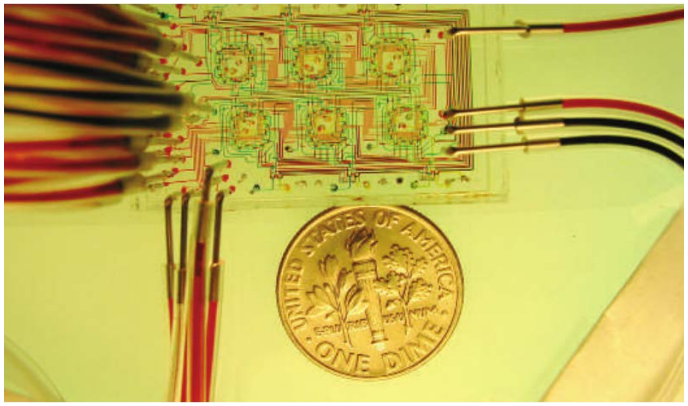
Microfluidic-Raman Spectroscopy of Single Cells

Raheel Samuel, PhD

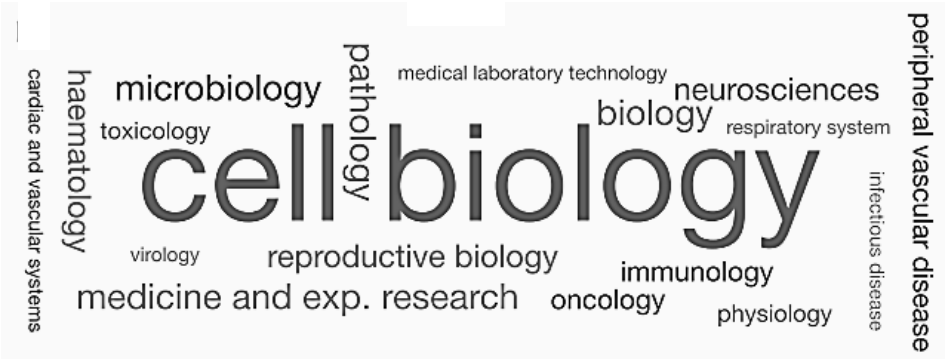
Andrology Labs, School of Medicine, University of Utah

Microfluidics

- Microfluidics is an enabling technology that utilizes the physics of fluid flow at microscale to perform unique processes.
- Microfluidics provides to the ability to measure and control microenvironment for cell biology.



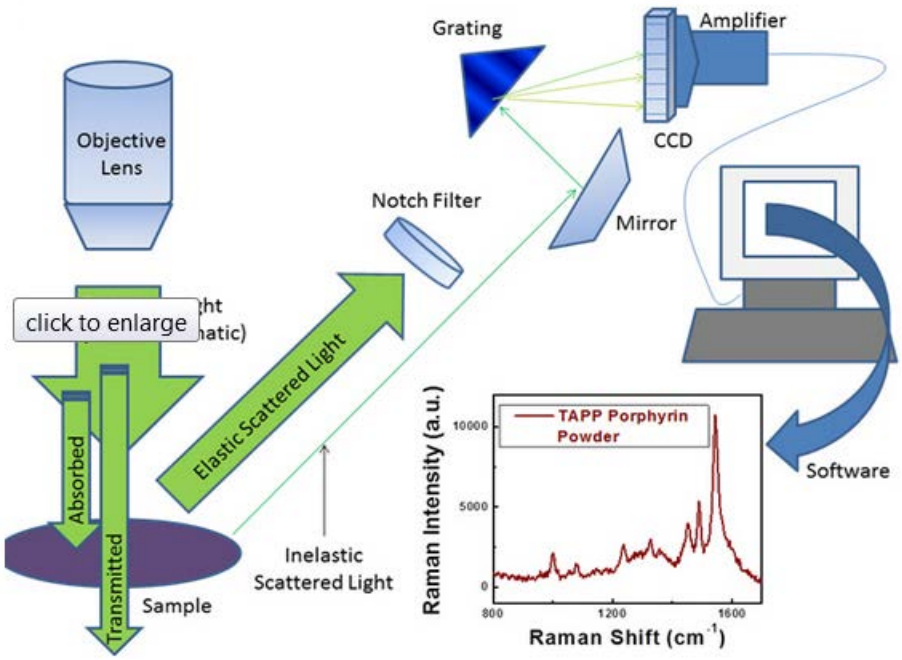
(Whitesides, Nature 2006)



(Sackmann, Nature 2014)

Raman Spectroscopy

- A form of vibrational spectroscopy relying on the detection of inelastic scattering of photons from monochromatic light sources, for quantification and identification of molecules in a substance.
- Currently extensively used of non-living substances
- Does not require sample prep
- Ideal for samples in aqueous solutions
- With selection of the right wavelength, intensity, and applied dose photo-induced damage to biological materials can be avoided



(Murphy, J. Phys. Chem. C, 2011*)*

Current work on Raman Spectroscopy of Single Cells

- **Motivation:**
  1. Identification of biomarkers of cell types that can be identified without causing any change to the natural state of the cell
  2. Identification of certain cells that are hard to distinguish with other imaging techniques

- **Some notable demonstrations:**
  1. Human cancer cells (and different stages of cancer)
  2. Mouse liver cells to identify cells infected by Hepatitis B or C
  3. Identification of particular stem cells from other cells
  4. Identification of bacterial cells or hard to culture microorganisms
  5. Protein distribution within the cells or cell media
  6. Real-time qualitative/quantitative monitoring of intercellular/extracellular species

Microfluidic-Raman Spectroscopy

- **Combined capabilities:**
  1. Both are ideally suited for low volume samples
  2. Both can de designed to offer non-destructive analysis of the sample of interest
  3. Can offer the ability to provide deep insight in cell biology by precise control of microenvironments
  4. Both are aqueous media friendly

- **Applications:** Health and Safety, Diagnostics, Industrial processes, Pharmaceuticals, Forensics, Food and Quality control, Biotechnology, Material Science

- **Current need:** Effective collaborations between multidisciplinary individuals with background in cell biology, analytical chemistry, microfluidics, optics, data analysis.

Microfluidic-Raman Spectroscope at Andrology Labs

- A collaborative effort of **Joel Harris Group** (Chemistry), **Bruce Gale Group** (Mechanical Engineering), and **James Hotaling/Douglas Carrell Group** (School of Medicine)

- Current funding secured through University of Utah RIF and SEED grant: $55,000 (approx.)

- **Current Specs:**
  1. Laser and associated optics retrofitted to a inverted microscope
  2. 785 nm laser source
  3. Microfluidic cell trapping/sorting chip
  4. Optical trapping capability of single cells/particles in microchannels

Possible Grant Calls for Collaborations

- NIH: Exploratory/Developmental Bioengineering Research Grants (EBRG) [R21]
- NIH: Development of Highly Innovative Tools and Technology for Analysis of Single Cells (SBIR) (R43/R44)
- NSF: Major Research Instrumentation Program (MRI)
- NSF/NIH: SBIR/STIR
- Others…

Thank you