A skeletal muscle tissue, which has been perfected over millions of years of evolution, remains a great source of inspiration for the design and development of artificial actuators. Even the most complex motion results from **simple contractions** of antagonistic muscle pairs transferred to the skeleton via tendons. From the mechanical point of view, muscle fibers contraction is more favorable as the expansion can lead to instability and fiber buckling. Among all the numerous strategies, photoactuation offers remote and spatiotemporal actuation of matter based on **light-to-motion conversion**. Foremost, the advantage of light over electrical or mechanical stimuli is the possibility of precise and wireless actuation of micro and nanoactuators. To date, the vast majority of photoactuators employ photochemical or photothermal effects. In photochemical materials, light-activated molecular level transformations can lead to macroscopic changes of dimensions or shape. Light-induced heat in photothermal materials can result in positive or negative thermal expansion, phase transitions, or adsorption/desorption of molecules, which can be harnessed into motion. Typically, photothermal materials merge light-absorbing heaters with thermo-responsive matrices. The search for photoresponsive material for artificial muscles mimicking their natural counterparts faces several trade-offs between light-to-motion conversion efficiency, light wavelength, dynamics, biocompatibility, operational temperature and environment, flexibility, multifunctionality, simplicity, and price.

Since its discovery in 2007, polydopamine has been the topic of an immense number of studies devoted to biomedical and environmental applications, catalysis, sensing, photonics, and electronics, to name a few. Due to its excellent photothermal properties, polydopamine has been combined with photoactive materials into composite photoactuators. Notably, the mechanical and thermal properties that are essential for effective photoactuation remain largely unexplored. Furthermore and foremost, **to date, the photoactuation of bare polydopamine or any similar poly-catecholamines has not been reported.**

In this project, we aim to investigate light-to-motion conversion, mechanical and thermal properties of nanomembranes made of nature-inspired polymers. We will use polydopamine and other poly-catecholamines (polydopamine, poly-levodopa, poly-epinephrine, and poly-norepinephrine), known for their excellent photothermal properties over a broad spectrum of light, as the building blocks for the membranes.

We want to verify the following research hypothesizes: (i) poly-catecholamine membranes can contract when exposed to visible light illumination, (ii) the subsequent membrane's expansion is spontaneous and driven by its mechanical and thermal properties, and (iii) the membranes are multi-responsive: the contraction can be triggered by light, temperature, and moisture.

To verify the above, we will employ state-of-the are fabrication and experimental tools. In particular, we will: (i) fabricate few-nanometer thick photoresponsive membranes, employ contactless and nondestructive techniques to (ii) evaluate membranes' **mechanical properties** under varied external conditions, and (iii) investigate **heat dissipation** via conduction and convection. Finally, we will investigate the **light-to-motion conversion** in the membranes with a particular focus on the dynamics and efficiency of the photoactuation for different light sources and varied ambient conditions.

Based on the project's results, soft bottom-up fabrication of closed life cycle nano- and microdevices can be realized, e.g., for remote actuation, artificial muscles, moisture, light sensing, and energy harvesting. In this regard, the fabricated membranes will benefit from exceptional broad-spectrum photothermal features, relatively high Young's modulus, and strong adhesion on various surfaces.