An integrated approach for standardized guidelines and validation of physicochemical characterization of nanopharmaceuticals

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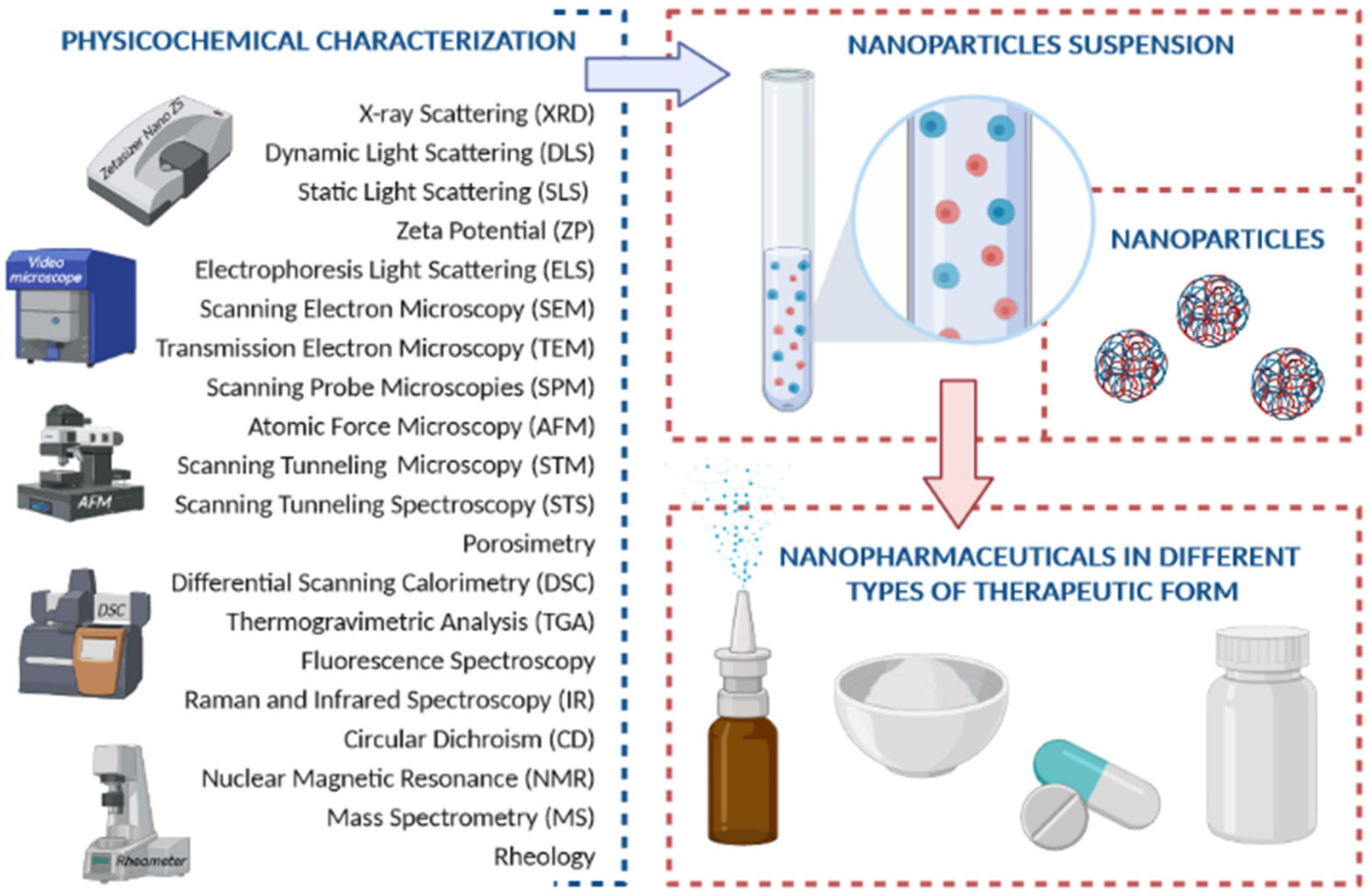
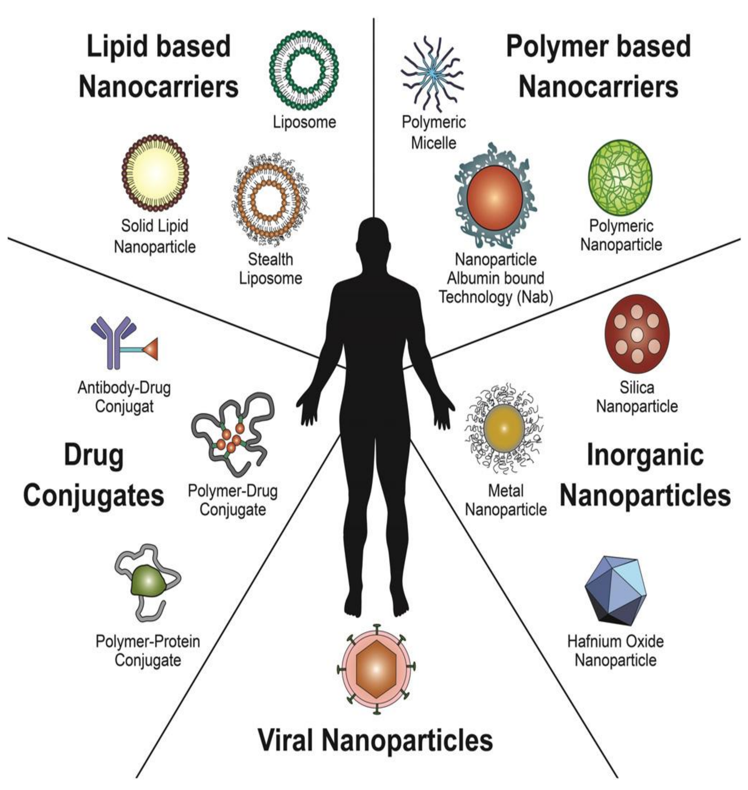
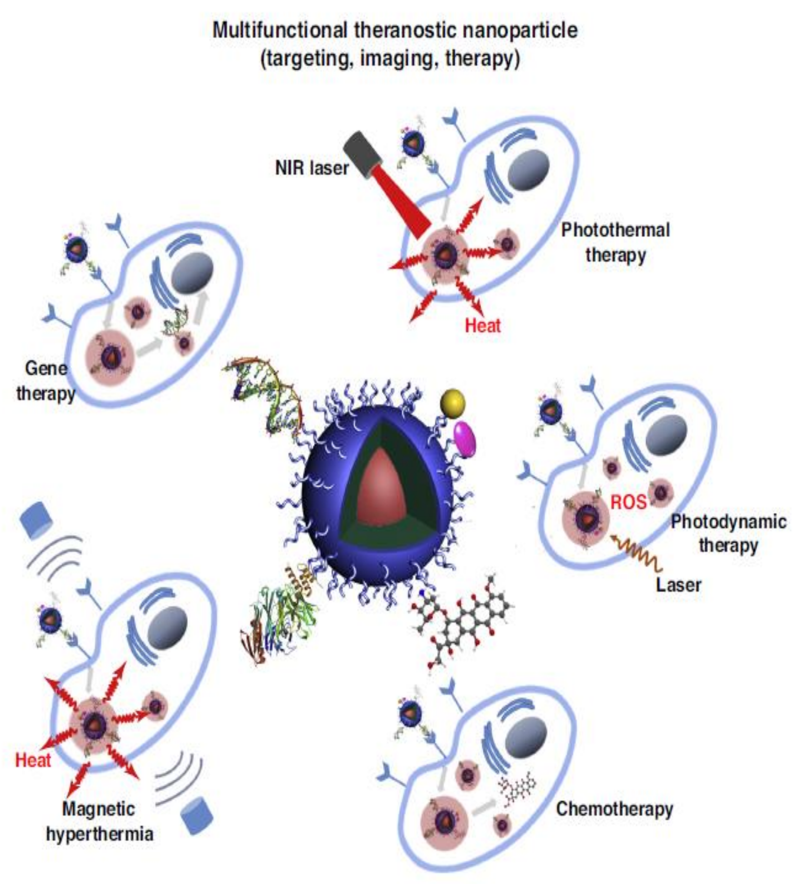
Introduction

