Osteoblast :
A cell under compression

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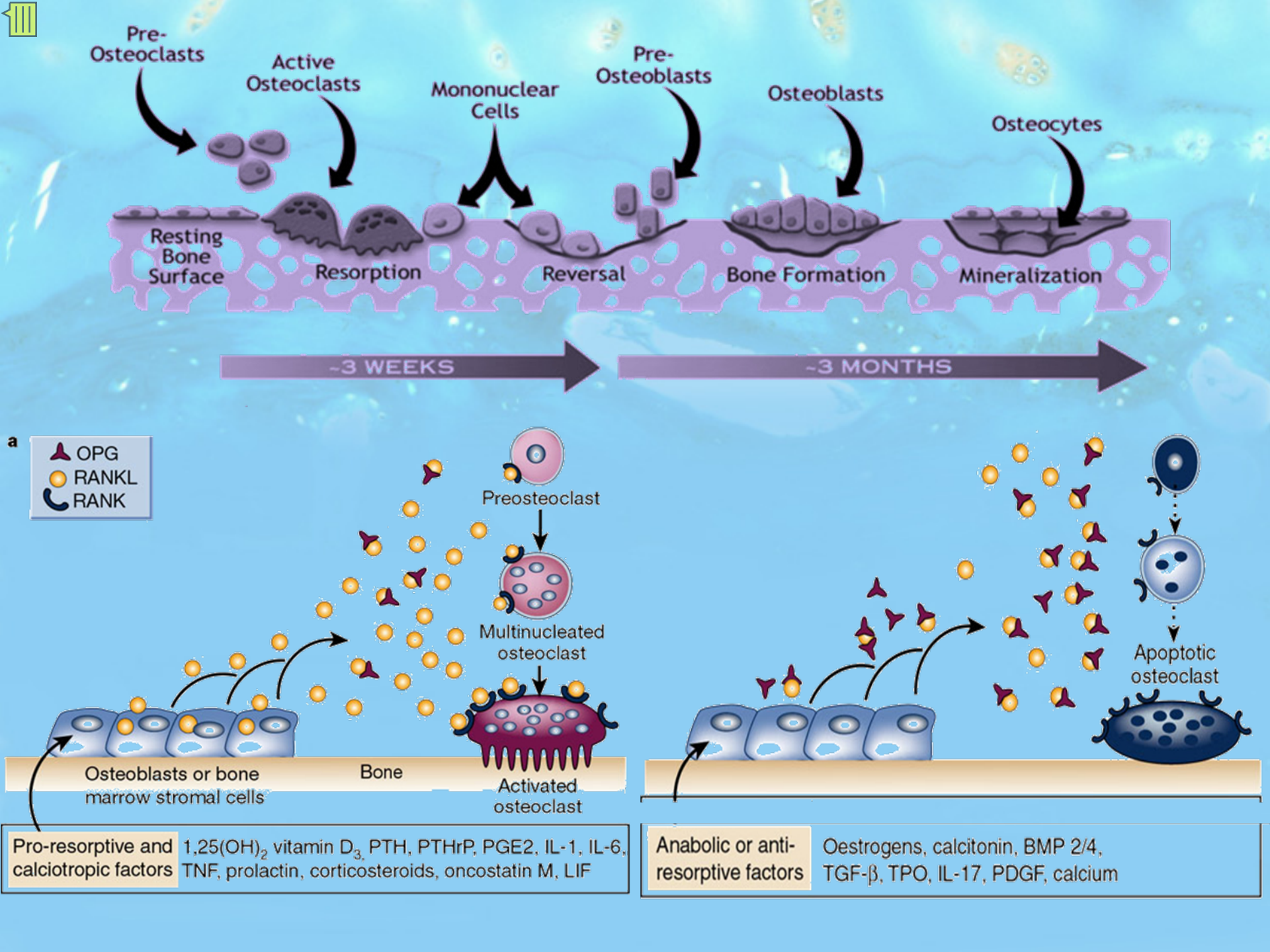

Pre-Osteoclasts
Active Osteoclasts
Mononuclear Cells
Pre-Osteoblasts
Osteoblasts
Osteocytes
Resting Bone Surface
Resorption
Reversal
Bone Formation
Mineralization
~3 WEEKS
~3 MONTHS
a
OPG
RANKL
RANK
Preosteoclast
Multinucleated osteoclast
Activated osteoclast
Osteoblasts or bone marrow stromal cells
Bone
Apoptotic osteoclast
Pro-resorptive and calciotropic factors
1,25(OH)2 vitamin D3, PTH, PTHrP, PGE2, IL-1, IL-6, TNF, prolactin, corticosteroids, oncostatin M, LIF
Anabolic or anti-resorptive factors
Oestrogens, calcitonin, BMP 2/4, TGF-β, TPO, IL-17, PDGF, calcium

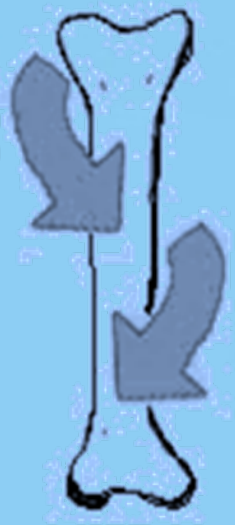
Osteoblast : a cell under compression

Different mechanical stimuli applied on bone

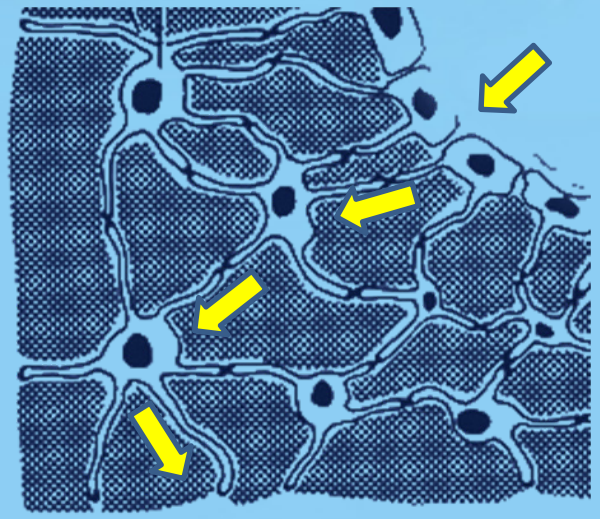
Compression

Tension

Shear (torsion)

