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Preface

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Cancer is still one of the top-ranked death-causing diseases which is continuously increasing globally. It is not only a serious concern to the health bus but also affects emotionally, and both patient and family are victims. Fortunately, the advancements in multidisciplinary biomedical sciences give hope to treat it if diagnosed at an early stage and further to manage it every detected at a mid- or later stage. In this direction, several anti-cancer drugs have been approved by the FDA and efforts are being made to investigate more drugs and explore others that can be integrated with treatment, monitoring, and diagnostics approaches, with the aim to manage cancer efficiently. To support and meet the demand, cancer treatment research and development will be occupying a market size of $365.99 billion by the year 2030.

It is expected that the design and development of selective, efficient, and affordable cancer treatment approaches including treatment of higher efficacy, targeted drug delivery, systemic therapies, radiotherapy, imaging, and surgery will keep getting attention worldwide. In this direction, the focus of exploring and adopting new materials that can support these approaches will also be equally crucial. This is much required in the case of personalized cancer management and to avoid or manage the situation of drug resistance. Yes, the tailored nanostructure of tunable and manipulative features supports the field of cancer treatment. Among a wide class of materials, sustained efforts in advancing therapeutics strategies have resulted in understanding the crucial role of functional biomolecules such as macromolecules and small molecules in combating cancer (Fig. 1). Biomolecules exhibit an inherent multifunctional property, which has been explored in developing routes to foster early detection, boost immunity, and prevent advanced-stage tumors. However, biomolecule-based cancer therapy may often have challenges such as insufficient delivery efficacy, interference of biological barrier in transporting nanostructure to targeted tissues, and limited tissue penetration. With the aim to project the capabilities and aspects of functional biomolecules in managing a targeted cancer, we appreciate the opportunity provided by the *Cancer Metastatic Reviews* to manage a special to elaborate more about this field.

Various investigated potential functional biomolecules that have been established to support cancer management are discussed herein. Carbohydrates are widely available functional materials and exhibit various shapes, sizes, functionality, and biocompatibility. These materials of various glucose units have been accepted for various biomedical applications, especially for cancer management due to the following salient features: (a) carbohydrate-based synthetic anti-tumor vaccines improve immune response, (b) development of glycoconjugate pro-drugs, (c) glycosidase inhibits immune-sugars, and early-cancer diagnosis. Based on their remarkable performance, immunotherapy and cancer carbohydrates are established as key targets in the development of safe and effective anti-cancer vaccines. Natural products support the approach of nutraceuticals due to their therapeutic effects and almost no adverse effects. Adopting these materials will be a powerful approach to discovering biologically active compounds with unique structures and mechanisms of action. These materials are extracted from medicinal plants and successfully demonstrate their anti-cancer ability in the following ways: (a) The main sources of anti-cancer drugs are microbes and plants, (b) fewer side effects, and (c) greater therapeutic efficacy.

Lipids are programable biomaterials that have been investigated for targeted drug delivery wherein payload incorporation of multiple drugs and sequential release can be planned according to the disease model. These smart materials have also supported cancer treatment and management research as (a) lipids are merging as unique disease biomarkers to support diagnostics and predictive aspects, (b)

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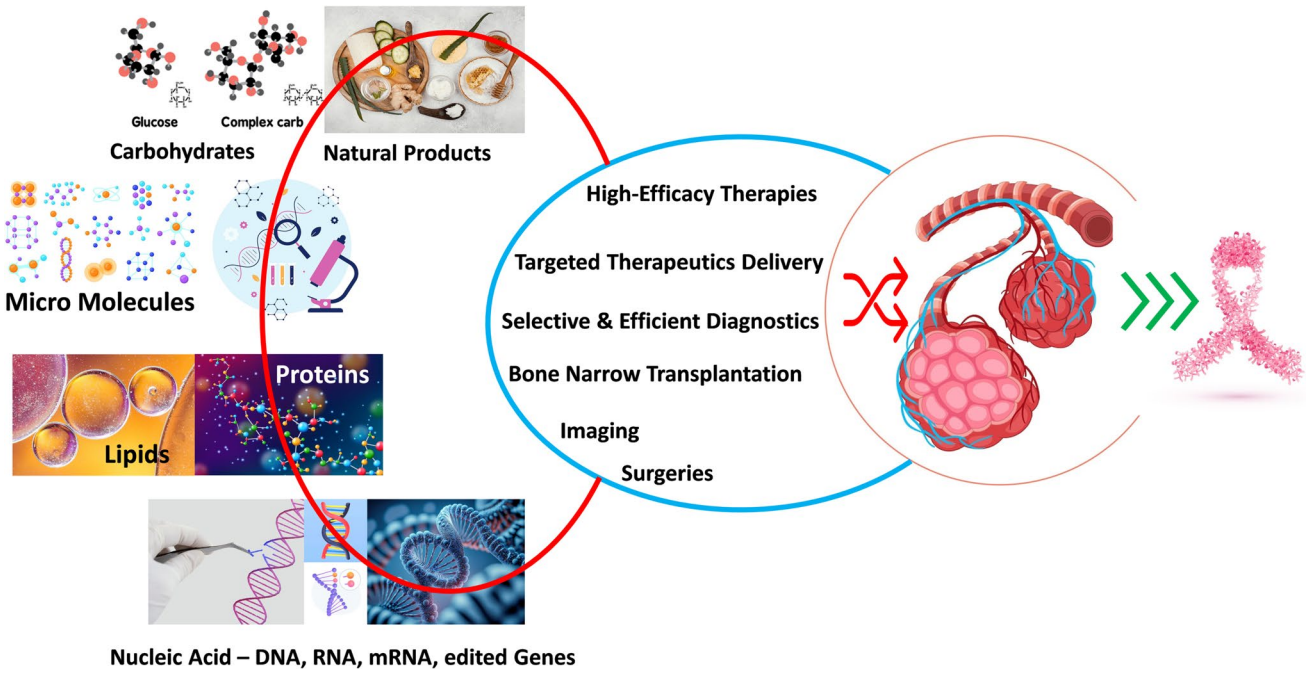

