Can light help us diagnose prostate cancer?

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Prostate cancer

Prostate cancer facts for England:

- ✓ Every hour one man dies from prostate cancer
- ✓ More than 100 men are diagnosed with prostate cancer per day
- ✓ 1 in 8 men between the ages of 60 and 80 suffer from the disease
- ✓ Many men die **with** prostate cancer but not **from** it

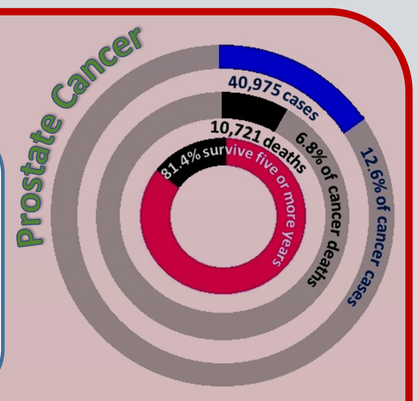
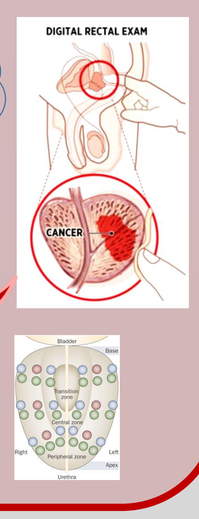


Figure I: Prostate cancer statistics in 2011
Source: Cancer Research UK

Current diagnostic techniques

- **PSA, digital rectal exam, ultrasound:** not always reliable[1-3]
- **prostate biopsy + histopathology:** invasive and inconvenient for the patient

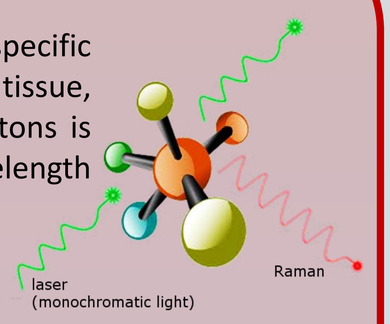


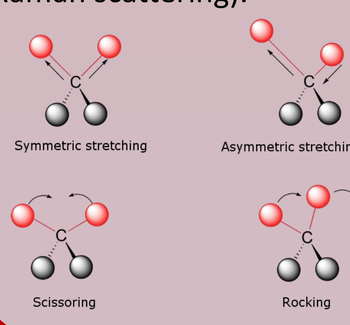
Pathology: The lottery of conventional prostate biopsy[4]

How can Deep Raman help in prostate cancer diagnosis?

What is Raman spectroscopy?

When a near-infrared light beam of a specific wavelength interacts with matter (e.g. cells, tissue, materials etc.), a small fraction of the photons is scattered with a slightly different wavelength (Raman scattering).

