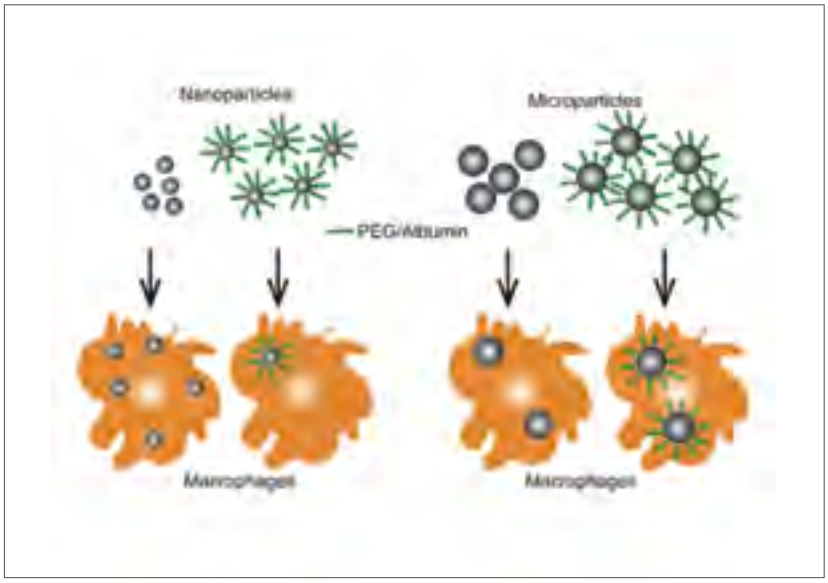
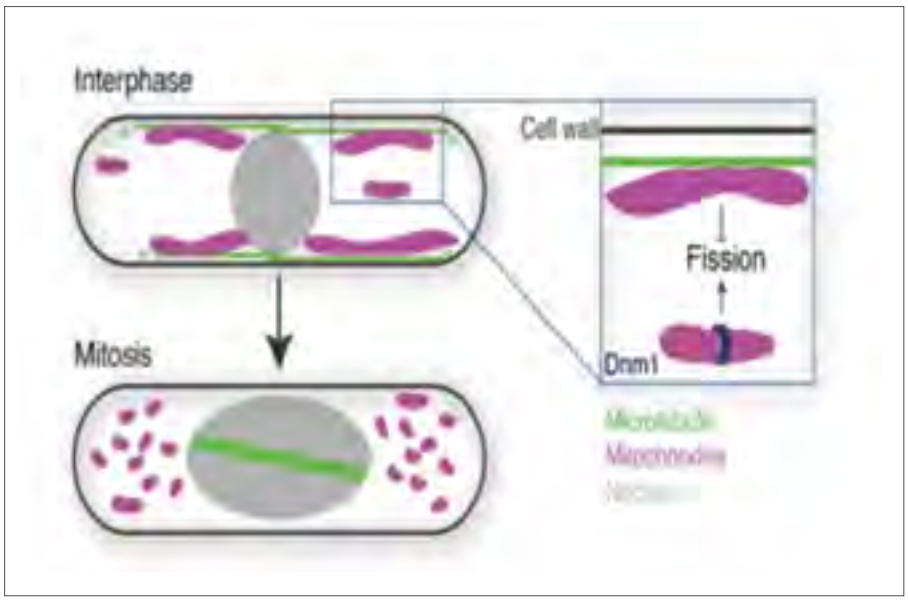
Research Snapshots 2018-19



Siddharth Jhunjhunwala (BSSE)

A number of nano- and micro-particulate formulations are either currently in use or are being developed for a variety of biomedical applications. These particulates are primarily cleared from the body by phagocytes, and preventing this process is necessary to improve circulation or retention times. A common strategy to prevent phagocytic uptake of nano-particulates is to coat their surface with polyethylene glycol or albumin. However, it remains unclear if this strategy works for particulates of all sizes. In this study, Siddharth Jhunjhunwala's team show that the aforementioned surface modification strategies that help nano-particulates evade phagocytic uptake do not work for micro-particulates. Further, it highlights the need to reassess the importance of particulate size in clearance from the body.

Preeti Sharma, Devashish Sen, Varsha Neelakantan, Vinidhra Shankar, Siddharth Jhunjhunwala*. Disparate effects of PEG or albumin based surface modification on uptake of nano-and micro-particles. *Biomaterials Science, 2019.* Vol. 7, Pg. 1411-1421. DOI: 10.1039/C8BM01545G



Vaishnavi Ananthanarayanan (BSSE)

Most of us remember from our early years of learning biology that mitochondria are the ‘power house of the cell’. The textbook representation of mitochondria that we are familiar with is not entirely accurate. Within a cell, mitochondria are actually present in the form of an intricate network of tubes that are constantly moving about, bumping into each other and tearing apart. This dynamic nature of mitochondria is characteristic to any healthy, living eukaryotic cell. To enable these dynamics, separate players - molecular scissors which cut the mitochondria, and molecular glues which enable fusion of mitochondria – are essential. All these players come together to maintain a perfect balance of fission and fusion for the proper functioning of the cell.