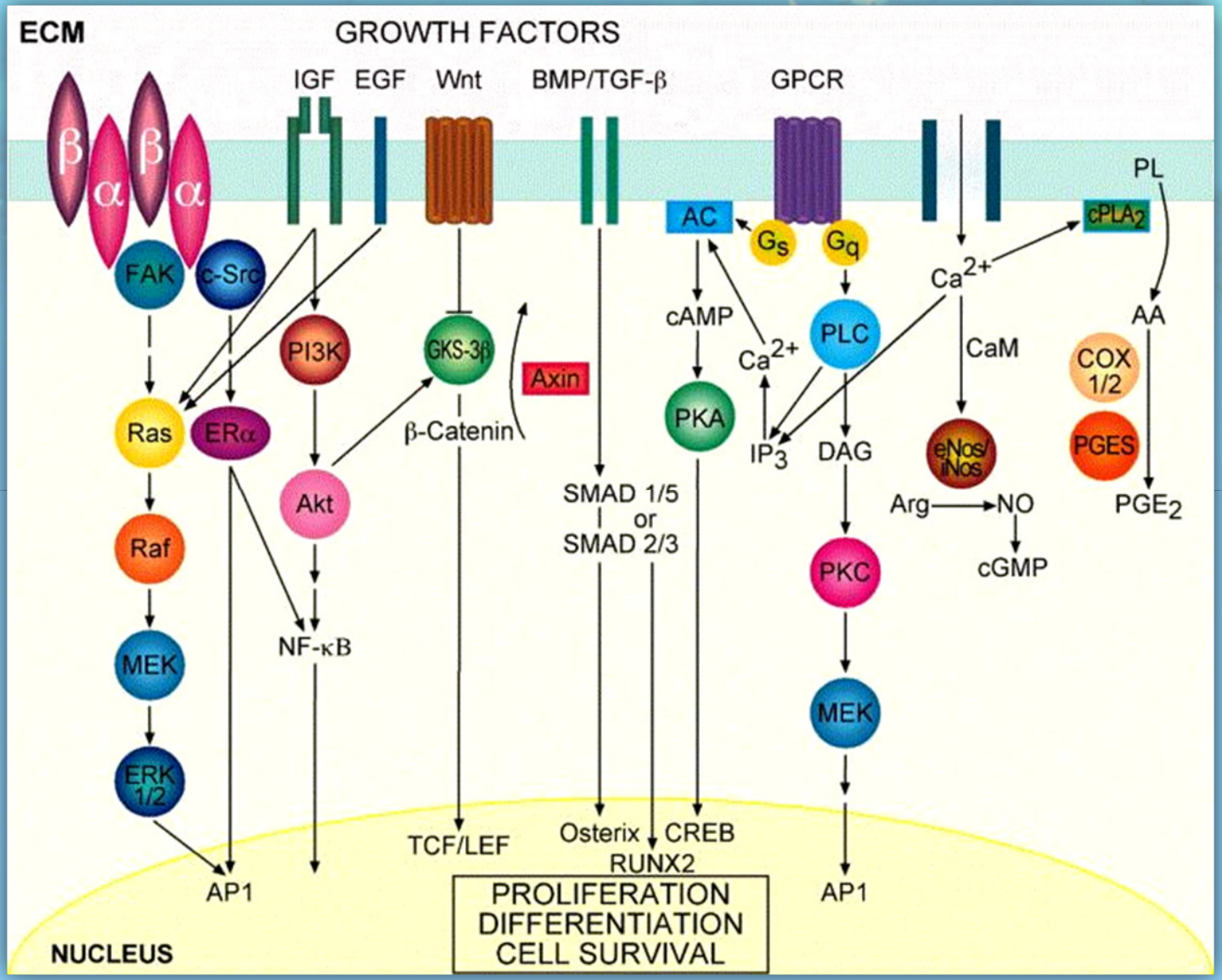


Fluid flow

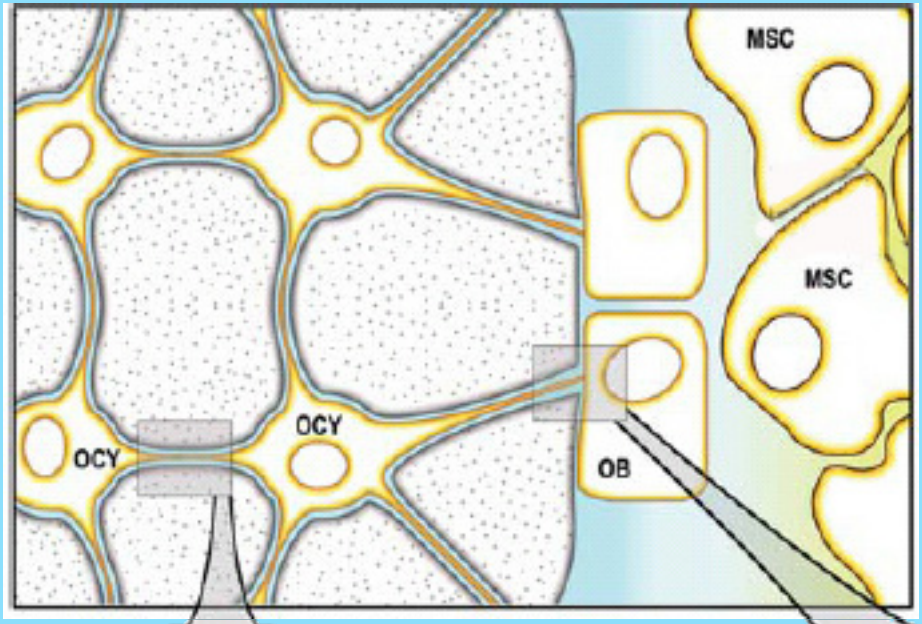


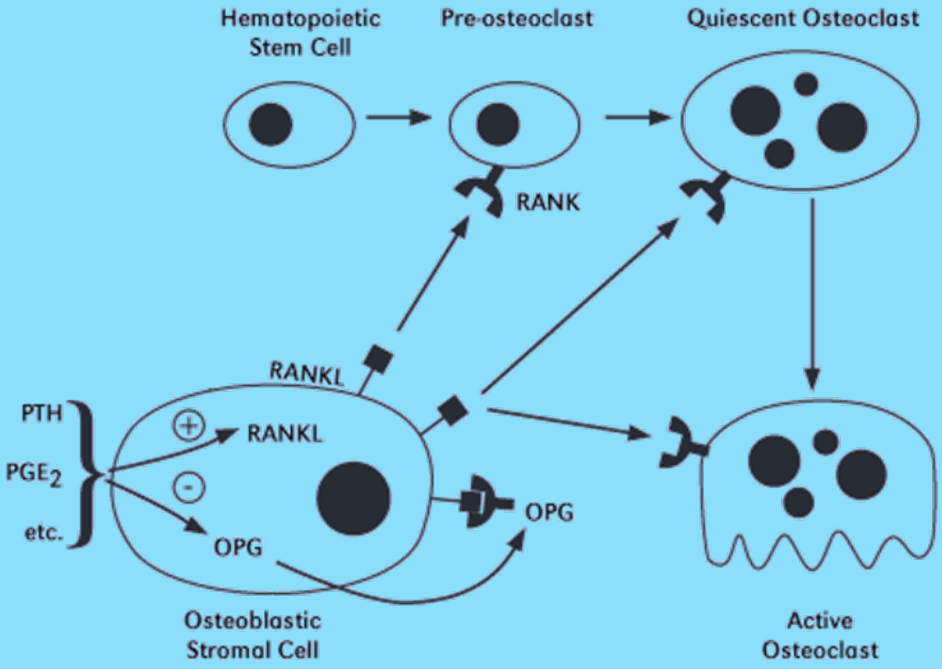
Mechanotransduction pathways in OB

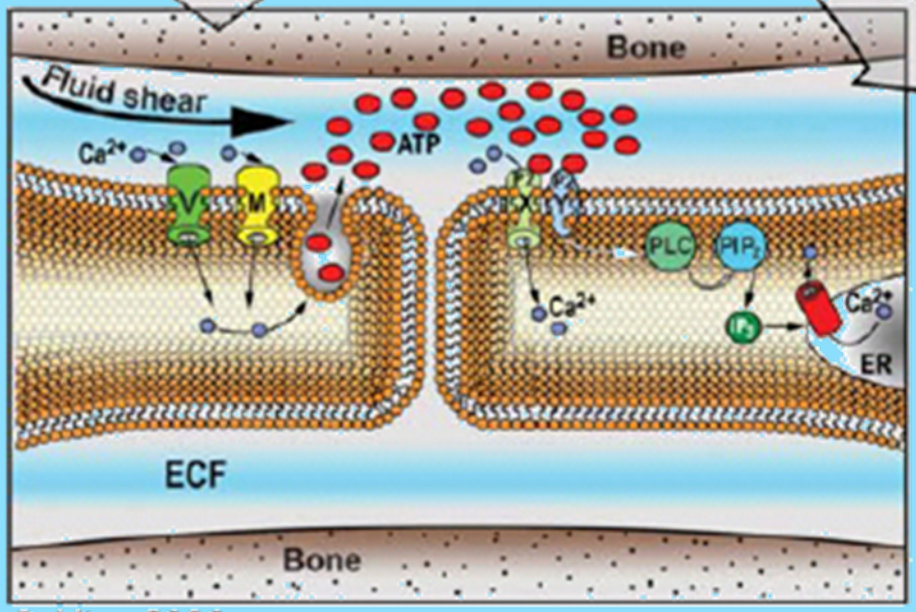
Liedert A 2006

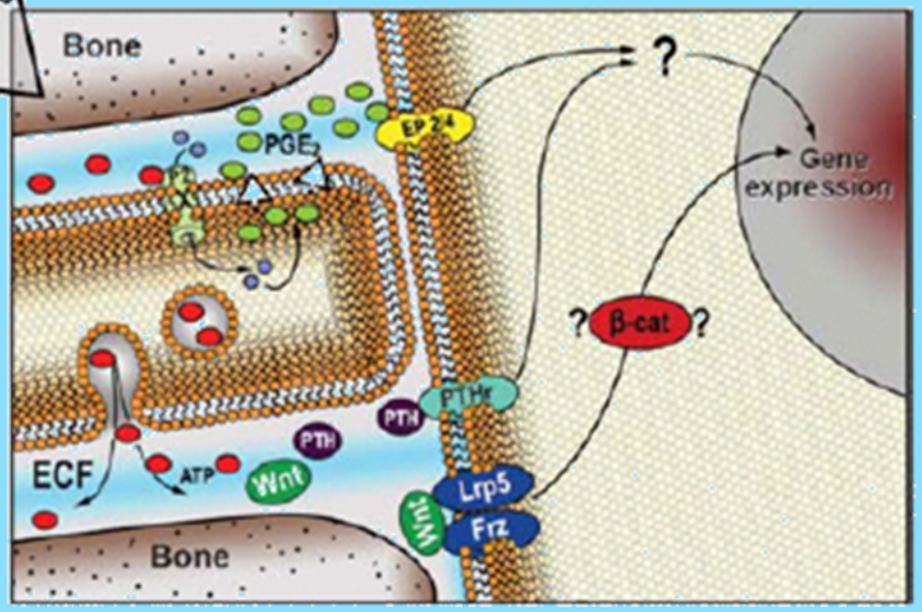


Cross talk between bone cells



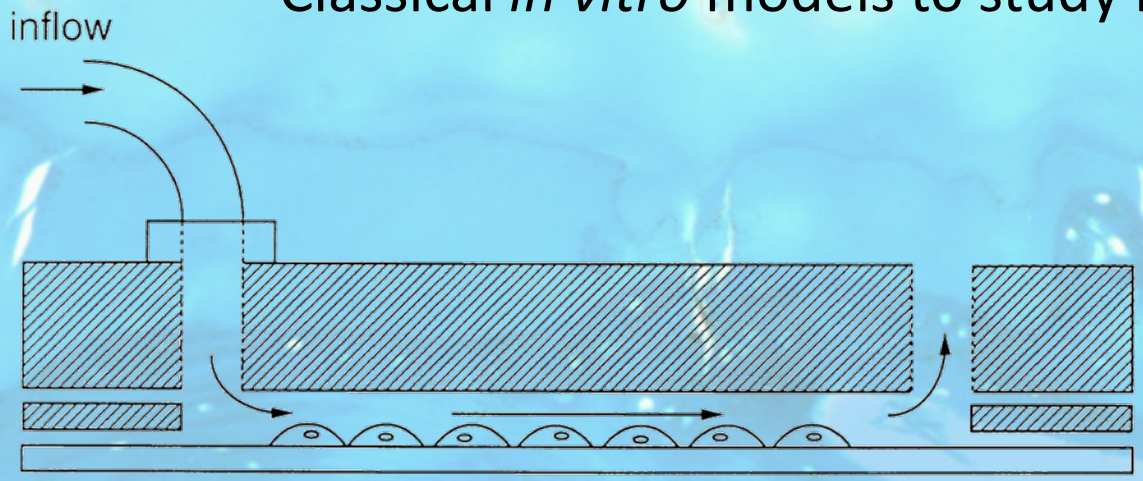




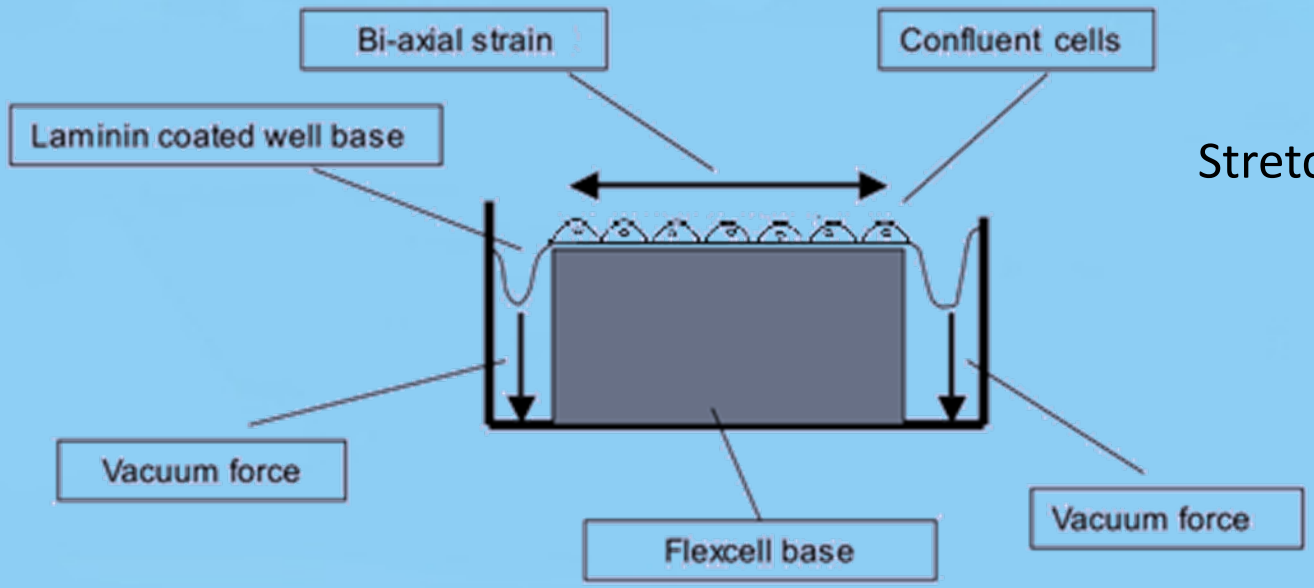


Robling 2006

Classical *in vitro* models to study mechanical stress

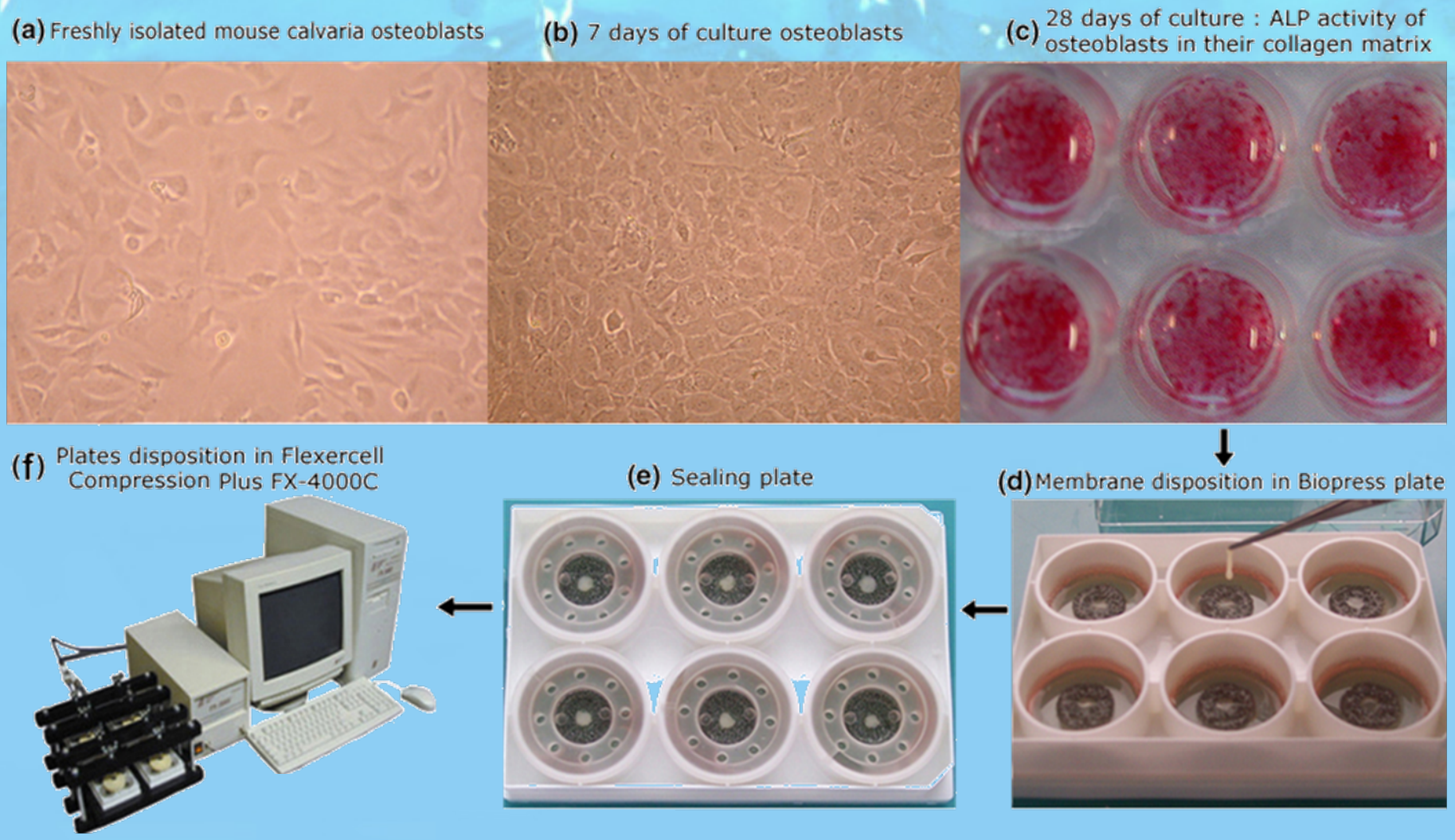


