Multi-modality imaging of engineered tissue in vivo

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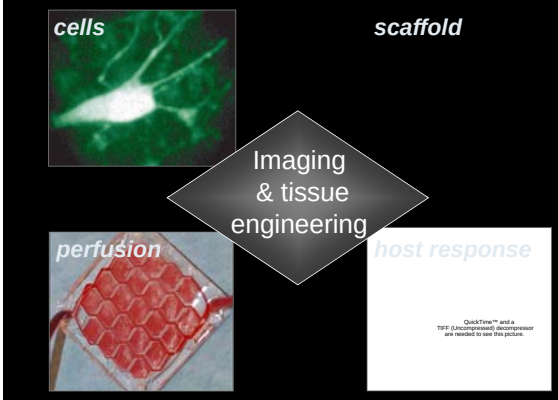
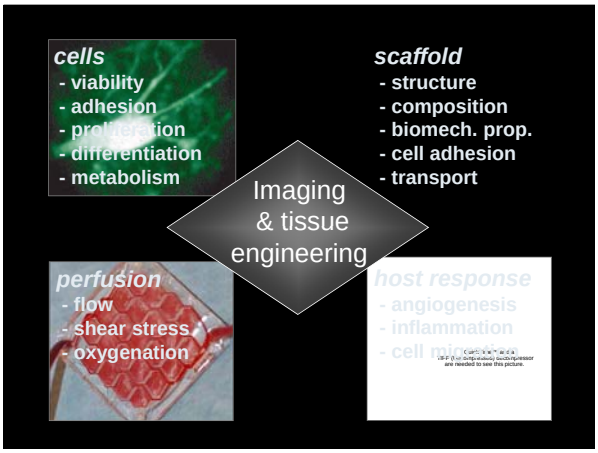
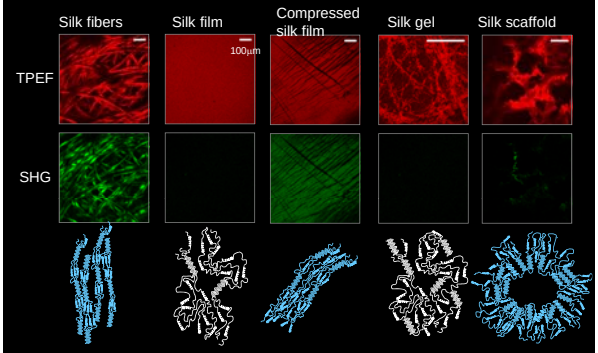
Wellman Center for Photomedicine
Massachusetts General Hospital





Optical microscopy
high resolution
3D optical sectioning
non-invasive, real-time
continuous monitoring
molecular specificity

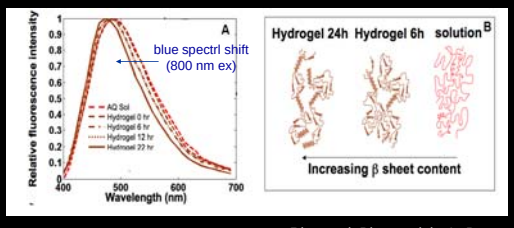
scaffold
- structure
- composition
- biomech. prop.
- cell adhesion
- transport



Courtesy of Irene Georgakoudi
Tufts University
Biomedical Engineering Department

Rice et al. Biomaterials, In Press

Dynamic monitoring of structural changes by TPEF within the same sample over time

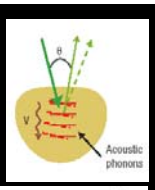


Rice et al, Biomaterials, In Press

Georgakoudi
Spectral two-photon imaging for functional characterization of engineered tissues

Confocal Brillouin microscopy

Scarcelli & Yun Nature Photonics (2007)



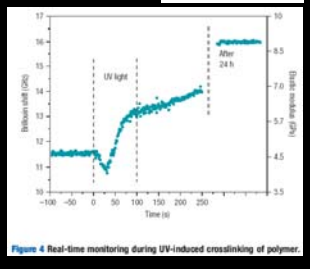
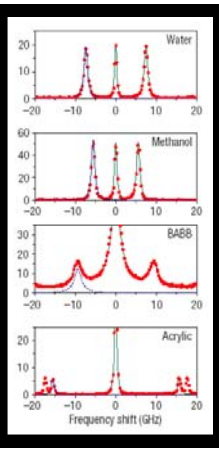


Figure 4 Real-time monitoring during UV-induced crosslinking of polymer.



cells
- viability
- adhesion
- proliferation
- differentiation
- metabolism

scaffold
- structure
- composition
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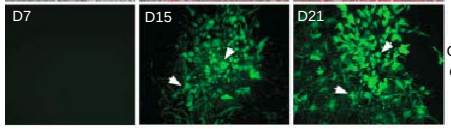
- transport

Visualizing osteoblast differentiation (MSC culture)

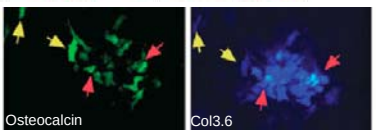
XO stain (mineral)