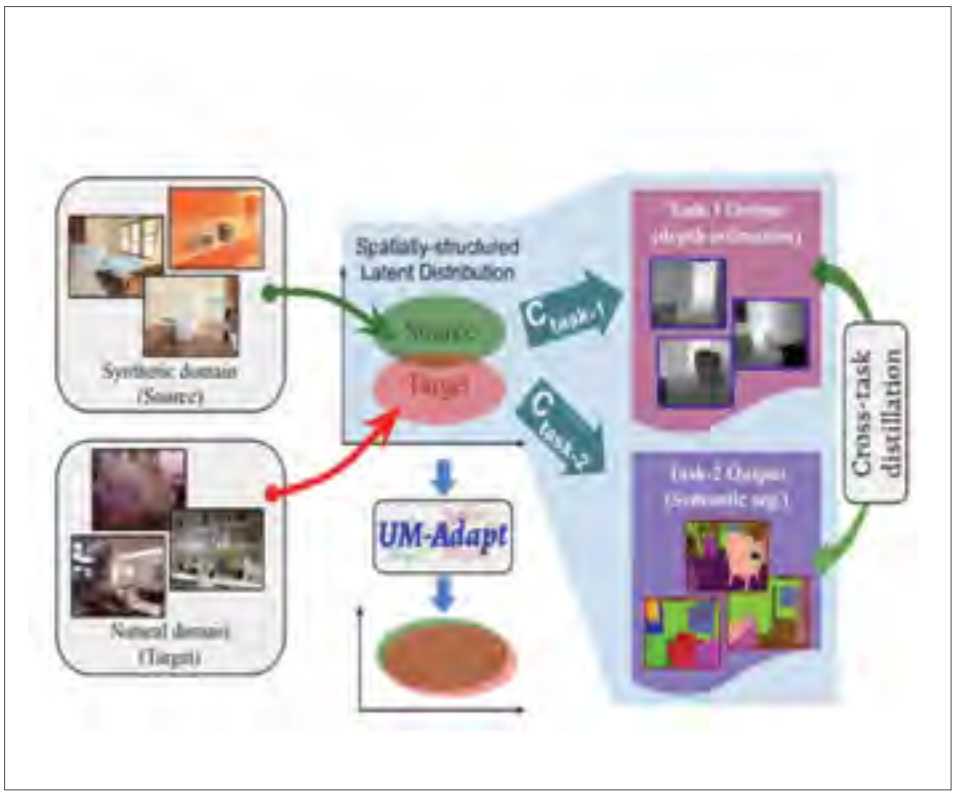
Recent work from our lab has shown that another component of cells, the cytoskeleton, which can be thought of as the skeleton inside your cells, plays an important role in controlling mitochondrial dynamics. This class of cytoskeletal structures called ‘microtubules’, are self-organizing tubes that can grow and shrink. In the model organism we used in this study, called the fission yeast, mitochondria remain bound to the microtubules. We discovered that this attachment to microtubules is essential to maintain the balance between fission and fusion of mitochondria. When microtubules shrink, mitochondria undergo fission, and conversely, when microtubules grow, mitochondrial fission is prevented. Why is this important? In several diseases including neurodegeneration, mitochondrial form, and therefore function, is affected. This work gives us insight into how we might be able to restore mitochondrial function in disease states by changing microtubule dynamics.

Mehta + , Chacko + , Chug, Jhunjhunwala and Ananthanarayanan*. (2019) Association of mitochondria with microtubules inhibits mitochondrial fission by precluding assembly of the fission protein Dnm1. (in press) (+ , equal contribution; *, corresponding author) http://www.jbc.org/content/early/2019/01/02/jbc.RA118.006799

M Sekhar (ICWaR)

Groundwater accounts for approximately half of Indian urban water use. We conducted a study to understand the sustainability and future water security of groundwater resources in Bangalore city, which is largely unknown. Moreover, very little is known about role of recharge from extreme events, which have the potential to buffer urban floods. The study revealed that in highly urbanized areas such as Bangalore we could show that the natural water cycle is altered dramatically by the effect of leaking pipes and recharge of waste water in resulting in the positive groundwater balance in core areas. However, in the rapidly growing peripheral areas, the converse was true. The excess rainfall event during August–September 2017 had resulted in a recharge of 47 Mm3 for those months when compared to 19 Mm3 for the entire year of 2016.

