

Editorial

Recent Trends in Nano-Biotechnology Reinforcing Contemporary Pharmaceutical Design

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Pharmaceutical design is vast topic covering tools, techniques and their up-to-date implementations to improve pharmaceutical product discovery and development. Traditionally, much emphasis has been drawn to tests drug potentially, neglecting fundamental property, leading to huge loss in clinical trials in terms of cost, time and labor. To combat the challenges, bioinformatics and nanobiotechnology has come to savior, fueling novel methods to improve metabolic stability, solubility, transporter effect and permeability for drug discovery and development. Innovative high throughput ADME/TOX assays overcame the erroneous data previously obtained through poor understanding through structure-activity relationships (*SAR*) in enzyme and cell-based assays.

Many novel actors played important role in improving drug design ever since pure oncolytic, monoclonal antibodies (MAbs) and nucleic acids have been adapted as drug. One particular challenge with MAbs is their propensity to self-association and/or with other molecules (colloidal) via nonspecific interactions, which lead to high viscosity, hence, low solubility and off-target binding resulting in fast antibody clearance. Nanobiotechnology based antibody engineering and design via inhibition of self-aggregation and conformation specific antibodies development have yielded fresh breath in pharmaceutical design. Novel high-throughput screening techniques such as self-interaction nanoparticle spectroscopy (SINS) has helped to recognize mutant hotspots and physicochemical parameters to prevent antibody aggregation and self-associations in solution conditions. Further, biocompatible nano- or micro-carrier for drug encapsulation lend a better half-life to therapeutic molecules undergoing spontaneous degradation under physiological clinical conditions and insulate the drugs intoxication. Biophysical methods microparticulate and stealth multipartite nanocarrier design directly act as immunomodulators to disguise innate immune response of the host, and improve bioavailability and channelize drug to avoid phagocytosis in systemic circulations. Combating MRSA and antibiotic resistance is another significant area of antimicrobial pharmaceutical design that has catch up nanobiotechnology routes. Nanocarrier mimicking probiotic non-colonizing bacterial membrane ghost and micelle microcarrier tethering lipoprotein molecules in their design has reached to clinics as smart pharmaceutical design for rapid wound healing and regenerative medicine. Fullerene and dendrimers as synthetic non-immunogenic encapsulating supra molecules further strengthened drug loading efficacy and slow release, as up front nanocarrier technology.

The theme Issue on recent trends in pharmaceutical design in *Current Pharmaceutical Design Journal* brings together a collection of multidisciplinary reviews and articles that discuss novel trends, with special emphasis to nanobiotechnology and their applications in pharmaceutical design. Although we cannot cover all aspects of pharmaceutical design being very vast topic in one special issue, we hope that this issue will act as a springboard to highlight to our readers the importance of interdisciplinary and nanobiotechnology based approaches both instant and in the near future drug discovery and development.

In this issue, as guest editorial topic, Singh and Sitti propose a very recent and novel concept of robots at mili/microscale for theranostics (therapy-diagnosis) applications [1], a very recent paradigmatic shift in pharmaceutical filed. Targeted drug delivery have been a long standing challenge for pharmaceutical industry, these miniaturized untethered robots has tremendous capability to transform many aspect of healthcare and drug development.

Satpute and colleagues propose bio-surfactants as antibacterial therapeutics [2]. Team show prospect and potential of bio-surfactants to inhibit microbial quorum sensing mechanisms in bacteria. Quorum sensing is an important aspect in the communications of bacteria, and has been shown to play a role in the pathogenesis. As bio-surfactants have been extensively studies, yet, their use in inhibiting the quorum sensing mechanism in microbes is not explored.

Gemmati *et al.* report on the use Factor XIII a candidate molecule possessing intrinsic properties useful to design a new drug in wound healing [3]. Recognition of novel bio-molecular markers in complex disease is one of the challenges in molecular medicine and detection of such tool should give diagnostic/prognostic information on how to proceed in the drug design and clinical care.



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Dwivedi *et al.* propose Nanofibers based Smart Pharmaceutical design for wound repair and regenerations [4]. Their team puts forth the rational of electrospinning and functional three dimensional Nano fibrous scaffolds designs in a wide spectrum of biomedical practices, such as tissue engineering, drug/gene delivery and wound dressing.

An article by Usmani and colleagues, show the impact, occurrence, behavior of nanomaterials and its applications in pharmaceutical [5]. The surge in nanotechnology research has been attributed to the significant properties and parameters of the nanoparticles that make them more versatile than their bulk forms. The field is expected to impact a large spectrum of existing technologies such as drug delivery, biomedical, therapeutics, healthcare.

