contracture of the wound edges (from 5/7 to 2/12).
- Aim is to produce tissue with similar mechanical capabilities to that of the previously injured structure
- Collagen reorganised in response to the stress that it is placed under thus giving it tensile strength in a given direction
- Initially Type III is laid down. Structurally weak
- As the scar matures it becomes stronger, with the Type III collagen being reabsorbed and Type I collagen replacing it.



HEALING PHASES



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SCAR TISSUE

Collagen

- Major structural protein
- Type I, II, III (80-90%)
- 28 Types
- Function – hold CT together

Tendon - Dense Regular Connective Tissue

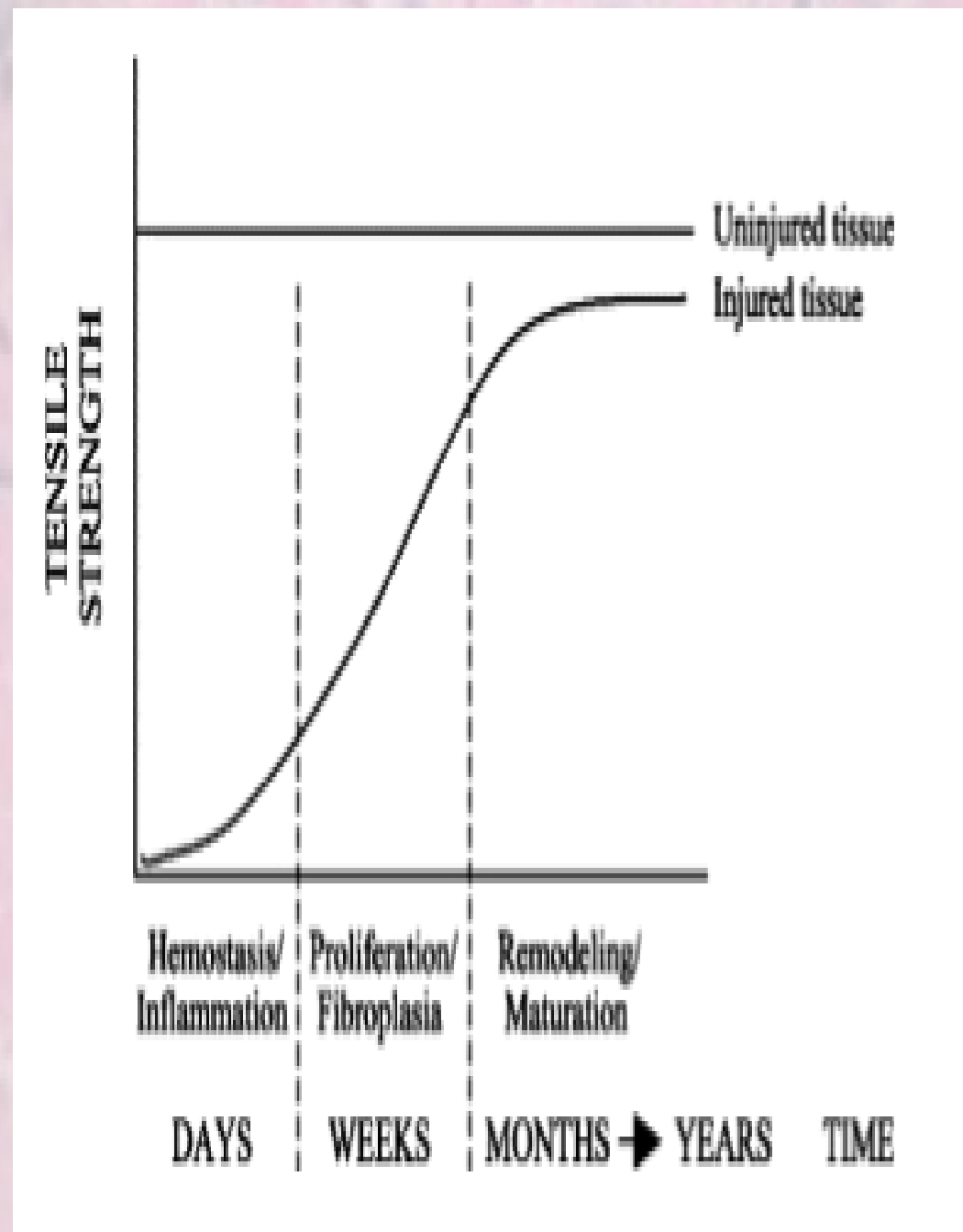
fibroblast nuclei between collagen I bundles



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SCAR TISSUE



Mechanical components of Collagen

Tendon - Dense Regular Connective Tissue

fibroblast nuclei between collagen I bundles



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SCAR TISSUE

Mechanical components of Collagen

Tendon - Dense Regular Connective Tissue

- Resists Mechanical deformation
- Load bearing components of CT
- Binds elastin
- Not able to cope with shear and compressive forces
- Arrange themselves to tolerate tensile loads

fibroblast nuclei between collagen I bundles



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TASK

Write a paragraph on your understanding of the inflammatory process and submit to TurnItIn.



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DAN's QUIZ

Questions

In which order does tissue repair occur?

Name one structure that is unable to regenerate/ repair?

List the vascular effects in the initial healing process?

How many types of collagen are there?

Name the main cell type that clean's debris away?

BONUS – other cells of the same family?



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