Fig. 1 Illustration of functional molecules, including natural products, carbohydrates, micro-molecules, lipids, proteins, and nucleic acids, supporting diagnostics, treatment, monitoring, and management of a targeted cancer

membrane disrupting agents, (c) components of nanocarrier, and (d) membrane-lipid targeting agents in combination with chemotherapeutic agents in a promising approach. Proteins are made of amino acids that can be tuned to achieve desired properties including targeted drug delivery and anti-cancer properties. Their role in cancer management is well accepted due to the following: (a) application as inert nanoscale carriers and functional targeting agents; (b) exhibit potent cytotoxic activities; (c) protein engineering and rDNA technologies empower cytotoxic proteins with accessory domains for oligomerization, targeting, endosomal escape, and self-activation; and (d) production of self-assembling and self-delivered protein drugs is becoming a feasible option.

Nucleic acids, a very wide class of small and micro-molecules, are emerging as an essential component due to tuned functionality and gene modification to achieve targeted effects. In cancer management, nucleic acids have been adopted as (a) immunostimulatory DNA/RNA, (b) mRNA/plasmids that can be translated into immunotherapeutic proteins/peptides, genome editing nucleic acids, and (c) expected to hold great potential to further advance the field of cancer immunotherapy. Micro-molecules (10 kDa) ranging/starting from minerals, → enzymes, → small peptides, → amino acids, → nucleotides, and → nucleosides are emerging as efficient anti-cancer agents and exhibiting the following unique advantages as (a) cell-penetrating capabilities, (b) shorter shelf-life, (c) increasing tumor immunogenicity, (d) overcoming tumor-assisted immunosuppression, (e) offering immune modulation to sustainability and improves the efficacy of cancer immunotherapy, and (f) compatible with systemic administration, and amenable to both extracellular targets.

All the aspects of functional biomolecules to manage cancer are well discussed in our projected special issue and the outcomes are as follows: (1) Verma et al. explore the nanomaterial-based therapies investigated for cancer cell therapies; (2) explore mechanisms, Wang and Deng explore the molecular mechanism, biomarkers, and cancer therapies; (3) new progresses in the field of tuberculosis scar carcinoma are well discussed by San et al.: (4) exploring potential biomarkers suitable for immunotherapy in non-small-cell lung cancer by Wang et al.; (5) cancer pathogenesis associated with short-chain fatty acids by Feitelson et al.; (6) oral delivery aspects, considering RNAi as therapeutics are well explored by Afrin et al.; (7) Vabhi et al. carefully explored the targeted therapeutics-based on miRNA mechanism; (8) signaling pathways and related challenges along with opportunities are well discussed by Shant et al.; (9) natural product-based cancer management is well explored by Hegde et al. and suggested to promote them not only to support cancer but also for immune support; (10) in the same direction, the aspects of tetrahydrocannabinols as efficient anti-cancer agent are discussed by Prateeksha et al. carefully and critically; (11) Sharma et al. explores the capabilities of thiazolidin-4-one containing molecules in cancer therapeutics; and (13) the new insights of gynecological cancer

therapies are well discussed by Zhang et al. carefully and critically. This special issue is well supported by expert opinion, in the form of an editorial by Dhasmana et al. to project next-generation immune checkpoints and CRT cell therapy, respectively, related to the aspects of functional biomolecules for cancer management.

In summary, numerous anti-cancer drug development drives have been growing to achieve specificity, affordability, applicability, personalized treatment, and no, least, or acceptable risks of adverse effects or loss of function. Surely, this will be multidisciplinary research and need time-to-time assessments and evaluation to have an efficient treatment against a targeted cancer. To cover some of the state-of-the-art gaps and highlight aspects, this special issue is an attempt to highlight such efforts that discuss the recent developments, challenges, alternative effective solutions, and expected application of biomolecules and biomolecular technologies in the field of cancer therapeutics. Additionally, the experts also discussed underlined insight into the potential benefits of integrating biomolecular therapy with chemotherapy. This combinational approach based on compartmentalization is a substantial step forward in the furtherance of personalized medicine in clinical practice.

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Data availability The related data will be available on request.

Declarations

Conflict of interest The authors declare no competing interests.