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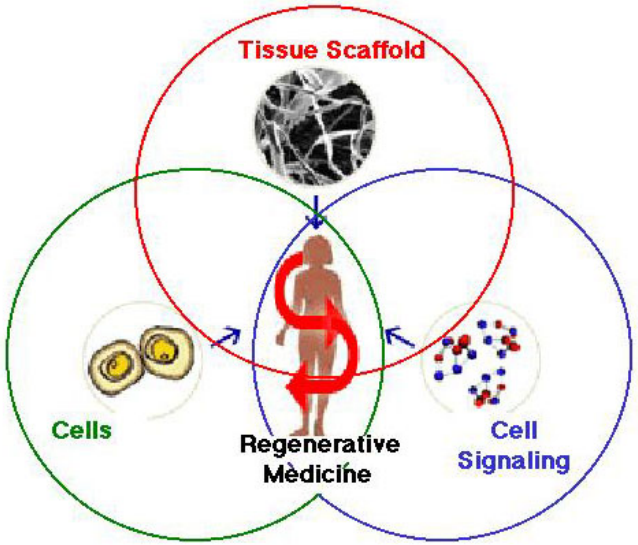
MIND MEDICAL INNOVATIONS DEVELOPMENT CENTER

Orthopaedic Tissue Engineering

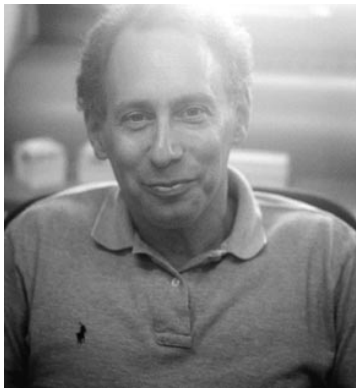


Tulyapruek Tawonsawatruk MD., PhD.

Orthopaedics

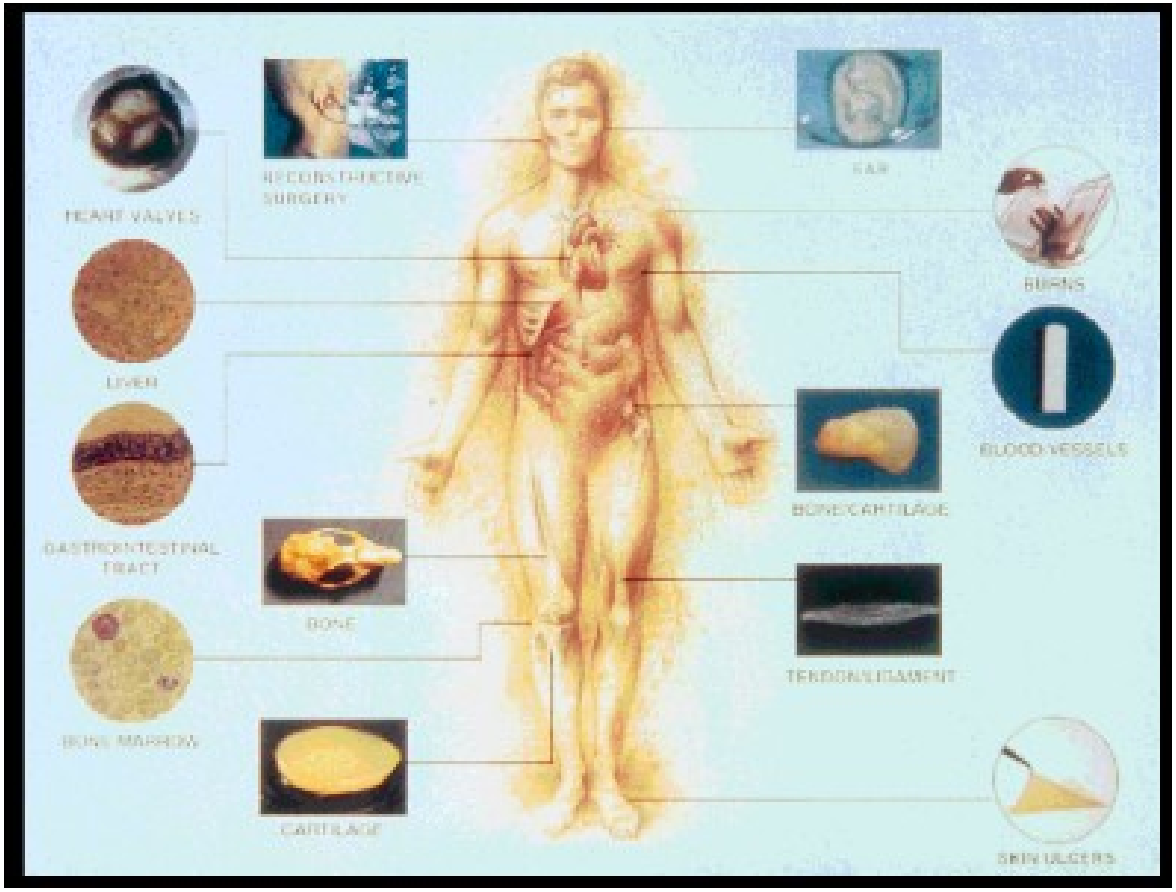
INTRODUCTION

"Tissue Engineering is an interdisciplinary field that applies the principles of engineering and life sciences toward the development of biological substitutes that restore, maintain, or improve tissue function or a whole organ"



Langer, R & Vacanti JP, Tissue engineering. Science 260, 920-6; 1993.

Some Fabricated Tissue Engineering Constructs



Need for Replacement

- Skin - 3 million procedures per year
- Bone - 1 million procedures per year
- Cartilage - 1 million procedures per year
- Blood Vessel - 1 million procedures per year
- Kidney - 600 thousand procedures per year
- Liver - 200 thousand procedures per year
- Nerve - 200 thousand procedures per year

Why Tissue Engineering?

....)

