Лекция профессора Кирилла Ларина (Университет Хьюстона)

В рамках программы Фонда Дмитрия Зимина «Династия»
«Краткосрочные визиты иностранных ученых в российские научные центры»
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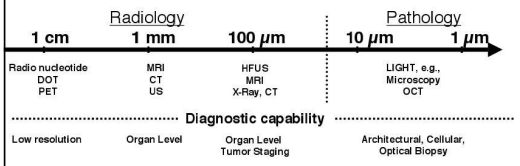
Мониторинг оптического просветления биологических тканей и обзор последних достижений

Introduction

- Light can be absorbed, reflected, scattered and remitted by a tissue and each of these processes carries information about the micro- and macrostructure, the movement and shape of its components
- The functional imaging and monitoring of the state of human organs and tissues is a very attractive feature of the optical method
- The microscopic, spectroscopic, polarimetric, interferometric, and speckle methods are key techniques for tissue optical imaging and medical diagnosis

7

Optics in Medicine



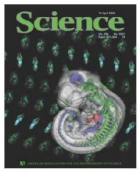
Histopathology is the golden standard especially for cancer diagnosis

Only optical technique approach cellular resolution

DOT: Diffuse Optical Tomography; PET: Positron Emission Tomography;
MRI Magnetic Resonance Imaging; CT: Computed Tomography; US: Ultra Sound;
HFUS: High Frequency Ultra Sound; OCT: Optical Coherence Tomography.

Introduction

- Light in Medicine and Biology (broader than "just imaging"…)
  - Therapeutics: photo-thermal, -mechanical, -chemical modes
  - Diagnostics: imaging, spectroscopy, "remote sensing"
  - Analytics: advanced optical microscopies



9

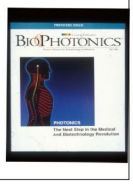
Basic definitions

- **Photonics:**
  science & technology of light generation, manipulation, transmission, and measurement
  ultraviolet-visible-infrared
- **Biophotonics:**
  applications of photonics to life sciences and medicine

Why light?

- photon energies ≡ molecular energy levels
- wavelengths ≡ cell, tissue micro-structures

→ Probe for diagnostics+analytics
→ Modify for therapeutics



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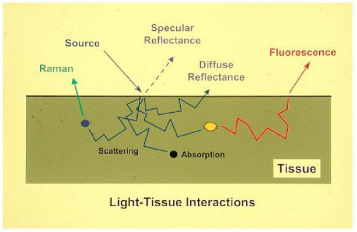
What happens to light when you shine it onto tissue?
(where does it go? what does it do when it gets there?)

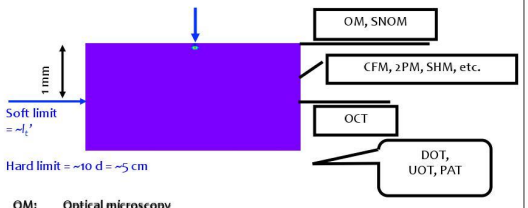


Light-Tissue Interactions

- relative probability/importance λ-dependent
- therapy (PDT, thermal, ablative) follows absorption
- (multiple) scattering dominant 600-1300 nm

11

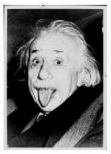
Challenges in Optical Imaging



OM: Optical microscopy
SNOM: Scanning near-field optical microscopy
CFM: Confocal microscopy
2PM: Two-photon microscopy
SHM: Second harmonic microscopy
OCT: Optical coherence tomography
DOT: Diffuse optical tomography
UOT: Ultrasound-modulated optical tomography
PAT: Photoacoustic tomography

Courtesy of Dr. L. Wang

Optical Clearing

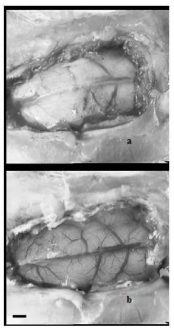


Transparent

Not Transparent!

- being transparent would improve optical imaging and diagnostics!

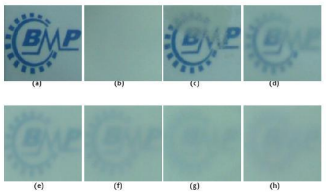
Optical Clearing



Visual changes and the measured optical changes for *in vivo* rabbit *dura mater* before and after treatment with glycerol epidurally.

Bashkatov et al, Biophysics J. 85, (2003).

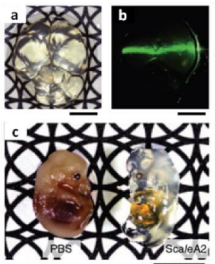
Optical Clearing



The photographic images of OCA-induced optical clearing of Intralipid-based tissue phantom in the sample cell: background (a), 5%-Intralipid (b), and 5%-Intralipid with 50%-PEG200 (c), -PEG400 (d), -DMSO (e), -glycerol (f), -1,4-butanediol (g), and -1,2-propanediol (h).

A.T. Yeh, et. al, J. Invest. Dermatol. 121 (2003).

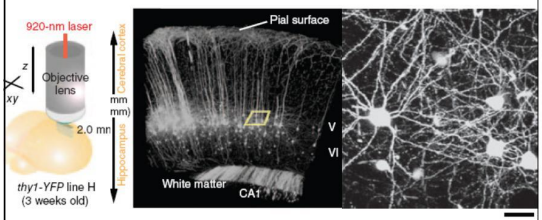
Optical Clearing



(a) Cleared brain was taken with patterned background. (b) A 1-mW, 532-nm laser beam irradiated at the cleared brain. (c) Two embryos placed in PBS or incubated in ScaleA2 solution for 2 weeks after fixation.

H. Hama, et al, Nat. Neurosci. 14 (2011).

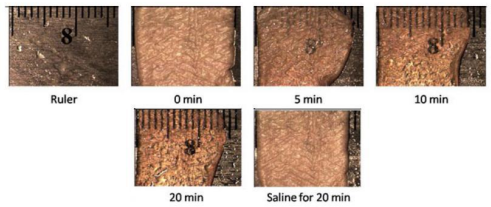
Optical Clearing



Reconstruction of ScaleA2-treated brain in the cerebral cortex and hippocampus of YFP-H mice. Right- An expanded view at a depth of 0.9 mm (a yellow box in b)

H. Hama, et al, Nat. Neurosci. 14 (2011).

Optical Clearing of Skin



Microvascular Therapeutics & Imaging Laboratory, UCI