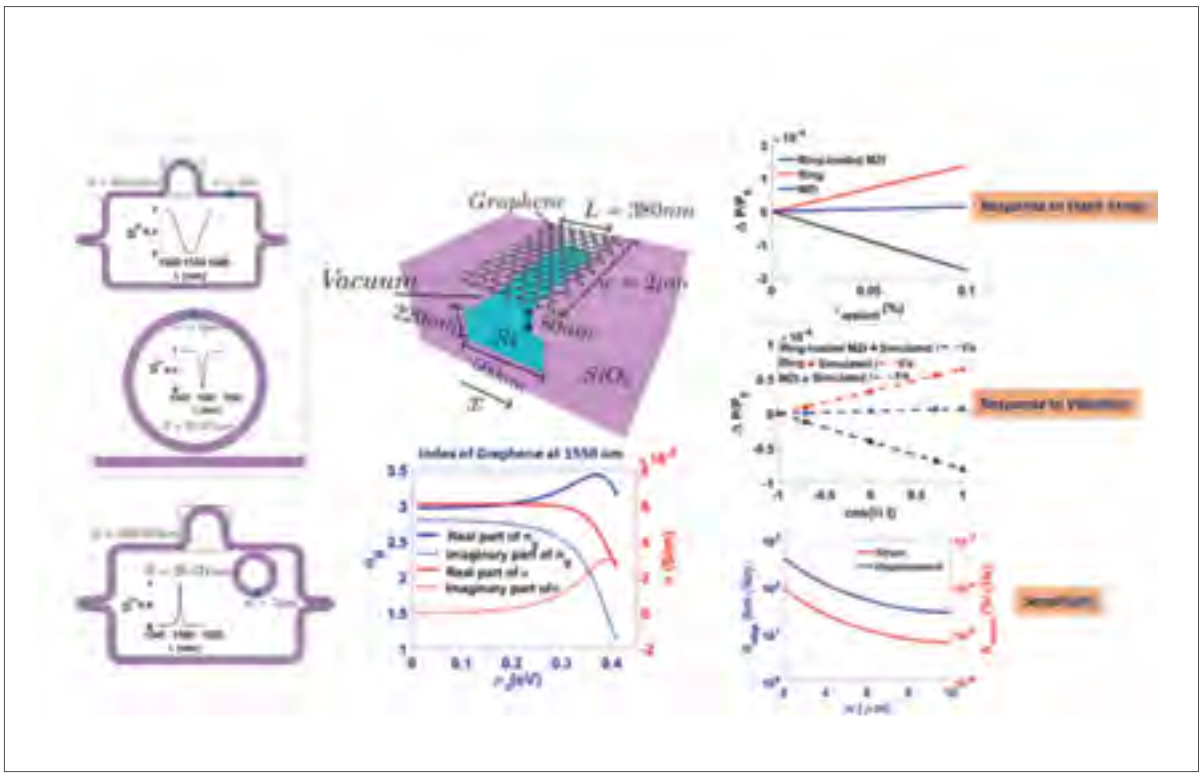
Sekhar, M., Tomer, S., Thiyaku, S., Giriraj, P., Murthy, S., & Mehta, V. (2018). Groundwater Level Dynamics in Bengaluru City, India. Sustainability, 10(1), 26.



Venkatesh Babu R (CDS)

Recent advances in deep learning heavily rely on the availability of a huge amount of clean annotated information involving substantial manual effort. Although such methods achieve near human-level performance on popular benchmarks, many recent studies show that these benchmarks only weakly test their intended purpose, because these models exhibit an alarming level of dataset-bias (or non-generalizability). Generalization refers to the intelligence, or the ability of abstraction, that enables an algorithm/model to be effective across a range of inputs and applications. Most of the existing approaches independently address task-transferability and cross-domain adaptation, resulting in limited generalization. In this research work, we have proposed a simple, yet effective unsupervised multi-task adaptation framework, that yields generic image representations with superior transferability across both tasks and domains. Such a learning approach is of immense importance for the advancement of Artificial Intelligence, as it not only reduces the data-dependency of deep models, but also provides an effective solution to adapt models trained solely on controlled synthetic environment, to unknown natural scenarios.

Jogendra Nath Kundu, Nishank Lakkakula, R. Venkatesh Babu, “UM-Adapt: Unsupervised Multi-Task Adaptation Using Adversarial Cross-Task Distillation”, accepted in IEEE International Conference on Computer Vision (ICCV) 2019.



Akshay Naik (CeNSE)

Scaling of Micro-Electro-Mechanical System (MEMS) toward highly sensitive nano-electro-mechanical systems (NEMS) requires the use of ultra-low mass structures like Graphene membrane. The fundamental question is - how would the material would behave when the size is scaled to a one or two atomic layers? Characterising mechanical property of such materials becomes extremely challenging with the current techniques. Recently, researchers at Centre for Nano Science and Engineering, IISc have proposed a novel method to measure strain and displacement of Graphene. The transduction scheme exploits Silicon Photonics; a versatile photonic integrated circuit platform developed for optical interconnect application. The scheme uses overlap between a guided wave and Graphene to interrogate the changes in the mechanical property which is demonstrated to detect the strain and displacement of graphene based nanoelectromechanical system. The scheme, if implemented using ring loaded Mach-Zehnder interferometer with modest optical quality factors of about 2500, should be able to achieve displacement sensitivity of about 30fm/√Hz and strain sensitivity of 6x10-6 %/√Hz. This is the first time such an integrated photonics-based transduction proposal is made and accepted by the community as a viable option for probing materials at such extreme scale.

Ref: Aneesh Dash, S. K. Selvaraja, and A. K. Naik, “On-chip optical transduction scheme for graphene nano-electro-mechanical systems in silicon-photonic platform”, *Optics Letters, 2018.* DOI: 10.1364/OL.43.000659