Della Pina and coauthors represent an up-to-date overview on the preparation and modification of gold nanomaterials (AuNMs) designed for biomedical and therapeutic applications, including biosensor, bioimaging, phototherapy and gene/drug delivery [6]. They emphasize potential risk of AuNMs to biological systems in context with biocompatibility and for safe pharmaceutical application.

Hassan *et al.* write in detail pharmaceutical aspect of fighting diabetes using Xenotransplantation and Nanomedicine approaches [7]. Authors majorly focused upon 2 aspect: firstly, they reviewed islet studies from other vertebrates especially, jawless fish, cartilaginous as well as bony fishes and chick islets, with pre-clinical results and data in the pig-to-primate model. Secondly, nanotechnology based excellent module for addressing the diabetes problem from detection and treatment points of view are also addressed.

In review entitled pharmacological drug delivery strategies for improved therapeutic effects: recent advances Savaliya and Singh describe recent advances in pharmaceutical design focused towards different strategies such as physical and biological methods for efficacious delivery of drugs at desired tissues and even sub cellular targeting [8]. Uses of biodegradable materials, such as liposomes and polymeric particles are another class of drug delivery vehicles, which have shown tremendous success, are described in detail.

Sarioglu *et al.* show a new frontiers in current pharmaceutical design based on biosystems engineering of prokaryotes with tumor-killing capacities [9]. Authors emphasize genetic engineering routes to minimize the risks associated with tumor-targeting pathogens, as well as to increase their efficiency in killing tumor cells. Review details advances in genetic circuit design which led to the development of bacterial strains with enhanced tumor-targeting capacities and ability to secrete therapeutics, cytotoxic proteins and prodrug-cleaving enzymes, which allows their safe and effective use for cancer treatment.

Babak Mostaghaci *et al.* review new advancements and emerging opportunities in calcium phosphate system for gene delivery [10]. In this manuscript, the authors describe several experimental details which elucidate the impact of several key parameters that affect transfection efficiency in-vitro. The authors discuss small variables that have been listed in this manuscript include effect of DMSO addition, exposure time of the DNA/CaCl₂ complex, pH of the solution, and the order in which the DNA/CaCl₂ complex is added to the HEPES phosphate buffer.

Mehta and Singh reviewed recent directions in the development of novel and advanced oropharmacological products with Top-down versus bottom-up nanoengineering routes [11]. They discuss the wave of shifting current interest in dental material design towards biomineralization method and green chemistry synthesis to support oral tissue biocompatibility, and oropharmacology. In this context, they argue the biofriendly recipes using nanoengineering routes for dental materials, without using complex physicochemical, energy intensive and chemical approaches.

Barghash and Abdou discussed the role of the second generation of bisphosphonates in context with advance medicinal use, in particular, pathophysiology of metastatic bone disease [12]. Authors highlight the internalization of bisphosphonates by osteoclasts, where they interfere with biochemical pathways and induce osteoclast apoptosis. Bisphosphonates antagonistic role in osteoclastogenesis and promoting differentiation of osteoblasts also reviewed. Authors cite Zoledronic acid as a novel example, one of the second generation of BPs (*nitrogen-containing BPs*), which inhibits tumor cell invasion of extracellular matrix.

Considering drug discovery a multistep process, chance observation have little to add in new drug development, however, extremely rigid and focused nature of rational pharmaceutical design greatly mitigated the serendipitous drug discovery. Therefore current pharmaceutical design needs multidisciplinary approaches and collaborations to significantly improve the field. Rational drug discovery based on Computer-aided trial and error methods have very limited scope due to evolving nature of multidrug resistance. Therefore we need new approaches and partners, such as micro-robotic based hybrid technology and nanoscale multipartite theranostics discovery and development. We hope multidisciplinary topics discussed with the theme issue will promote further discussion among pharmaceutical industry and researches. I would like to thank all the authors and coauthor for their excellent contributions. Last but not the least, I would like to acknowledge the support from Kazim Baig, and Aamer M. Khan from Current Pharmaceutical Design publishing team for their help during the past 6 months in compiling

this issue. Considering versatile and multidisciplinary articles, we hope that readers will find in this issue new avenues of research in the related with pharmaceutical design. As guest editor, I would sincerely thank and acknowledge the diverse group of experts and colleagues who offered their substantial reviewing efforts and suggestions.

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