Multi-drug resistant diseases are one of the biggest healthcare challenges society is facing today. The rapid resistance development in microbes, for instance, has completely eviscerated the current antimicrobial drug pipeline. Likewise, resistance onset in cancer renders treatment with a single therapeutic agent completely ineffective, requiring a combination therapy of at least four drugs. To broadly address the multi-faceted problem of drug-resistance as well as other important concerns in disease treatment, we have exploited polymer science to (1) develop novel macromolecular therapeutics for treating infectious disease and cancer, (2) targeted macromolecular delivery agents for poorly soluble drugs and (3) organic macromolecular MRI imaging agents that can be either used alone as a diagnostic or as a concurrent therapeutic delivery agent (theranostics).

- Macromolecular antimicrobials, antivirals and chemotherapeutics demonstrate high efficacy with selectivity.
- Macromolecular therapeutics consists of polymeric assemblies that exhibit selective, but non-specific interactions with the pathogen, and genomic analysis has shown that no bacterial genes responsible for drug resistance were up-regulated during the course of polymer treatment, demonstrating the polymer’s ability to circumvent traditional resistance pathways in microbes. Similar results were obtained with cancer models.
- The foundation of the macromolecular therapeutics is the use of organocatalysis for preparing biocompatible and biodegradable polymers with precisely defined molecular structure to enable the tailoring of macromolecules for specific therapeutic applications including disease treatment, precision delivery of drugs or genes, and MRI imaging agents.
- Overall, the field of macromolecular therapeutics offers significant promise for improving human health by applying the tools of biomimetic chemistry and nanotechnology to create materials for precise, highly effective disease treatment that does not induce resistance.

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