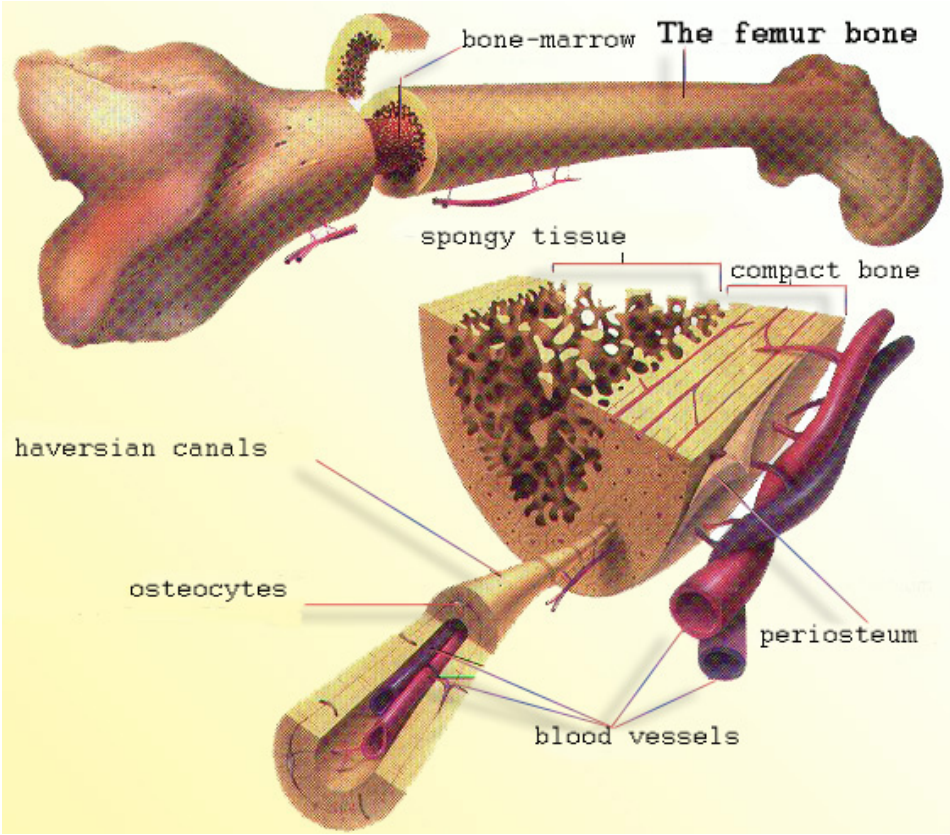
ear,

Tissue (Orthopaedics)

CARTILAGE

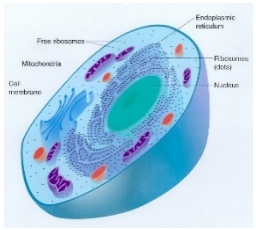
UCSD Cartilage Tissue Engineering Lab

BONE



3 Tools of Tissue Engineering

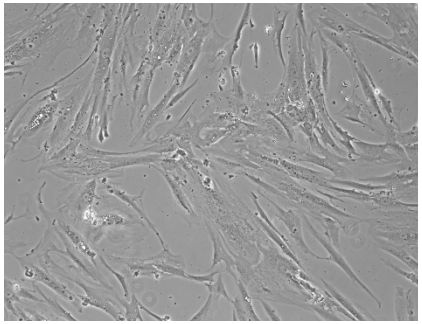
- Cells
  - Living part of tissue
  - Produces protein and provides function of cells
  - Gives tissue reparative properties

