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EDITORIAL

Recent Advances in Drug Delivery

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Drug delivery continues to be a critical field of science for advancing effective treatments across a wide range of diseases. In this special issue, drug delivery advances in immunotherapy, RNA therapies, formulation optimization and characterization, and imaging are presented. Advances across a variety of delivery systems including exosomes, fusion molecules, liposomes, nano/microparticles, and micelles are presented from an outstanding group of drug delivery researchers. This special issue includes papers from the groups of Drs. Molly Stevens (University of Oxford), Robert Langer and Giovanni Traverso (Massachusetts Institute of Technology), Yu-Kyoung Oh (Seoul National University), Brittany Givens (University of Kentucky), Erin Lavik (University of Maryland), Quanyin Hu (University of Wisconsin-Madison), Sean Geary and Aliasger Salem (University of Iowa), Simon Matoori (Université de Montréal), M.N.V. Ravi Kumar and Meenakshi Arora (University of Alabama), Gaurav Sahay (Oregon State University), Hamidreza Ghandehari (University of Utah), Glen Kwon (University of Wisconsin-Madison), Kristy M. Ainslie (University of North Carolina at Chapel Hill), Shawn Owen (University of Utah), and Zhengrong Cui (University of Texas at Austin).

In this special collection, a review on delivery strategies for RNA therapies is presented by Dr. Oh. The review discusses different strategies employed in the design and development of nanomaterials for RNA delivery and highlights recent advances in the pharmaceutical applications of RNA delivered via nanomaterials (1). Dr. Givens discusses how emulsion properties influence the size of poly(caprolactone) particles for use in drug delivery (2). Dr. Stevens presents a review that compares commercially available single particle techniques, with a particular focus on single particle Raman spectroscopy (3). Dr. Lavik compares exosomes against liposomes for treatment of traumatic brain injury (4). Drs. Langer and Traverso describe how poly(β-amino ester) (PBAE) nanoparticles are potent mRNA delivery platforms that can elicit B cell and T cell activation, including antigen-specific cellular and humoral responses (5). Dr. Hu introduces the role of macrophages in tumor progression, summarizes the recent advances in macrophage-centered anticancer therapy, and discusses their challenges as well as future applications (6). Dr. Matoori presents a proof-of-concept study that shows the potential of ethiodized oil to localize alginate hydrogels in real time inside the body and identifies a new use of this FDA-approved contrast agent (7). Drs. Kumar and Arora describe a glucose-responsive microgel comprising conventional insulin and curcumin-laden nanoparticles for potential treatment of diabetes (8). Dr. Sahay formulates and characterizes an array of lipid nanoparticles containing prime editors (9). Drs. Geary and Salem build on past studies showing the synergy between small molecules and biological immunotherapies (10–15) by demonstrating that anti-PD-1 in combination with resiquimod can significantly prolong the survival of melanoma-challenged mice, compared to untreated mice and mice treated with anti-PD-1 alone (16). Extracorporeal membrane oxygenation (ECMO) is a life-saving cardiopulmonary bypass device used on critically ill patients with refractory heart and lung failure. Dr. Ghandehari demonstrates the potential of micellar propofol to reduce drug adsorption to ECMO circuit (17). Dr. Kwon shows the plasma stability and plasma metabolite concentration–time profiles of Oligo(Lactic Acid)8-paclitaxel prodrug–loaded polymeric micelles. In comparison to equivalent doses of Abraxane®, plasma PTX exposure is two orders of magnitude higher for Abraxane® than PTX from o(LA)8-PTX prodrug–loaded PEG-b-PLA micelles, and plasma o(LA)1-PTX exposure is fivefold higher than PTX from Abraxane®, demonstrating heightened plasma metabolite

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exposure for enhanced antitumor efficacy (18). Dr. Ainslie presents data on vinyl sulfone–functionalized acetalated dextran microparticles as a subunit broadly acting influenza vaccine. This vaccine approach was evaluated *in vivo* with a prime-boost-boost vaccination schedule and illustrated generation of a humoral and cellular response that could protect against a lethal challenge of A/California/07/2009 in BALB/c mice (19). Dr. Owen presents a review on therapeutic fusion proteins (20). Finally, Dr. Cui presents a review on connexin-containing vesicles for drug delivery which have significant potential because connexin is a transmembrane protein present on the cell membrane of most cell types (21).

