NANOMEDICINE: FROM HIGH TECH TO GLOBAL HEALTH

Robert K. Prud'homme,
Jie Feng, Joanna Zhang, Chet Markwalter, Robert Pagels, Kurt Ristroph, Jack Lu, Chang Tian, Madeleine Armstrong
Dept. Chemical and Biological Engineering, Princeton University, Princeton, NJ, USA

Nanotechnology in drug delivery has a schizophrenic dichotomy of goals. One goal is to make drugs more bioavailable, which is normally associated with oral drug delivery. This bioavailability is associated with rapidly releasing drugs. The goal is achieved by making nanocarriers (NCs) with high surface-to-volume ratios, and with the drug in an amorphous state. The other goal is to encapsulate and deliver drugs to specific disease sites. This requires retaining the drug in the NC until targeted delivery is achieved. We will discuss examples of nanoparticle formulations based on our rapid micromixing platform – Flash NanoPrecipitation (FNP)– that address both of these goals. Sustained release of more hydrophilic drugs is achieved either by making insoluble ion pairs or through pro-drug synthesis. For oral delivery, enhanced dissolution of very hydrophobic drugs requires the high surface-to-volume ratio of NCs plus the drug being in a stable amorphous form in the NC core. Our research in oral nanoparticle formulations has been driven by funding from the Gates Foundation for low cost nanoparticle formulations. We demonstrate NC formation using lecithin, HPMC, and the corn protein, zein. The coupling of FNP to a spray drier enables a continuous, integrated, one step and scalable process for the production of powders for oral administration. The scalability of the platform is demonstrated from mg to kg scales. While FNP was initially developed for encapsulation of hydrophobic actives, soluble peptides and proteins are now the fastest growing segment of the pharmaceutical market. We will present a new *inverse* Flash NanoPrecipitation process (iFNP) which enables encapsulation of peptides and biologics at over 50% loading with 95% loading efficiency.