Fluid shear models



Stretching models

3D osteoblasts compression model



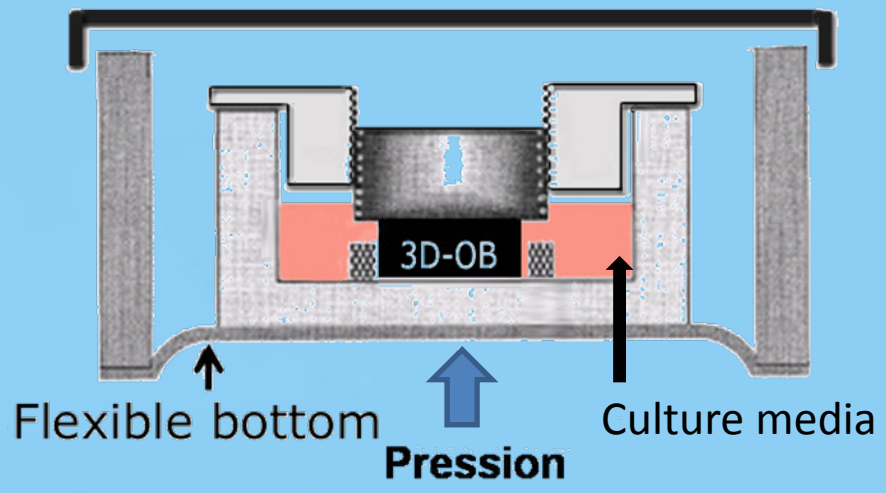
3D osteoblasts compression model

- Advantages
  - 3D connections between cells and extracellular matrix
  - Matrix neosynthetized by OB cells
  - Highly differentiated OB and also OCY
  - Compression of this 3D OB membrane submit many types of mechanical stimuli, including compression, tension and fluid shear
  - Easy to realize and manipulate, matrix resistant to large amplitude compression