References

1. Byun J, et al. RNA nanomedicine: delivery strategies and applications. AAPS J. 2023;25(6):95.
2. Manning AN, et al. Tuning the emulsion properties influences the size of poly(caprolactone) particles for drug delivery applications. AAPS J. 2023;25(6):100.
3. Saunders C, de Villiers CA, Stevens MM. Single particle chemical characterisation of nanoformulations for cargo delivery. AAPS J. 2023;25(6):94.
4. Hennigan K, Lavik E. Nature vs. manmade: comparing exosomes and liposomes for traumatic brain injury. AAPS J. 2023;25(5):83.
5. Kim H, et al. Gastrointestinal delivery of an mRNA vaccine using immunostimulatory polymeric nanoparticles. AAPS J. 2023;25(5):81.
6. Wang Y, Barrett A, Hu Q. Targeting macrophages for tumor therapy. AAPS J. 2023;25(5):80.
7. Guirguis N, Zellagui Y, Matoori S. Real-time tracking of in situ-forming alginate hydrogel by contrast-enhanced computed tomography. AAPS J. 2023;25(5):79.
8. Heyns IM, et al. Glucose-responsive microgel comprising conventional insulin and curcumin-laden nanoparticles: a potential combination for diabetes management. AAPS J. 2023;25(4):72.
9. Herrera-Barrera M, et al. Lipid nanoparticle-enabled intracellular delivery of prime editors. AAPS J. 2023;25(4):65.
10. Ebeid K, et al. Synthetically lethal nanoparticles for treatment of endometrial cancer. Nat Nanotechnol. 2018;13(1):72–81.
11. Geary SM, et al. Tumor immunotherapy using adenovirus vaccines in combination with intratumoral doses of CpG ODN. Cancer Immunol Immunother. 2011;60(9):1309–17.
12. Geary SM, et al. The combination of a low-dose chemotherapeutic agent, 5-fluorouracil, and an adenoviral tumor vaccine has a synergistic benefit on survival in a tumor model system. PLoS ONE. 2013;8(6):e67904.
13. Smith R, et al. Cationic nanoparticles enhance T cell tumor infiltration and antitumor immune responses to a melanoma vaccine. Sci Adv. 2022;8(29):eabk3150.
14. Zhang XQ, et al. Potent antigen-specific immune responses stimulated by codelivery of CpG ODN and antigens in degradable microparticles. J Immunother. 2007;30(5):469–78.
15. Tambunlertchai S, et al. Investigating silver nanoparticles and resiquimod as a local melanoma treatment. Eur J Pharm Biopharm. 2023;183:1–12.
16. Tambunlertchai S, et al. Anti-melanoma effects of resiquimod (RSQ) in vitro and in combination with immune checkpoint blockade in vivo. AAPS J. 2023;25(4):57.
17. Khurana N, et al. Micellar Encapsulation of propofol reduces its adsorption on extracorporeal membrane oxygenator (ECMO) circuit. AAPS J. 2023;25(4):52.
18. Repp L, et al. Plasma stability and plasma metabolite concentration-time profiles of oligo(lactic acid)(8)-paclitaxel prodrug loaded polymeric micelles. AAPS J. 2023;25(3):39.
19. Batty CJ, et al. Vinyl sulfone-functionalized acetalated dextran microparticles as a subunit broadly acting influenza vaccine. AAPS J. 2023;25(1):22.
20. Marsh MC, Owen SC. Therapeutic fusion proteins. AAPS J. 2023;26(1):3.
21. Hanafy M, Cui Z. Connexin-containing vesicles for drug delivery. AAPS J. 2024;26(1):20.