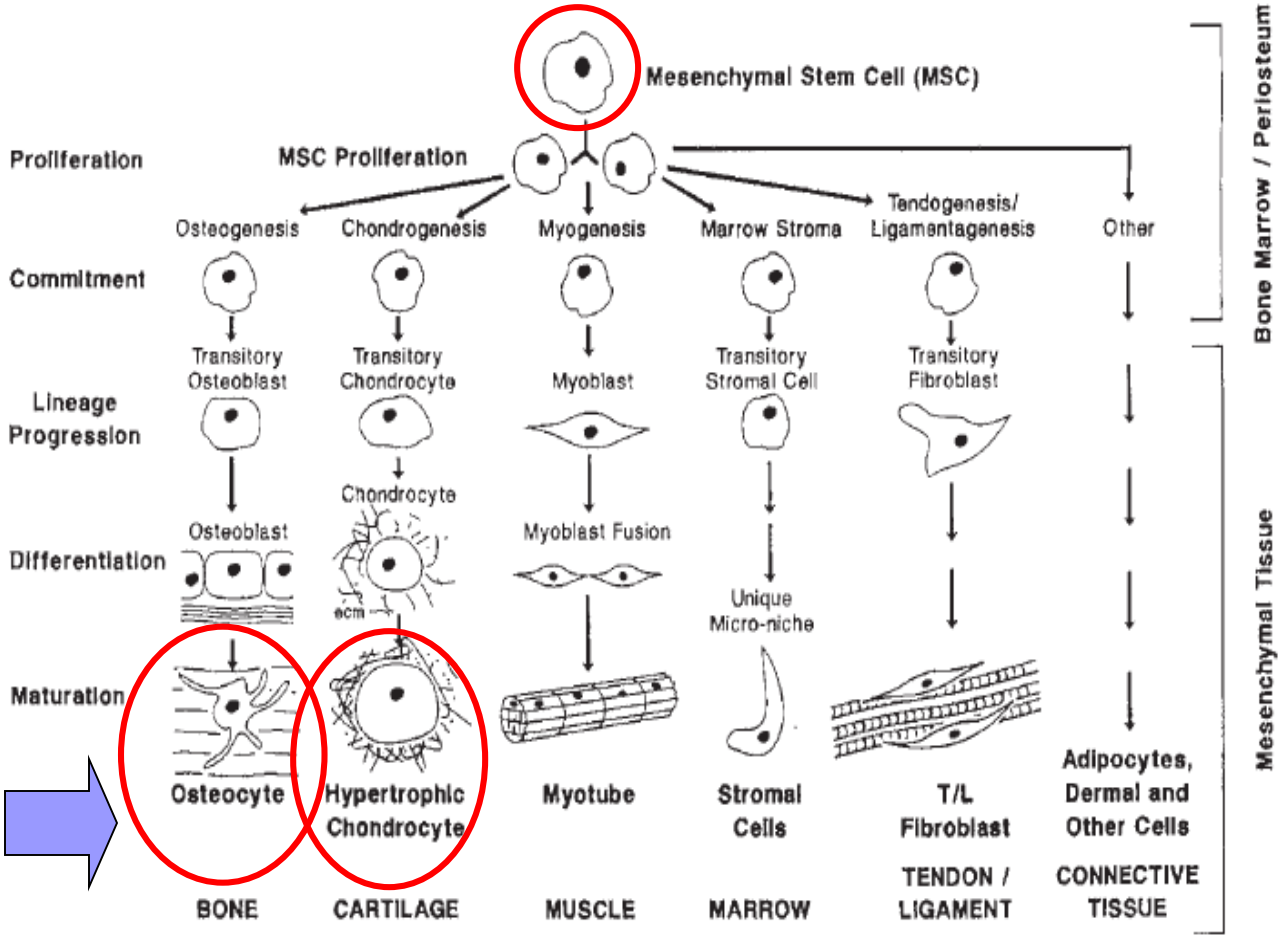


- Scaffold
  - Provides structural support and shape to construct
  - Provides place for cell attachment and growth
  - Usually biodegradable and biocompatible

- Cell Signaling
  - Signals that tell the cell what to do
  - Proteins or Mechanical Stimulation

Cells




Mesenchymal Stem Cell (MSC)
Proliferation
MSC Proliferation
Osteogenesis
Chondrogenesis
Myogenesis
Marrow Stroma
Tendogenesis/ Ligamentagenesis
Other
Commitment
Transitory Osteoblast
Transitory Chondrocyte
Myoblast
Transitory Stromal Cell
Transitory Fibroblast
Lineage Progression
Differentiation
Osteoblast
Chondrocyte
ecm
Myoblast Fusion
Unique Micro-niche
Maturation
Osteocyte
Hypertrophic Chondrocyte
Myotube
Stromal Cells
T/L Fibroblast
Adipocytes, Dermal and Other Cells
BONE
CARTILAGE
MUSCLE
MARROW
TENDON / LIGAMENT
CONNECTIVE TISSUE
Bone Marrow / Periosteum
Mesenchymal Tissue

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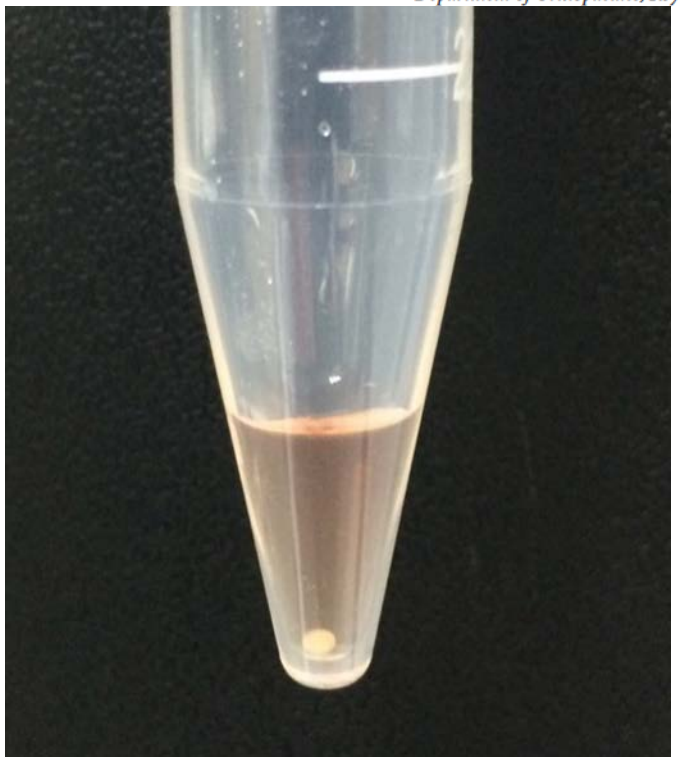
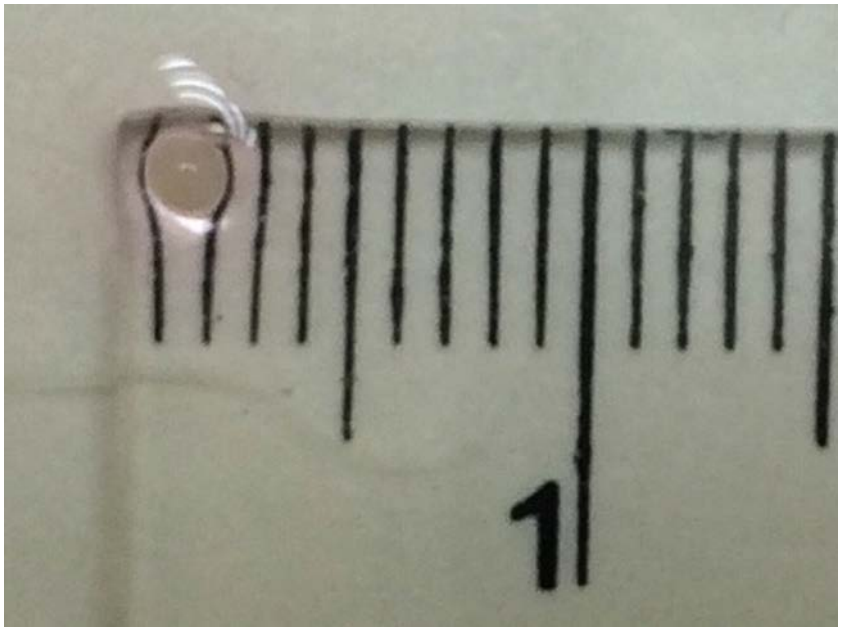
Research Article

Infrapatellar Fat Pad: An Alternative Source of Adipose-Derived Mesenchymal Stem Cells