  - Easy to recover cells and the matrix separately and to analyze gene expression and protein production

3D osteoblasts compression model

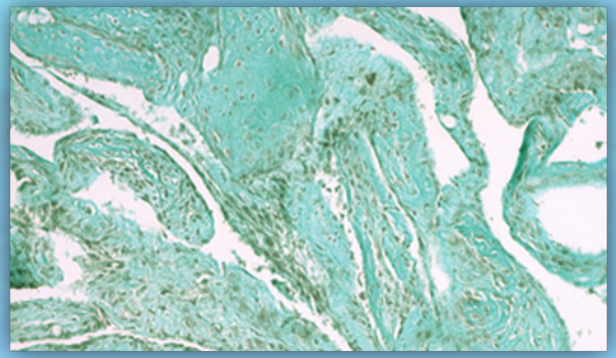
- Compressive stress submitted with flexercell
  - Dynamic sinusoidal at 1 Hz frequency
  - 6 - 10 % amplitude, corresponding to 1 - 1,7 MPa loading (~ 10 - 17 Kg/cm²)
  - 1 – 16h

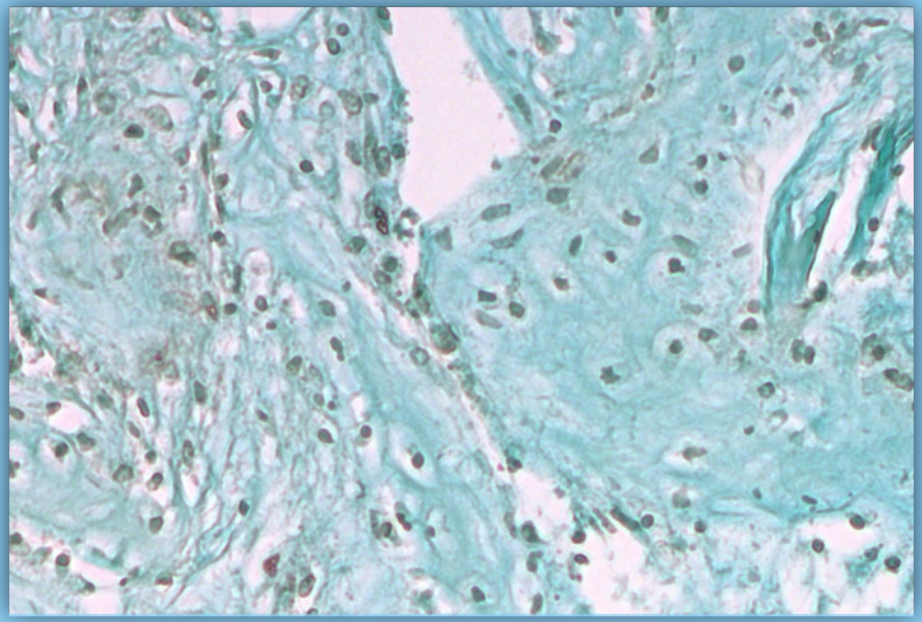
Schema of a well of a 6-wells compression plate