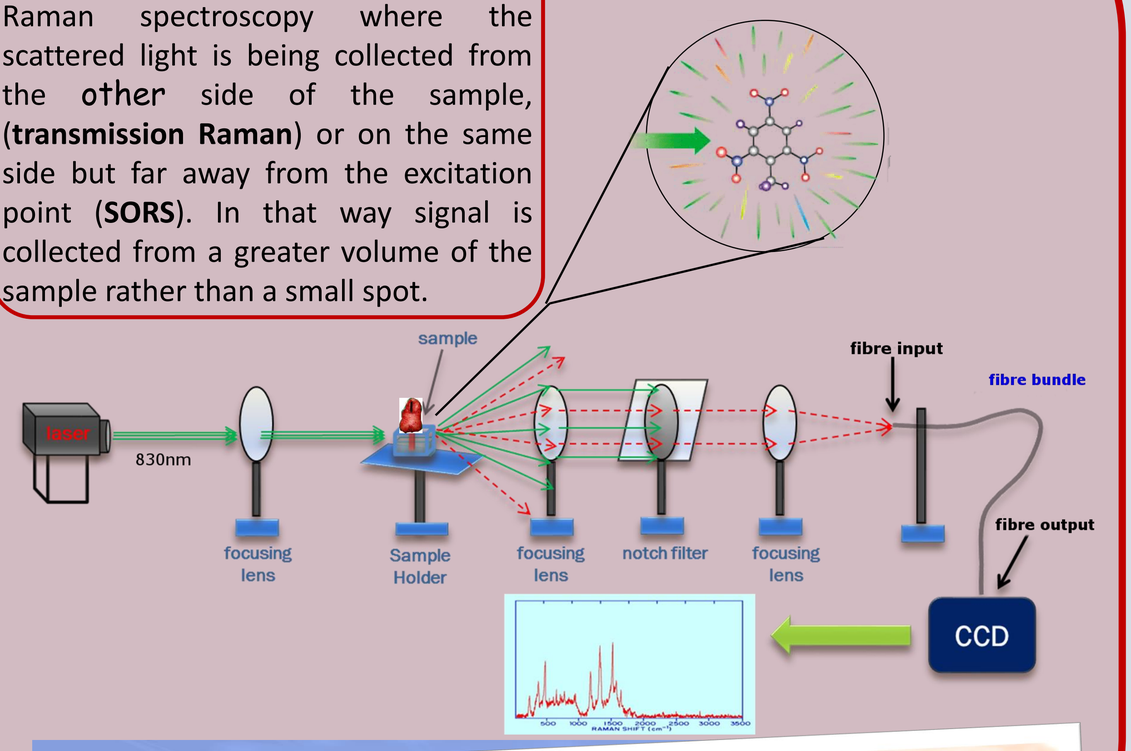




This is due to the various ways that different molecular bonds in tissues vibrate. These vibrations are the *fingerprint* of every molecule.

What is Deep Raman?

Deep Raman is a new concept of Raman spectroscopy where the scattered light is being collected from the other side of the sample, (**transmission Raman**) or on the same side but far away from the excitation point (**SORS**). In that way signal is collected from a greater volume of the sample rather than a small spot.



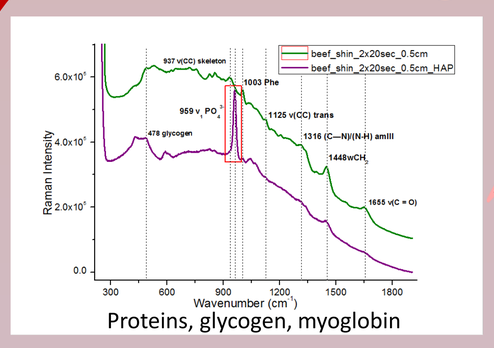
Why is Deep Raman so promising?

In contrast to the conventional Raman microscopy which can ''see'' up to a depth of only a few hundred micrometres (10^{-6} m), Deep Raman is able to measure beyond a depth of 2.7cm[5,6] within non-transparent samples, making the ***in vivo* application** a real possibility.

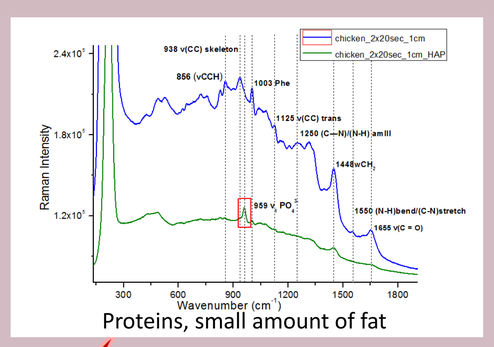
+

Deep Raman uses a harmless wavelength of light (near-infrared), making the diagnosis **SAFE** and complication-free for the patient

Testing animal tissue



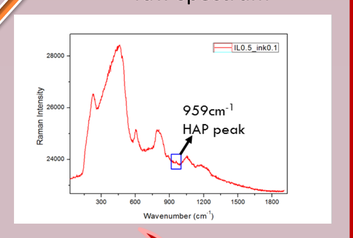
Proteins, glycogen, myoglobin



Proteins, small amount of fat

Beef shin of 0.5cm

Prostate liquid phantom raw spectrum



Spectral analysis

cosmic ray removal
baseline correction
principal component (PC) noise reduction
reconstruction into 2D images

