Targeted drug delivery and personalized nano-medicine

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The field of medicine is taking its first steps towards patient-specific care. Our research is aimed at tailoring treatments to address each person's individualized needs and unique disease presentation. Specifically, we are developing nanoparticles that target disease sites, where they perform a programmed therapeutic task. These systems utilize molecular-machines and cellular recognition to improve efficacy and reduce side effects.

Two examples will be described: the first involves a nanoscale theranostic system for predicting the therapeutic potency of drugs against metastatic cancer. The system provides patient-specific drug activity data with single-cell resolution. The system makes use of barcoded nanoparticles to predict the therapeutic effect different drugs will have on the tumor microenvironment.

The second system makes use of enzymes, loaded into a biodegradable chip, to perform a programed therapeutic task – surgery with molecular precision. Collagenase is an enzyme that cleaves collagen, but not other tissues. This enzyme was loaded into the biodegradable chip and placed in the periodontal pocket. Once the collagenase releases from the chip, collagen fibers that connect between the teeth and the underlying bone are relaxed, thereby enabling enhanced orthodontic corrective motion and reducing pain. This new field is termed BioSurgery.

The clinical implications of these approaches will be discussed.