The field of nanomedicine utilizes nanomaterials to improve diagnosis, prevention and treatment of many diseases and cancer [1]. Physicochemical characterization techniques for nanocarriers play a key role in the assessment of nanopharmaceuticals' application for diagnostics and targeted drug delivery of anti-cancers to neoplastic cells/tissues. If diagnostic tools and therapeutic approaches are combined in one single nanocarrier, a new platform called nanobiotheranostic is created [2]. Several analytical technologies are used to characterize nanopharmaceuticals and nanoparticles and their properties so that they can be properly used in cancer therapy.



Several physicochemical characteristics of nanomaterials including hydrodynamic size, shape, structure, aggregation state, and biomolecular conformation can be explored using radiation scattering techniques. DLS, one of themost popular light scattering modalities, can probe the size distribution of small particles.

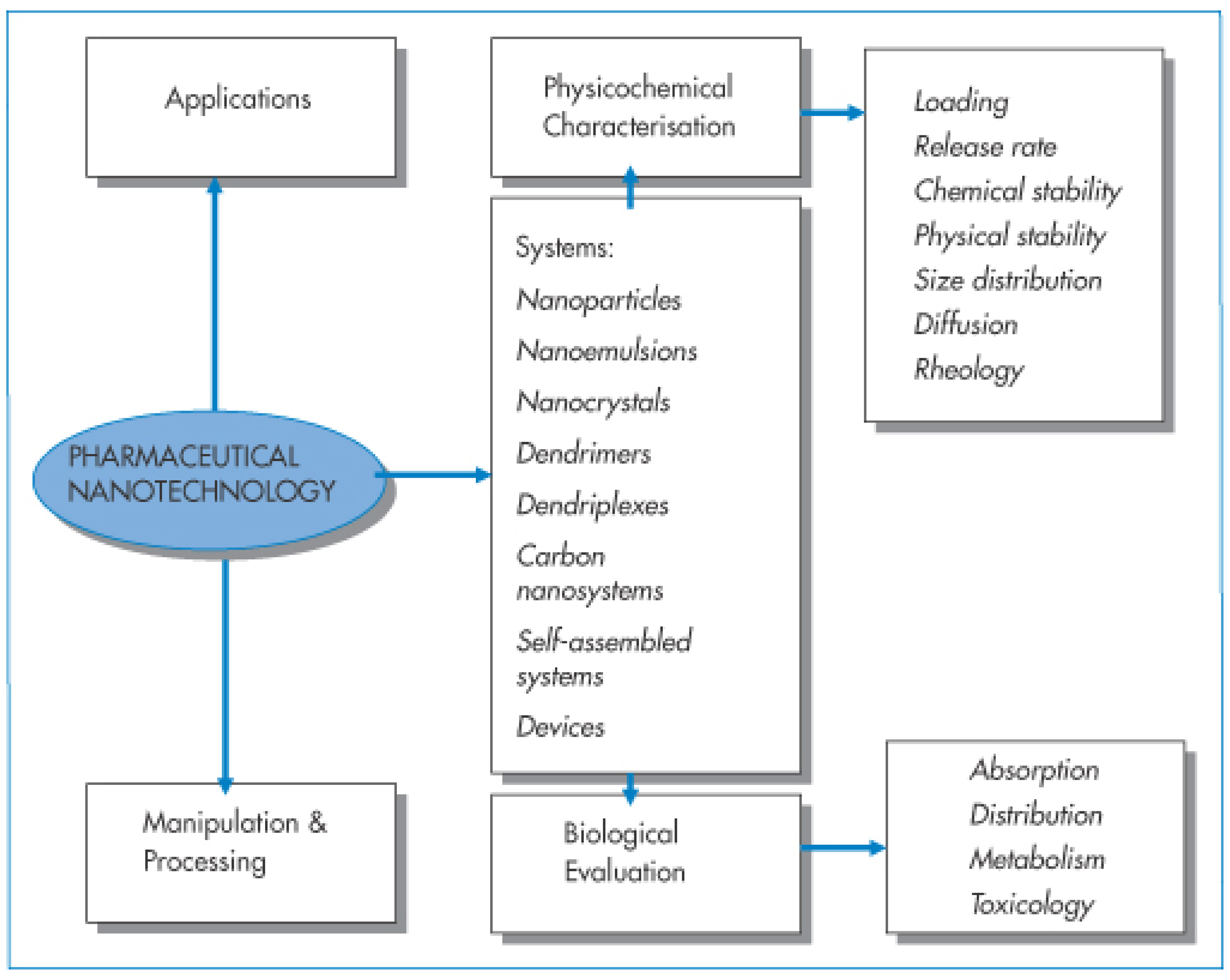




Nanomaterials properties

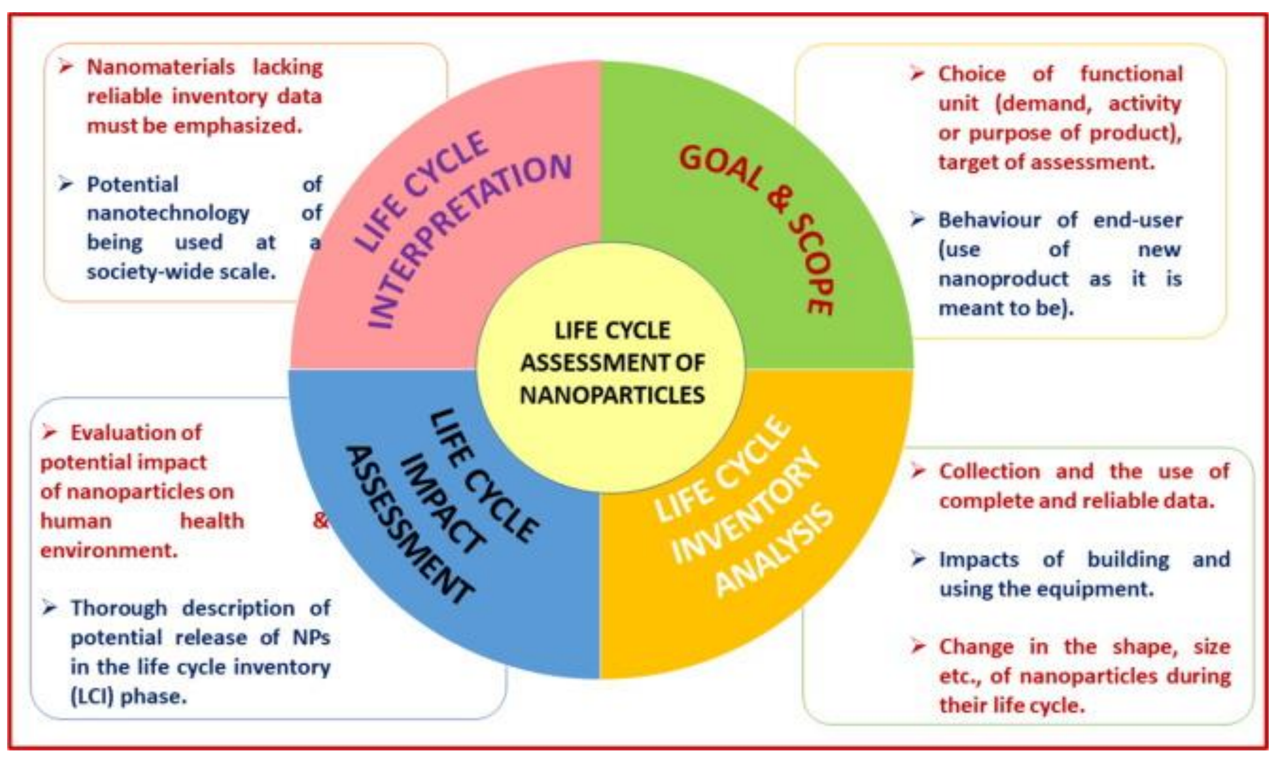
Nanomaterial characterization places special emphasis and focus on parameters such as size/size distribution, porosity (pore size), surface area, shape, wettability, zeta potential, adsorption isotherm (adsorption potential), aggregation, distribution of conjugated moieties and impurities and any other type of functionalization useful for investigating their biological nanomechanical properties. Compared to their bulk material counterparts, the distinct physicochemical properties of the nanomaterials, such as size, surface properties, shape, composition, molecular weight, identity, purity, stability and solubility, are critically relevant to particular physiological interactions.

Experimental overview



Specific Physicochemical characterization, Dynamic light scattering analysis and Zeta Potential of nanoparticles