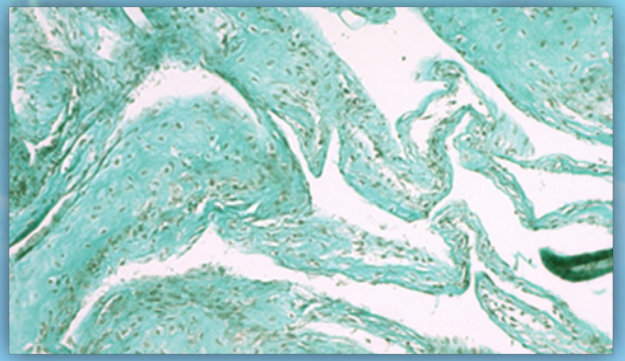
3D osteoblasts compression model

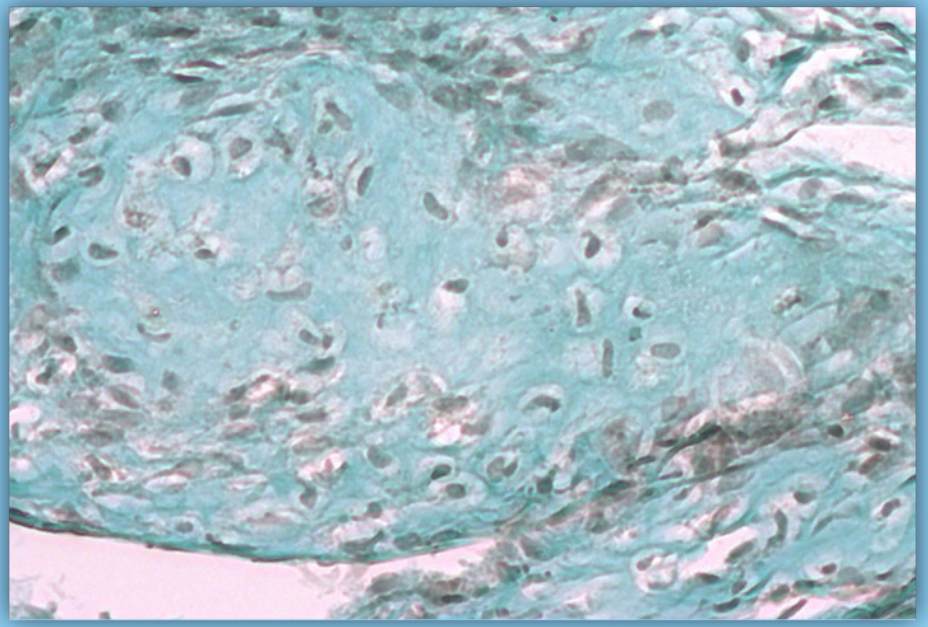
Unloaded control



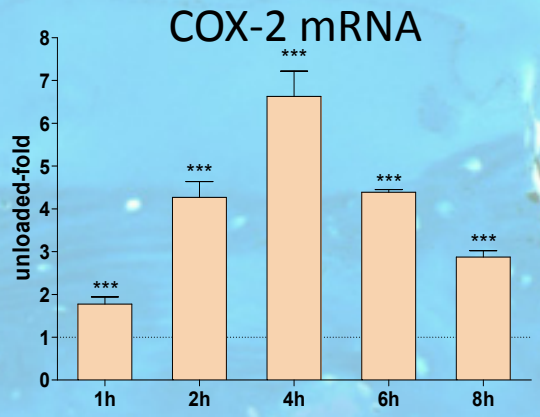


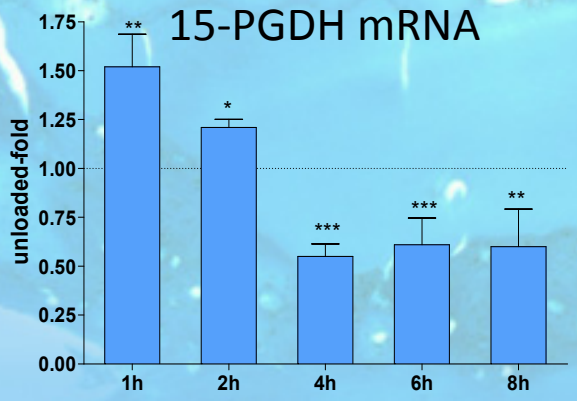
16h of 10 % compression, 1 Hz