P. Tangchitphisut,[1] N. Srikaew,[2] S. Numhom,[3] A. Tangprasittipap,[2] P. Woratanarat,[1] S. Wongsak,[1] C. Kijkunasathian,[1] S. Hongeng,[4] I. R. Murray,[5] and T. Tawonsawatruk[1]

[1]*Department of Orthopaedics, Faculty of Medicine, Ramathibodi Hospital, Bangkok 10400, Thailand*
[2]*Office of Research and Innovation, Ramathibodi Hospital, Bangkok 10400, Thailand*
[3]*Department of Surgery, Faculty of Medicine, Ramathibodi Hospital, Bangkok 10400, Thailand*
[4]*Department of Pediatrics, Faculty of Medicine, Ramathibodi Hospital, Bangkok 10400, Thailand*
[5]*Department of Orthopaedics, Royal Infirmary Edinburgh Hospital, Edinburgh University, Edinburgh, UK*





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SCIENTIFIC REPORTS

OPEN

Adipose derived pericytes rescue fractures from a failure of healing – non-union

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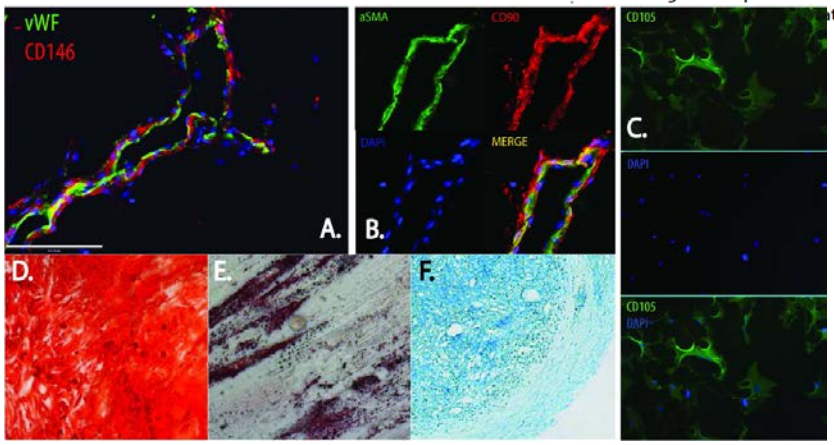
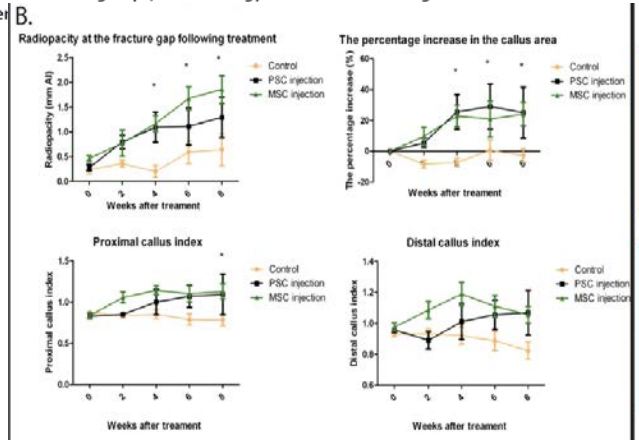
Accepted: 16 February 2016
Published: 21 March 2016

T. Tawonsawatruk[1,2,4], C. C. West[2,3], I. R. Murray[1,2], C. Soo[5,6,7], B. Péault[2,5] & A. H. R. W. Simpson[1]

Atrophic non-union is attributed to biological failure of the fracture repair process. It occurs in up to 10% of fractures, results in significant morbidity to patients, and treatment often requires complex reconstructive procedures. We tested the ability of human bone derived marrow mesenchymal stem cells (MSC), and human adipose derived pericytes (the native ancestor of the MSC) delivered percutaneously to the fracture gap to prevent the formation of atrophic non-union in a rat model. At eight weeks, 80% of animals in the cell treatment groups showed evidence of bone healing compared to only 14% of those in the control group. Radiographic parameters showed significant improvement over the eight-week period in the cell treatment groups, and histology confirmed bone bridges at



