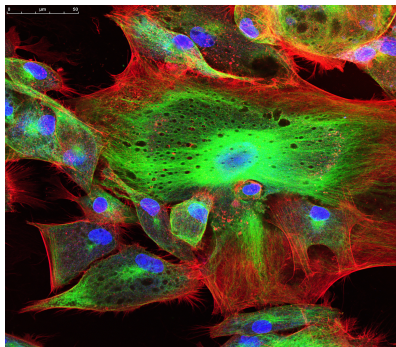


# Statistical Physics of Soft/Biological Matter

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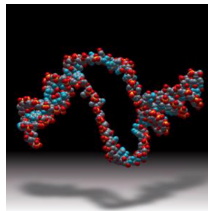
(Fluorescent micrograph of skin cells: DNA stained in blue, microtubules stained in green, F-actin stained in red.)

# Soft Matter

- ▶ Examples of soft materials: **polymers**, membranes, liquid crystals, colloids, surfactants, granular systems. Structural glasses (e.g., window glass) are hard, but share many features with soft systems.
- ▶ **Biological matter** at various degrees of organisation is also soft matter: **biopolymers** (e.g., DNA, F-actin, microtubules, intermediate filaments, collagen), biomembranes, cells, the extracellular matrix, tissues.
- ▶ Main characteristics:
  - ▶ **Entropy** dominated (large thermal fluctuations)  $\implies$  **Statistical Mechanics** is needed for **understanding!**
  - ▶ Large length and time scales
  - ▶ Very sensitive to external perturbations
  - ▶ Very often out of equilibrium (active, driven)

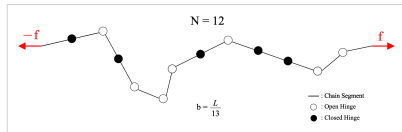
# Current project (with graduate student Geunho Noh)

*Elasticity of two-state polymers and polymer loops*



(Univ. of Glasgow)

- ▶ How does the topology (loops vs strings affect the elasticity)?
- ▶ What if we have loops which zip and unzip (breathing polymer chain)?



G. Noh and PB, "Tensile elasticity of a freely jointed chain with reversible hinges," *Soft Matter* 17

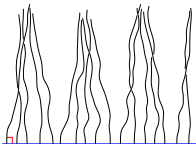
(2021), 3333-3345

# One graduate student position is available!

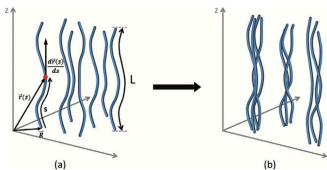
- ▶ **Prerequisites:** Curiosity and diligence, strong background in basic Physics (including Thermal/Statistical/Quantum Physics) and Mathematical Methods of Physics. Some familiarity with computer algebra systems (such as Maple or Mathematica) would be helpful. LaTeX for scientific writing.
- ▶ **Funding sources:**
  - ▶ BK21 FOUR Program
  - ▶ NRF supported project entitled "*Statistical Physics of looping, disordered, and confined polymers*"

# Proposed project: “ Order out of disorder ”

Bundle formation induced by permanent random cross-linking of aligned polymers



PB, E.M. Terentjev, and A. Zippelius, *Phys. Rev. E* **88**, 042601 (2013)



S. Dutta, PB, and Y.J. Jho, *Europhys Lett* **114**, 28001 (2016)

- ▶ What if, instead of an explicit attractive potential, we introduce random permanent cross-links between the polymers?
- ▶ **Random cross-links act as quenched disorder**, but they also give rise to an effective short-range attraction.
- ▶ Can we get order (bundling) out of disorder (random cross-linking)?

**??? Interested ???**

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