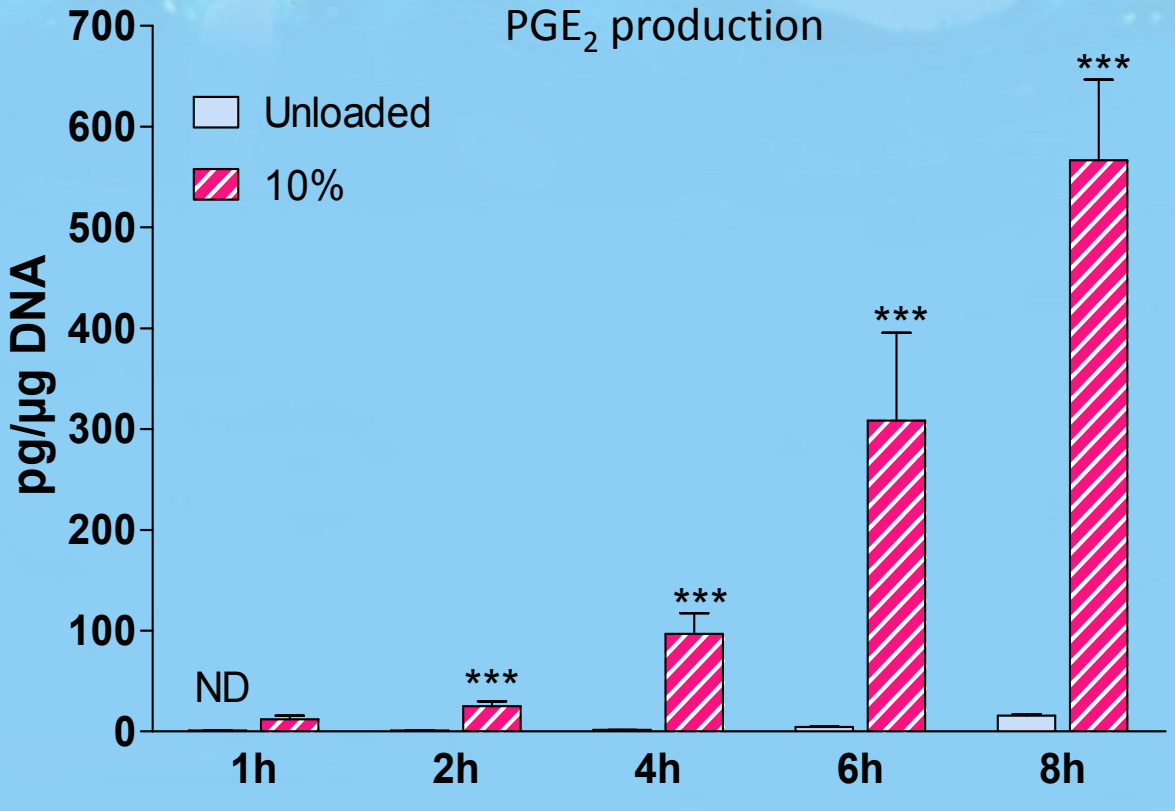




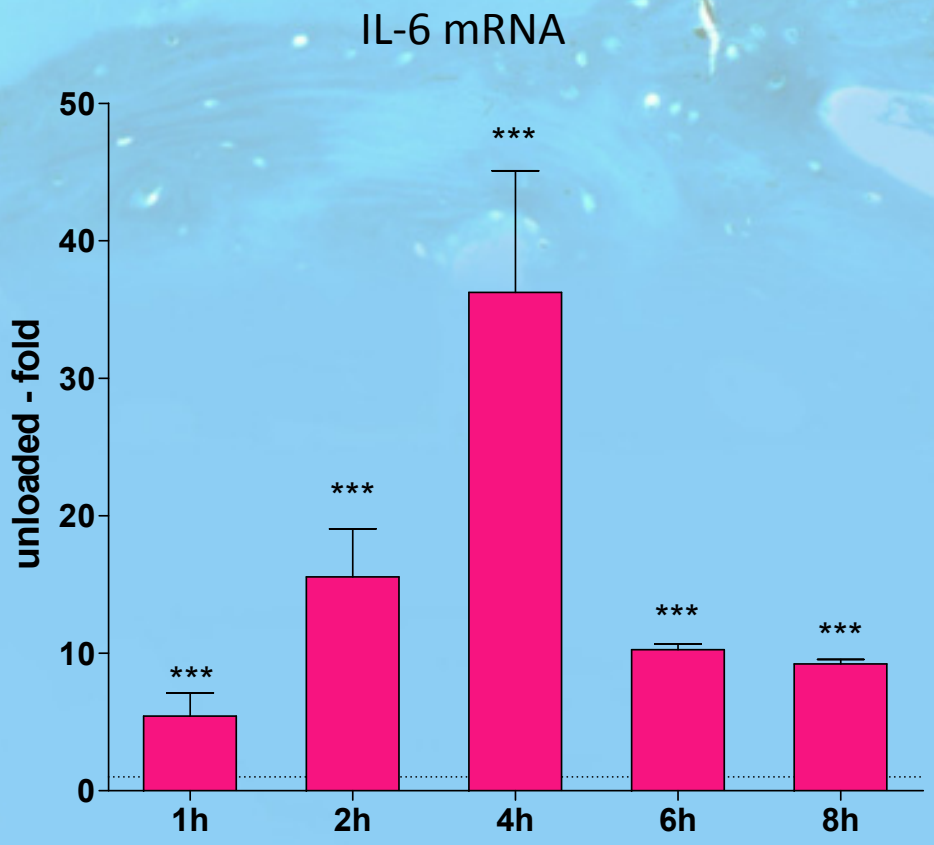
3D osteoblasts compression model

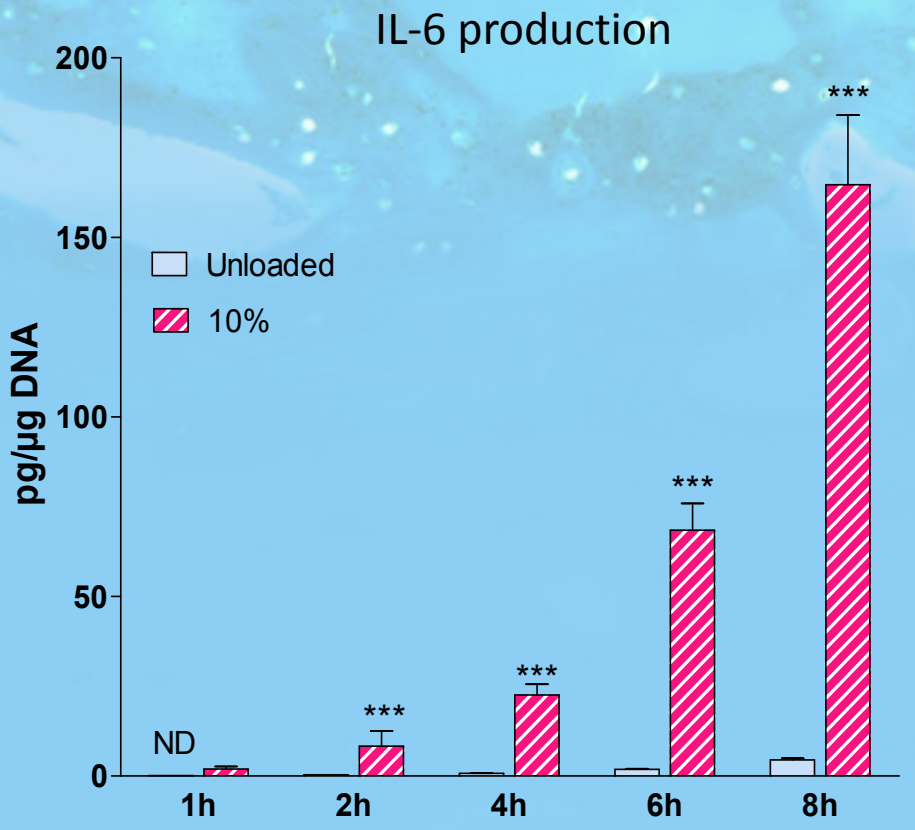






3D osteoblasts compression model





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