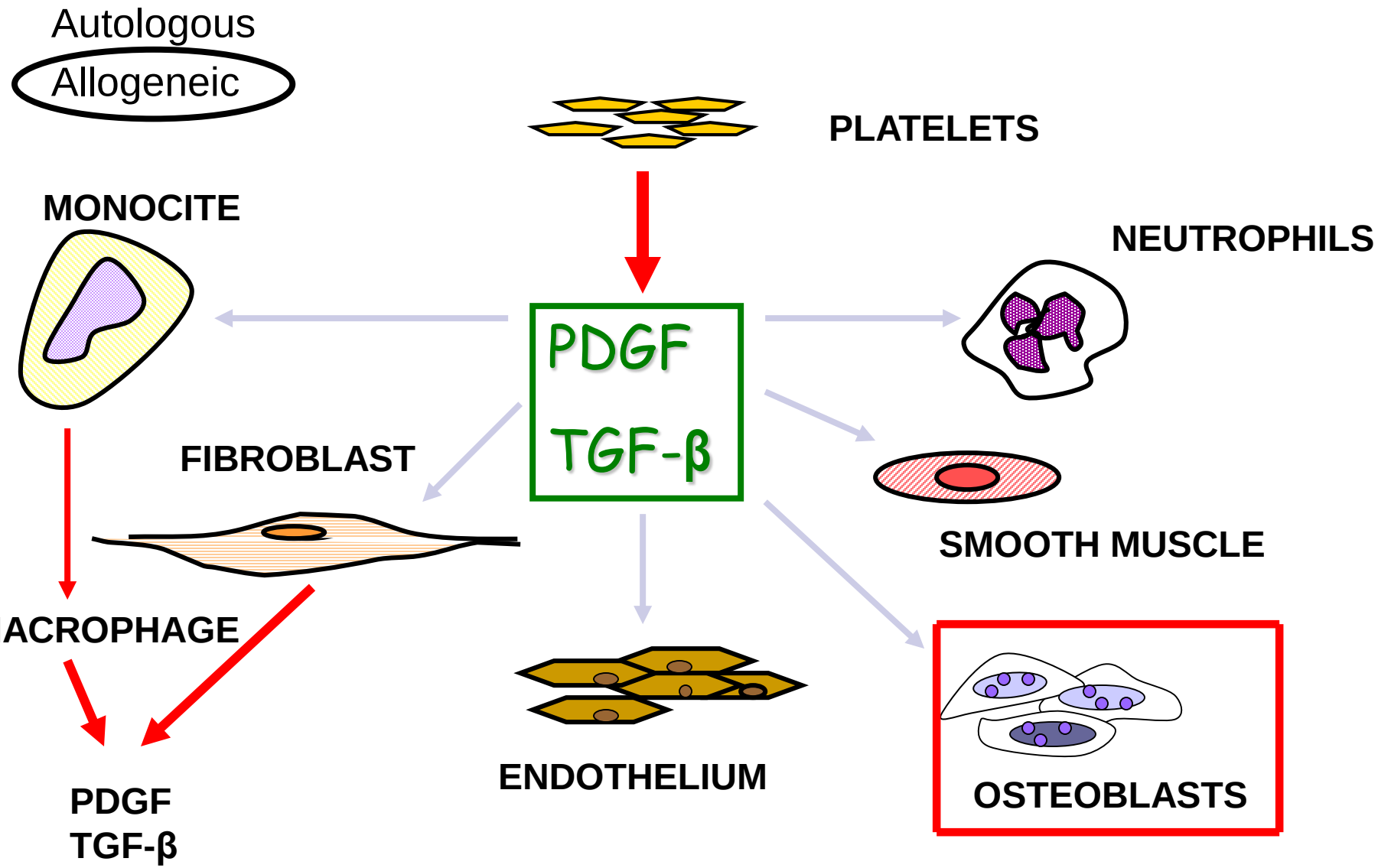


Promoting molecules

Growth and different factors

- The transforming growth factor-β (**TGF-β**) superfamily
  - Bone morphogenetic proteins
    (osteoprogenitors, mesenchymal cells, osteoblasts and chondrocytes within the extracellular matrix produce **BMPs**.)
    BMP-2, BMP-4
    BMP-5, BMP-6, **BMP-7**
    GDF-5 (BMP-14), GDF-6 (BMP-13), GDF-7 (BMP-12)
    BMP-3 (Osteogenin), GDF-10 (BMP-3b)
- Platelet-derived growth factor (**PDGF**)
- Fibroblast growth factor (**FGFs**)
- Insulin-like growth factor (**IGFs**)

Platelet rich plasma (contains high concentrations of growth factors) especially TGF-B and PDGF



BJR

RESEARCH

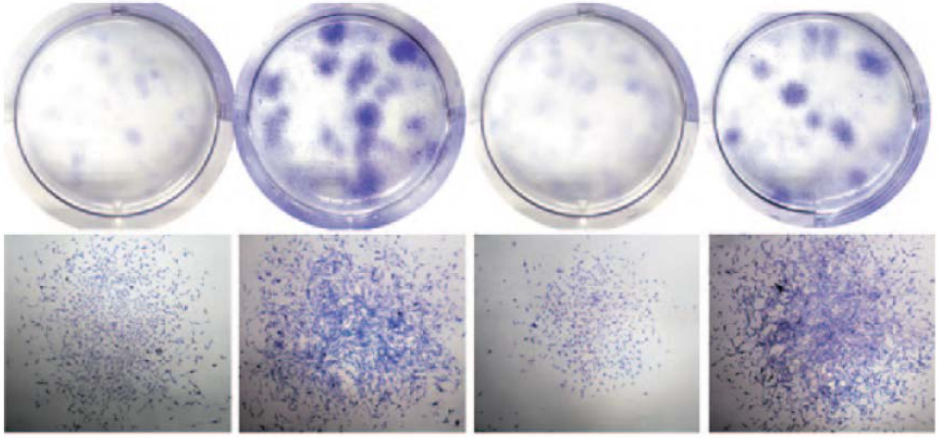
Re-using blood products as an alternative supplement in the optimisation of clinical-grade adipose-derived mesenchymal stem cell culture

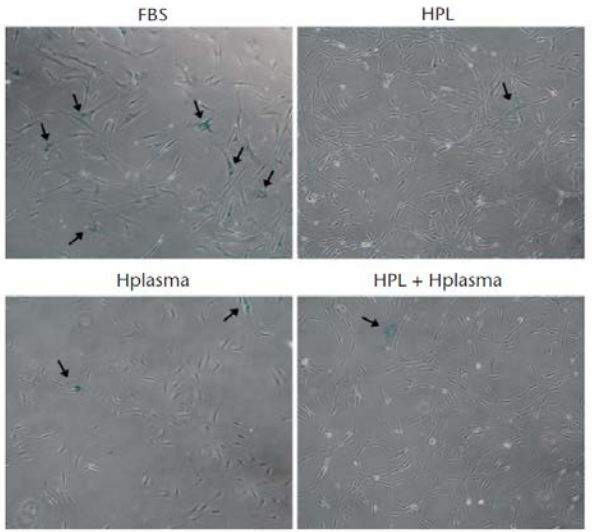
J. Phetfong,
T. Tawonsawatruk,
K. Seenprachawong,
A. Srisarin,
C. Isarankura-Na-Ayudhya,
A. Supokawej

Faculty of Medical

Objectives

Adipose-derived mesenchymal stem cells (ADMSCs) are a promising strategy for orthopaedic applications, particularly in bone repair. *Ex vivo* expansion of ADMSCs is required to obtain sufficient cell numbers. Xenogenic supplements should be avoided in order to minimise the risk of infections and immunological reactions. Human platelet lysate and human plasma may be an excellent material source for ADMSC expansion. In the present study, use of blood products after their recommended transfusion date to prepare human platelet lysate (HPL) and human plasma (Hplasma) was evaluated for *in vitro* culture expansion and osteogenesis of ADMSCs.