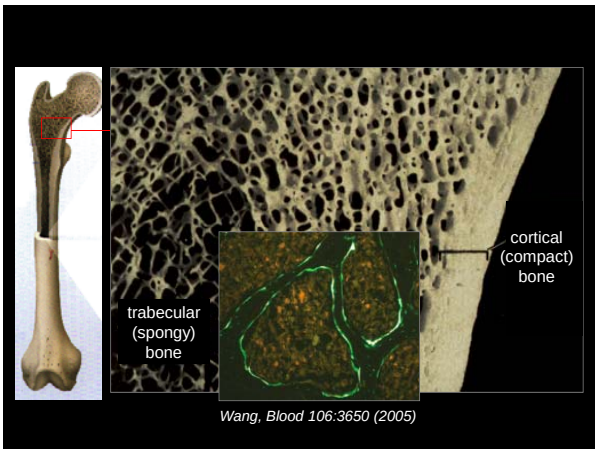


Osteocalcin expression

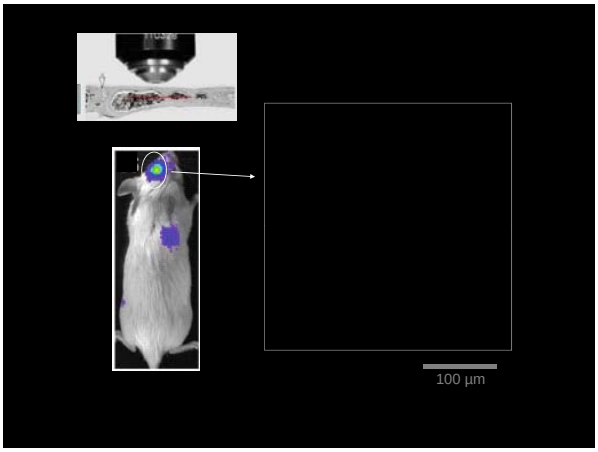
Genesis 43:87-98 (2005)

D. Rowe, Univ. Conn.

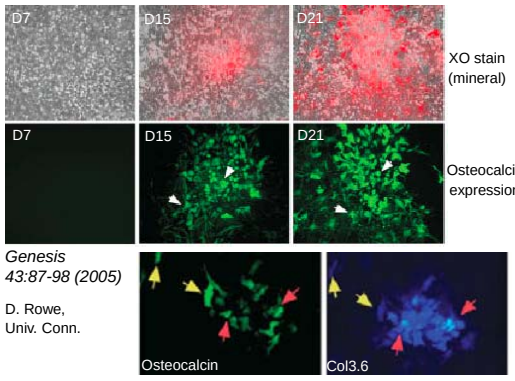




Wang, Blood 106:3650 (2005)



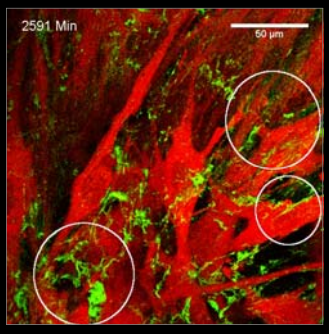
Visualizing osteoblast differentiation in MSC culture



Genesis
43:87-98 (2005)

D. Rowe,
Univ. Conn.

Molecular imaging: visualize collagen synthesis in real time



CNA35 - *Boerboom, J. Struct. Bio. 159:392-399 (2007)*

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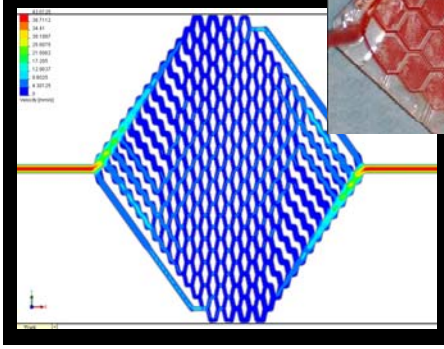
Imaging & tissue engineering

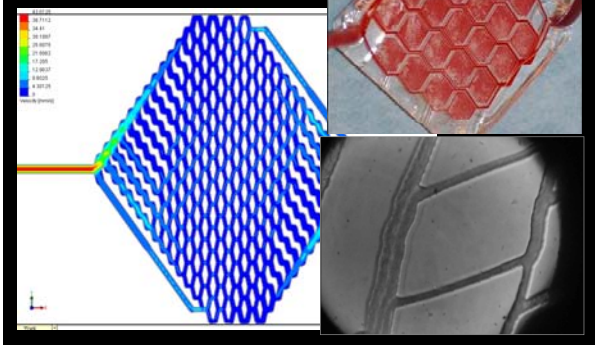
perfusion
- flow
- shear stress
- oxygenation