Assessing signal intensity

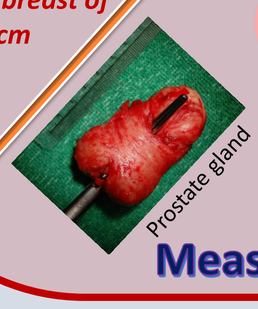
Assessing signal distribution

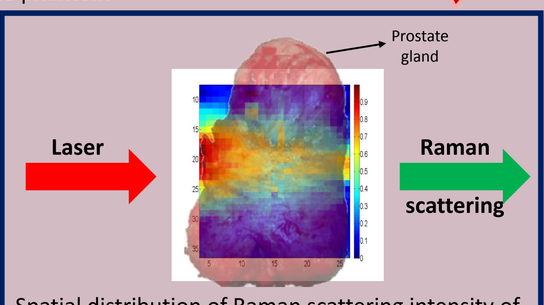
Prostate liquid tissue phantom

Equivalent to prostate in size

and optical properties

Chicken breast of 1cm



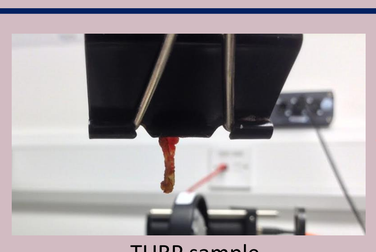


Spatial distribution of Raman scattering intensity of HAP throughout a prostate liquid phantom volume[6]

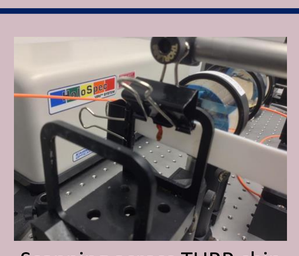
Measuring liquid prostate tissue phantoms

Getting closer to *in vivo* diagnosis

TURP chips

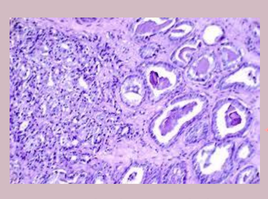


TURP sample

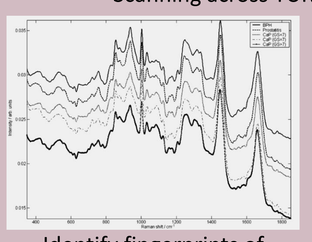


Scanning across TURP chip

Assessing pathological signals in prostate gland chips, removed during *Transurethral Resection* of the prostate (TURP)



Histopathology validation



Identify fingerprints of prostate cancer[7,8]

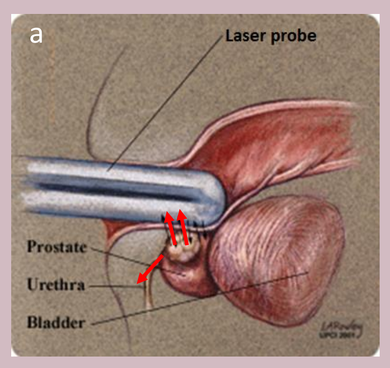
Current applications of Deep Raman

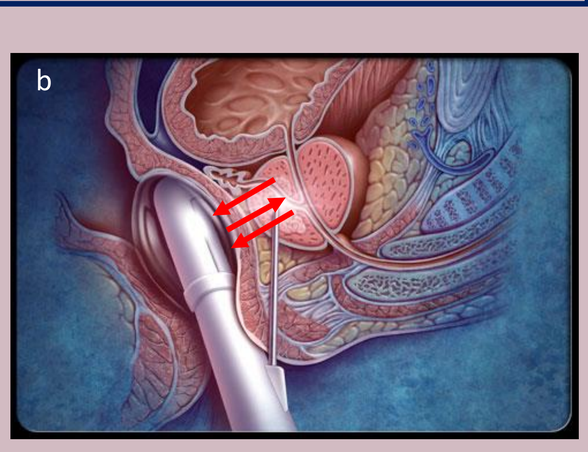
Quality control

Pharmaceutical analysis

Security check

Bone disease diagnosis





Potential prostate cancer diagnosis using Deep Raman approach: (a) SORS and (b) transmission mode

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[6]M. Vardaki, B. Gardner, N. Stone, P. Matousek (submitted for publication)
[7]P. Crow *et al*, 2003, British Journal of Cancer, 89(1), 106-108
[8]N. Stone *et al*, 2007, Analytical and Bioanalytical Chemistry, 387(5), 1657-1668