Platelet-rich plasma versus corticosteroid injection for recalcitrant lateral epicondylitis: clinical and ultrasonographic evaluation

VK Gautam,[1] Saurabh Verma,[1] Sahil Batra,[1] Nidhi Bhatnagar,[2] Sumit Arora[1]
[1] Department of Orthopaedic Surgery, Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi, India
[2] Department of Radiology, Sanjeevan Hospital, Delhi, India

Studies of platelet-rich plasma (PRP) versus corticosteroid (CS) injection for lateral epicondylitis

Studies	No. of patients	Follow-up	Re-intervention	Improvement in outcome (PRP vs. CS)
Peerbooms et al.,[23] 2010	51 PRP vs. 49 CS	1 year	-	Visual analogue scale (VAS) for pain (25–73% vs. 49%), Disabilities of the Arm, Shoulder and Hand Scale (DASH) score (25–73% vs. 51%)
Gosens et al.,[24] 2011	51 PRP vs. 49 CS	2 years	6 vs. 14	VAS for pain (25–77% vs. 43%), DASH score (25–73% vs. 39%)
Krogh et al.,[25] 2013	20 PRP vs. 20 CS vs. 20 saline	3 months	-	CS is superior to PRP at one month, but no significant difference at 3 months; decrease in tendon thickness after CS and increase in thickness after PRP
Current study	15 PRP vs. 15 CS	6 months	-	VAS for pain (77% vs. 59%), DASH score (54% vs. 41%), modified Mayo score (26% vs. 8%), Oxford Elbow Score (50% vs. 16%), hand grip strength (40% vs. 21%)

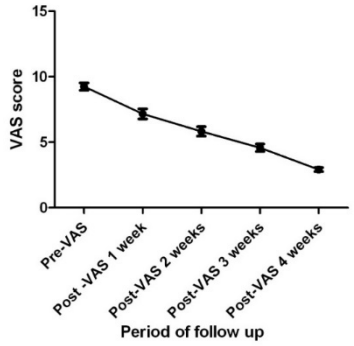
Functional Outcomes of Ultrasound guided Platelet Rich Plasma Injection in Recalcitrant lateral epicondylitis after Steroid Injection: Case Series

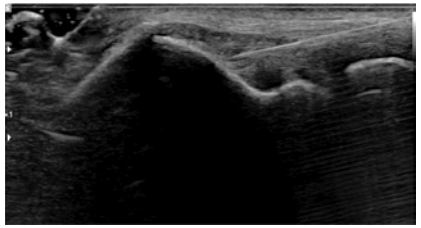
Tulyapruek Tawonsawatruk MD, PhD, Panithan Tuntiyatorn MD, Thepparat Kanchanathepsak MD, Ittirat Watcharananan MD

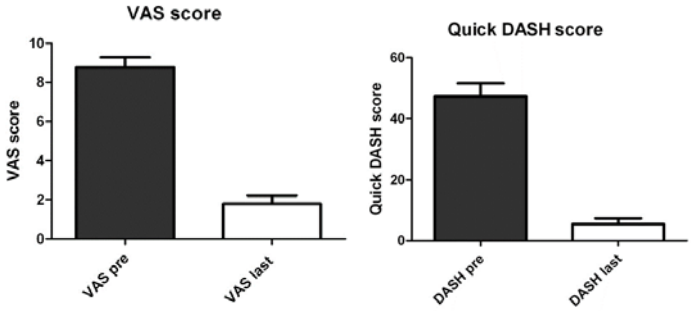
Department of Orthopaedics, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

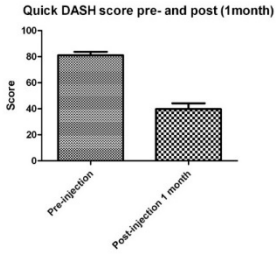
Email: Tulyapruek@gmail.com

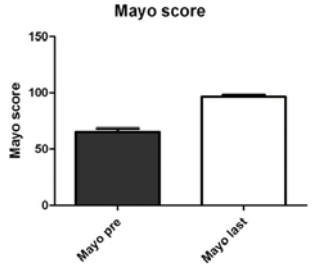
VAS score follow the period 1 month after injection