host response
- angiogenesis
- inflammation
- cell migration

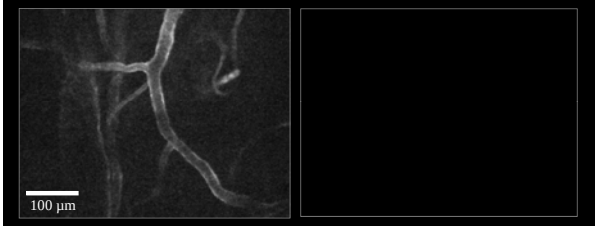
Engineered vascular network



Engineered vascular network



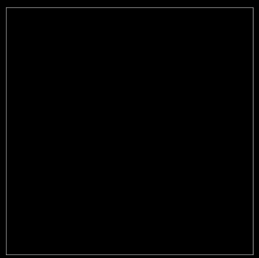
In vivo imaging of angiogenesis



FITC-anti-CD31 (1 mg/kg)
Two photon fluorescence
Excited @ 800 nm

Cy5.5-anti-CD31 (1 mg/kg)
Confocal
Excited @ 633 nm

In vivo imaging of vascular permeability



$$P = (1 - Hct)\frac{1}{I_v}\frac{V}{S}\frac{\partial L}{\partial t}$$

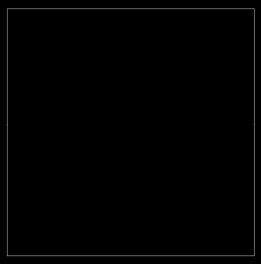
In vivo imaging of inflammation

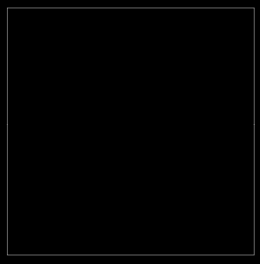
before LPS

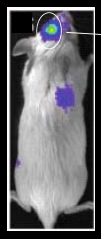
after LPS

Runnels, Molecular Imaging 2006

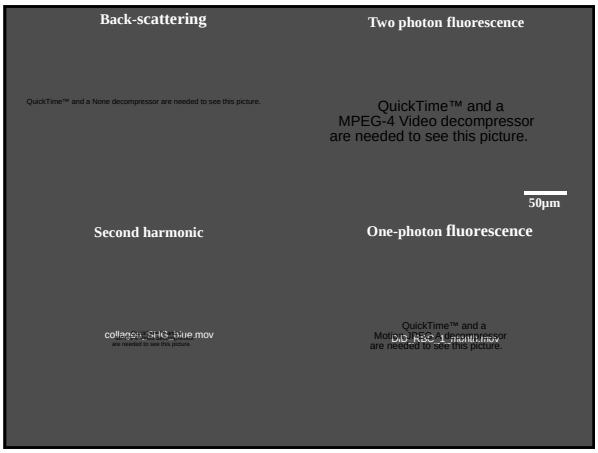
In vivo imaging of immune cell migration

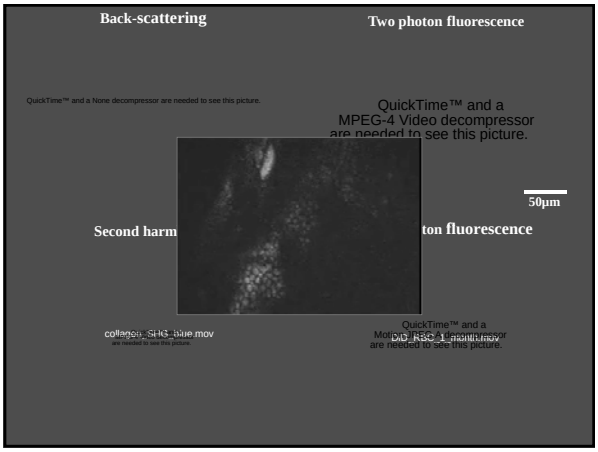






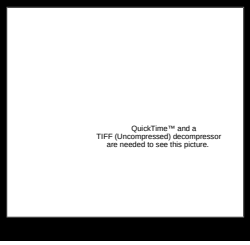
100 µm

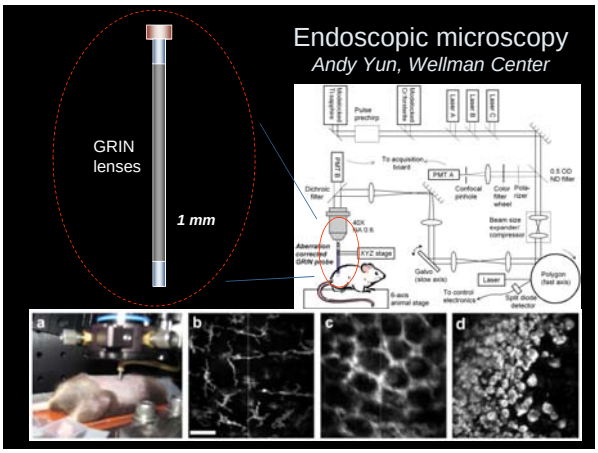




Key challenges

- Imaging deep tissue & internal organs
- Molecular markers & endogenous biomarkers
- 3D image analysis & quantification





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