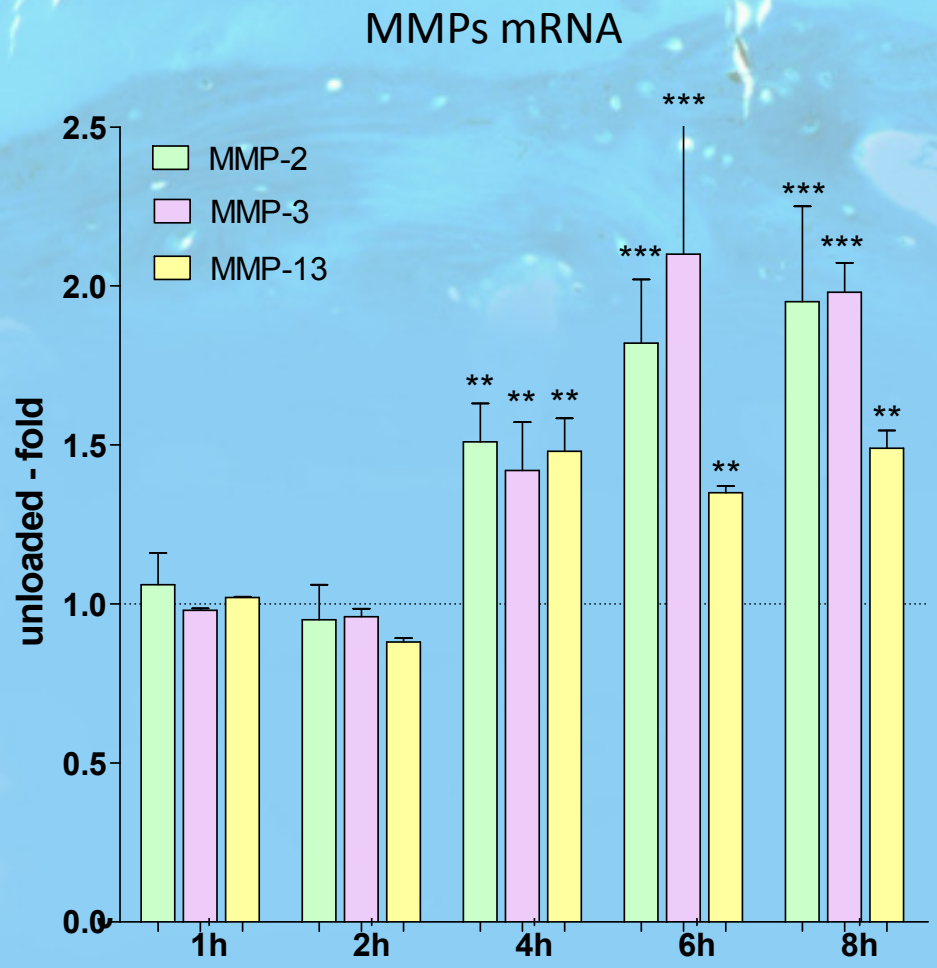
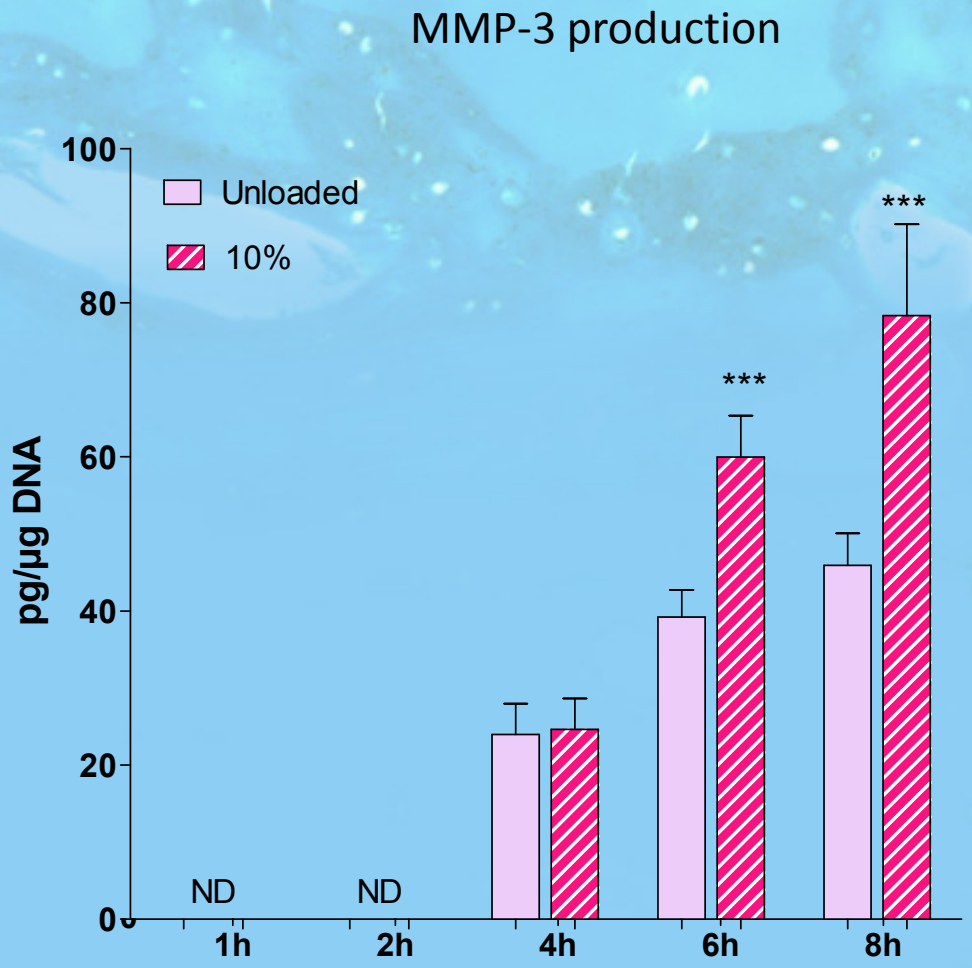




3D osteoblasts compression model

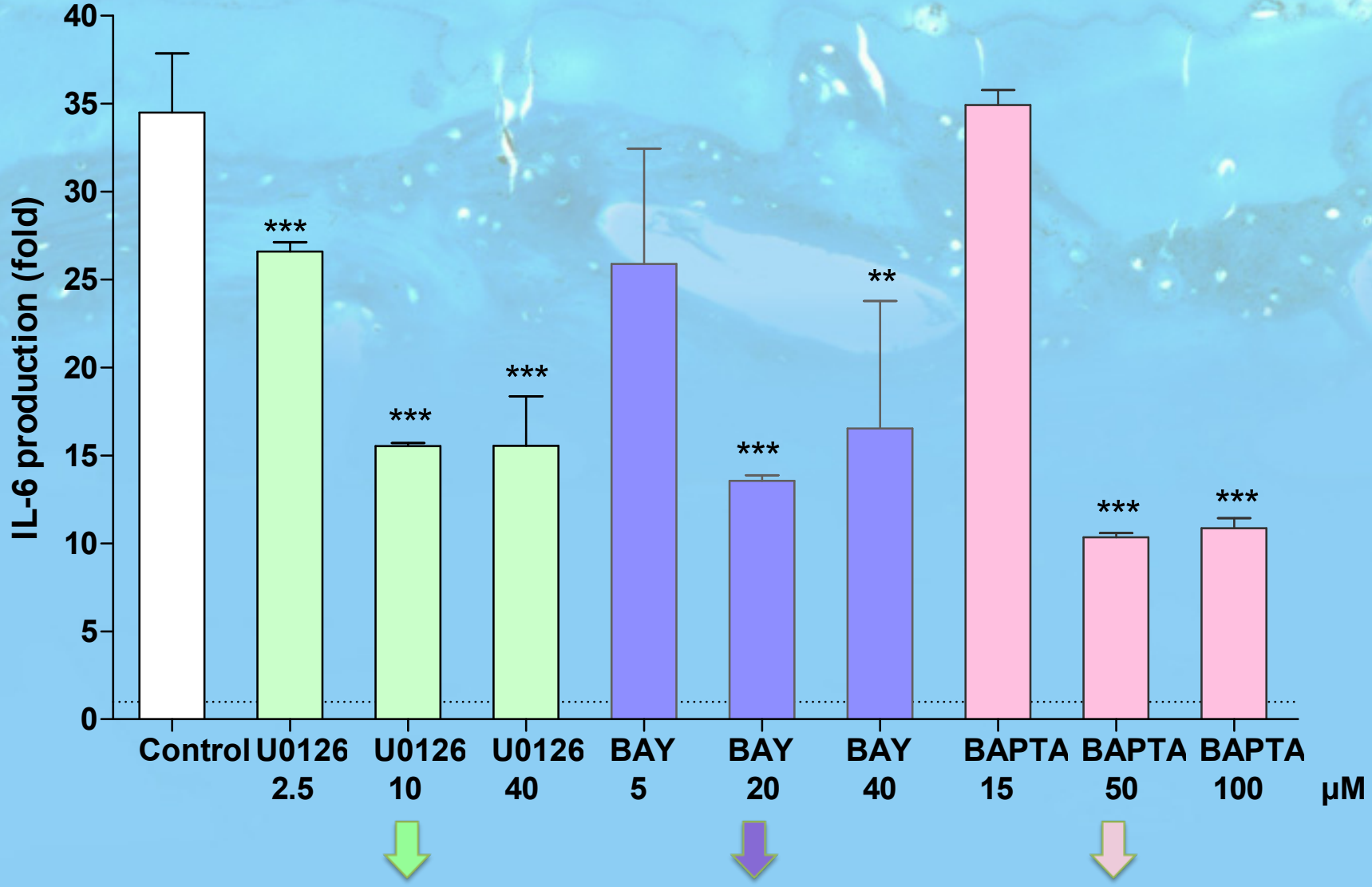
Other results:

Compression ↑ iNOS expression (4-fold)

↑ VEGF expression (3-fold)