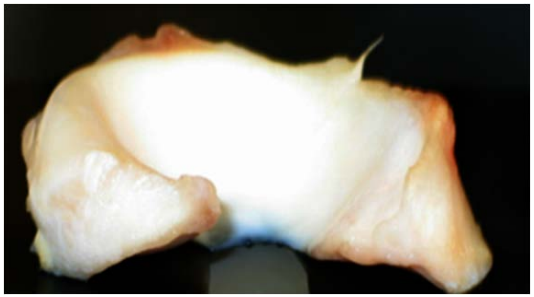


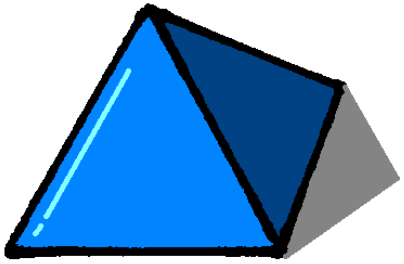


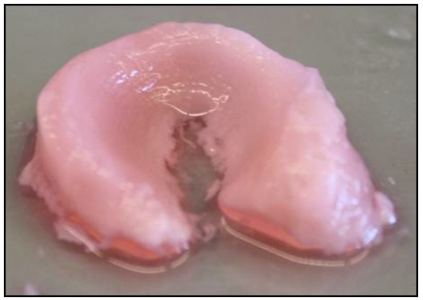
T Tawonsawatruk. Manuscript Accepted

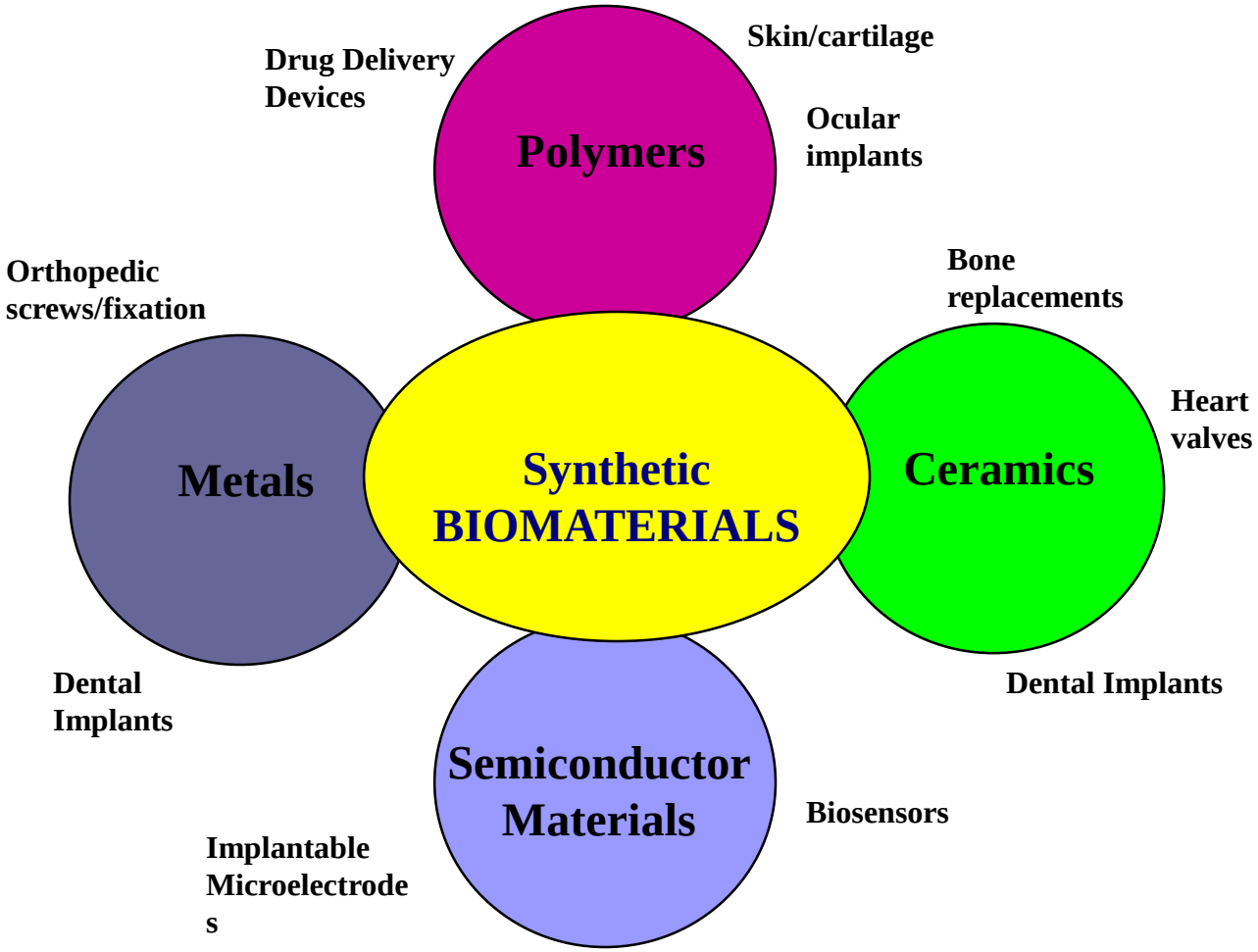
What do we want in a scaffold?

1. Biocompatible
2. Biodegradable
3. Chemical and Mechanical Properties
4. Proper architecture





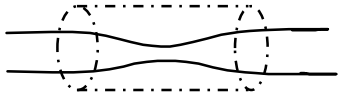



Drug Delivery Devices
Skin/cartilage
Polymers
Ocular implants
Orthopedic screws/fixation
Bone replacements
Metals
Synthetic BIOMATERIALS
Ceramics
Heart valves
Dental Implants
Dental Implants
Semiconductor Materials
Biosensors
Implantable Microelectrodes