Among the several techniques physicochemical characterization of nanomaterials, DLS, FCS, RS, NSOM, SEM, TEM, STM, AFM, NMR, XRD, SAXS, FS and several separation techniques are suitable for evaluating the size and size distribution of nano-drug delivery systems. NSOM, SEM, TEM, STM, AFM, XRD and SAXS are proper modalities for shape measurement, while appropriate methods for surface charge measurement include zeta potential measurement (ELS), ATR– FTIR, GE and CE. In addition, TERS, CD, MS, IR, STM, AFM, NMR, XRD, SAXS, FS and some of the thermal and separation techniques can investigate the structural properties of the nanomaterials.



Conclusions

The fundamental characterization of physicochemical characteristics at the nanometer scale, <u>nanomaterials have potential to revolutionize and nanoengineering physiological interactions from the molecular level, cell and organ level to the systemic level, making the chemical, physical and biological deep investigation and physical modelling of nanoparticles an integrated interdisciplinary field that can exploit and shaping ultra-precision medicine to fight human diseases</u>. The rapid development and production of nanomaterials for use as nanomedicines indicate the demand and wisdom for regulating the manufacture and use of nanomaterials. Robust techniques for characterization of nanomaterials are a key factor to regulatory guidelines and stakeholders for ensuring safety and efficacy of nanomaterials in general and nanomedicines in particular.

References.
[1] Duncan R, Gaspar R. Nanomedicine(s) under the microscope. Mol Pharm 2011; 8:2101-41.
[2] KimTH, Lee S, Chen X. Nanotheranostics for personalizedmedicine. Expert Rev Mol Diagn 2013;13:257–69.

Acknowledgments: This poster is based upon work from COST Action CA 17140 "Cancer Nanomedicine from the Bench to the Bedside" supported by COST (European Cooperation in Science and Technology).