↓ OPG expression by half

3D osteoblasts compression model



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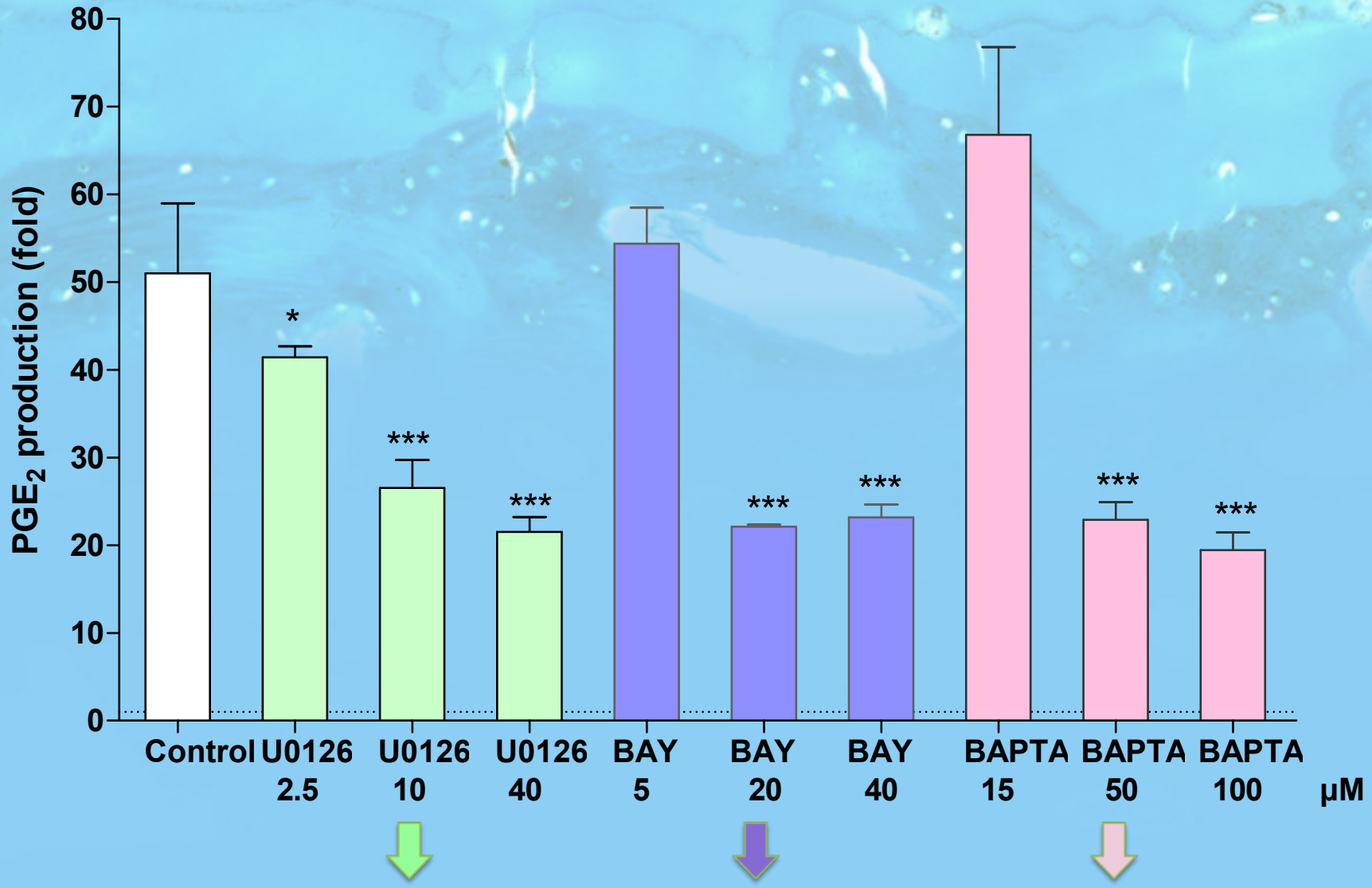
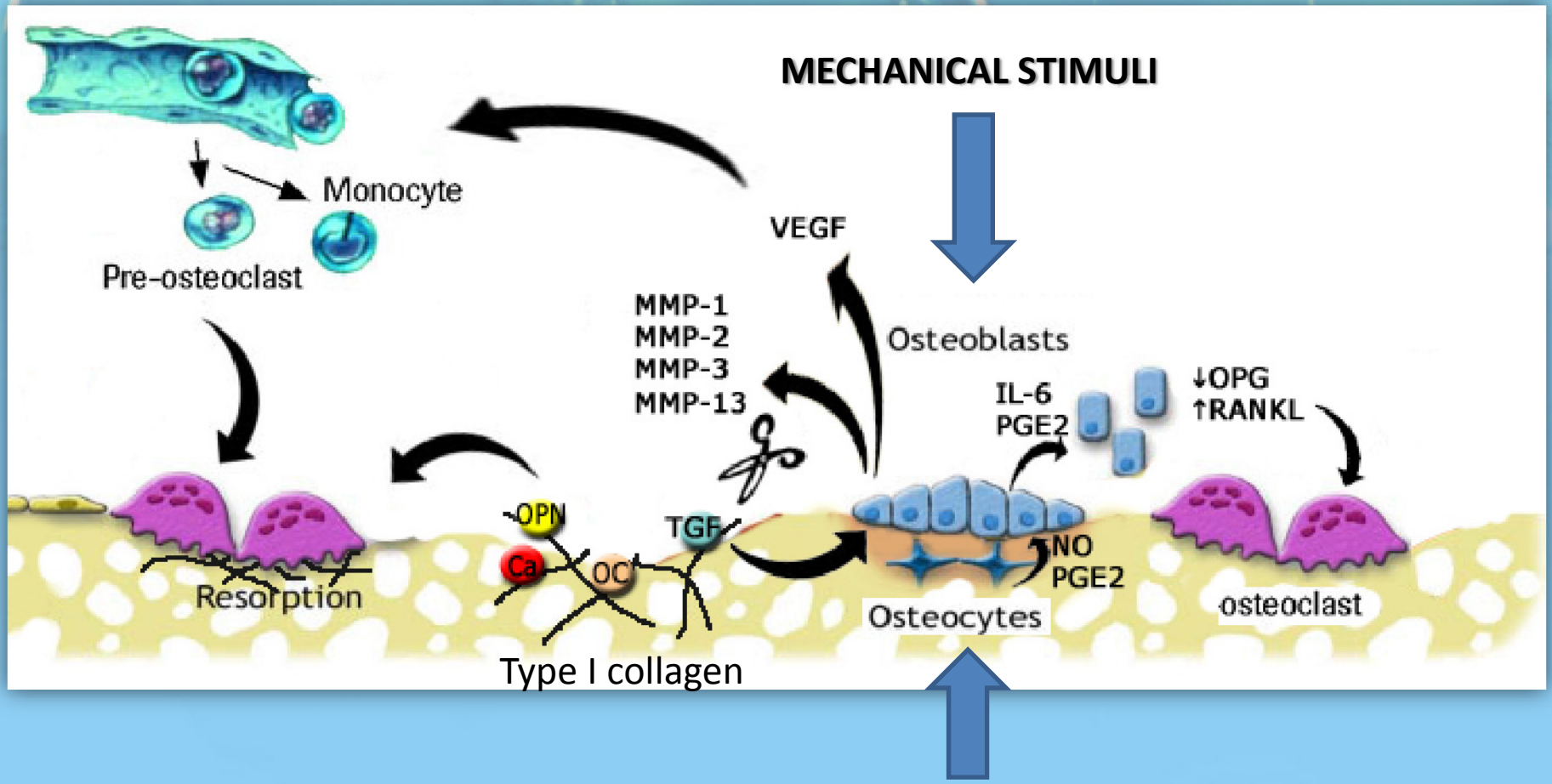


Hypothetical model for the biomechanical control of bone remodeling



Thanks to

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Bone and Cartilage Research Unit

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