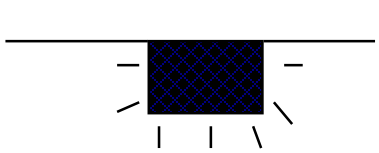
Biomaterials for Tissue Replacements

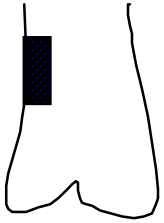
- Bioresorbable vascular graft

- Biodegradable nerve guidance channel



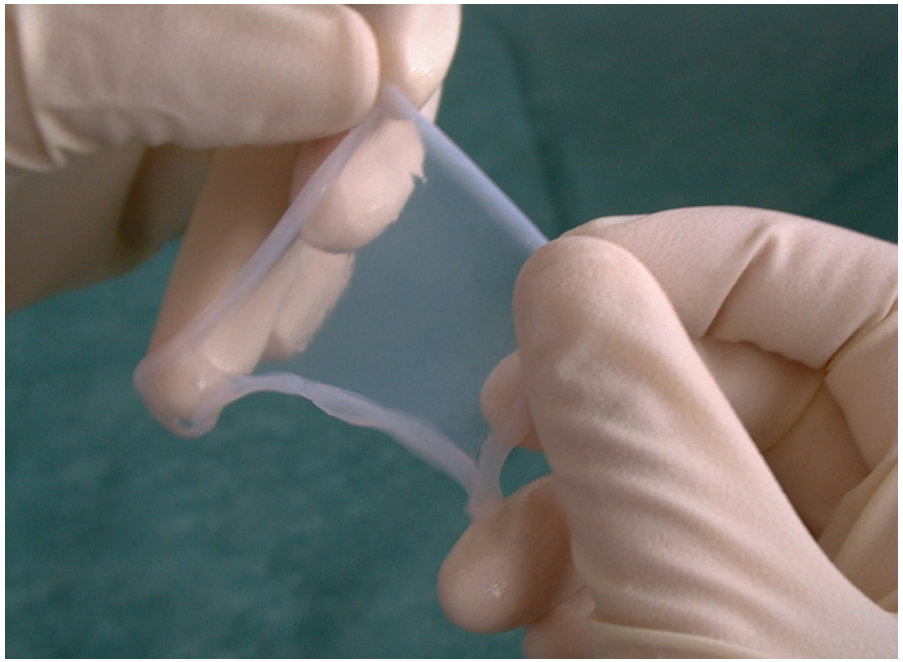
- Skin Grafts





- Bone Replacements

Preparation of autologous fibrin-based skin substitutes



3D Bioprinter

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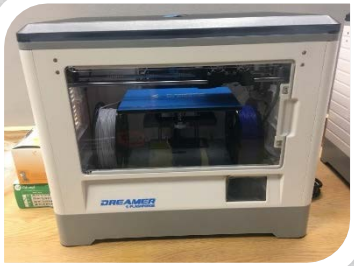
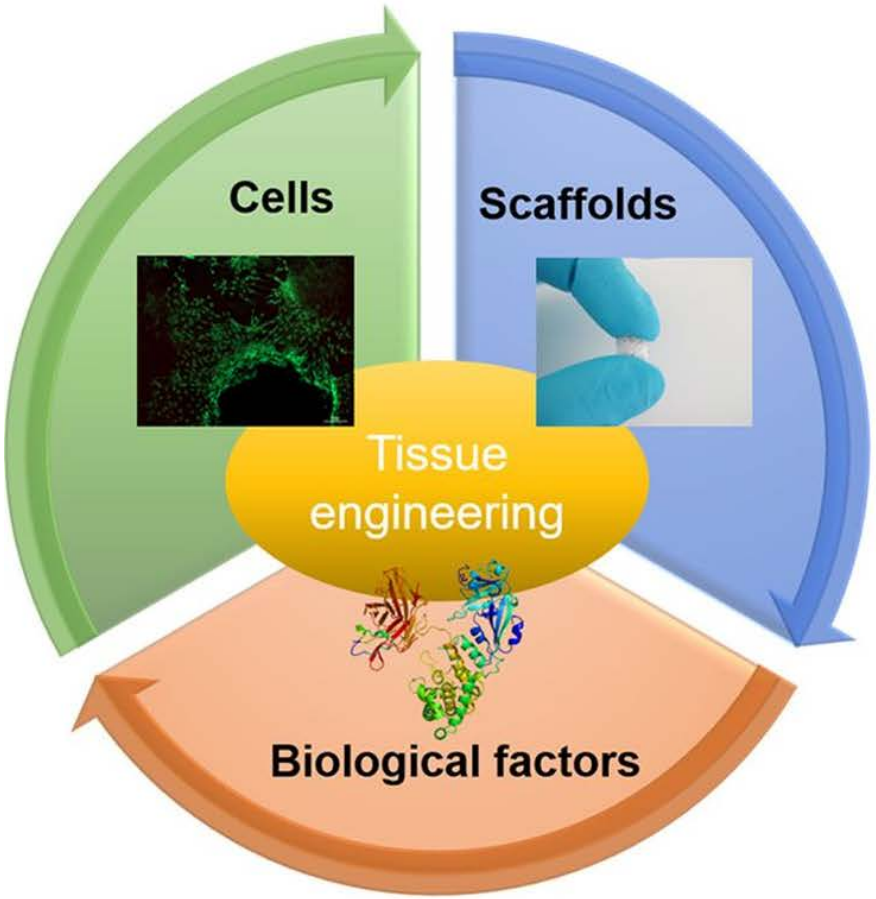
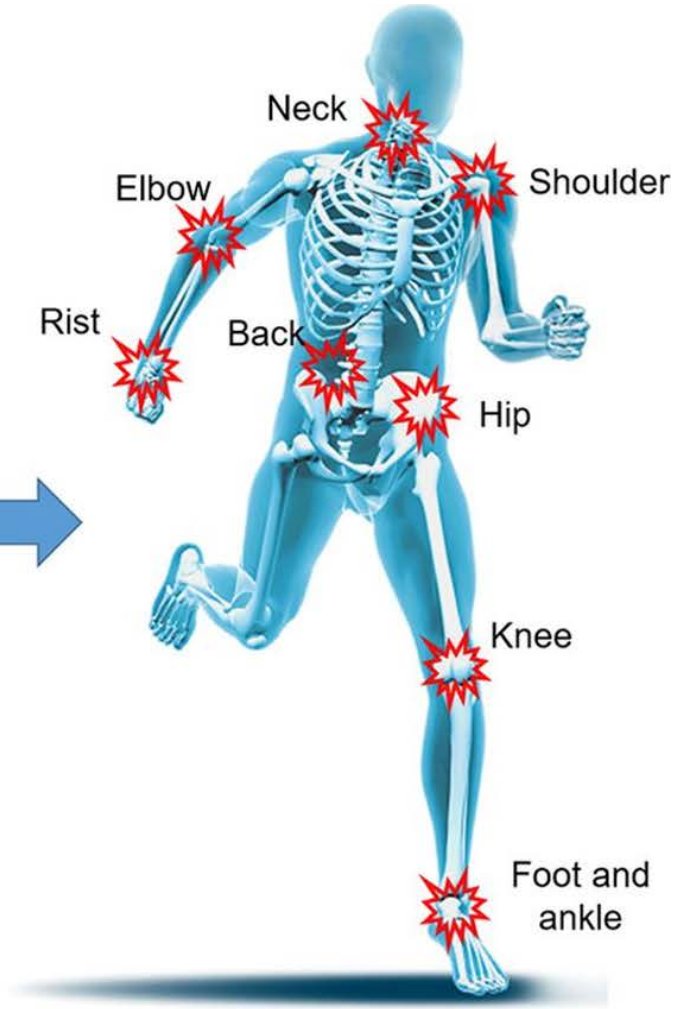
MIND CENTRE



Summary


Cells
Scaffolds
Tissue engineering
Biological factors


Neck
Elbow
Shoulder
Rist
Back
Hip
Knee
Foot and ankle

Thank you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