International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494

Cutting-Edge Advances in Diagnostics and Treatments for Brain Diseases and Cancer

Prof. Laura S L*, Jay Sree R B, Dr. BlancheAJ, Suganthi R
Corresponding Author: Prof. Laura S. L. Associate Professor K. K. College of Pharmacy, Chennai-600128.

Date of Submission: 15-11-2024 Date of Acceptance: 25-11-2024

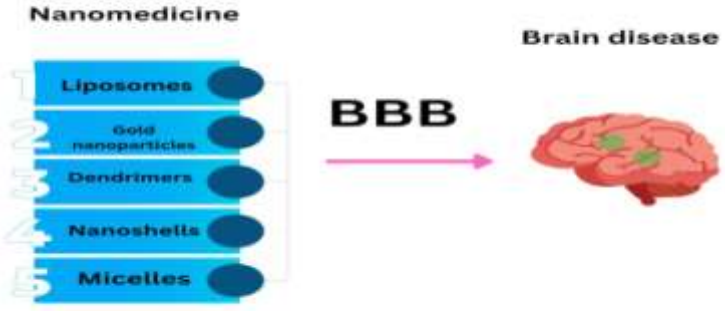
ABSTRACT
The brain is the most intricate organ. These organs targets for numerous illness that result in impairment and even death. These are the root causes of various ailments, including cancer, tumours, and so on. Cancer kills 10 million people worldwide. Sensor based on nanomaterials that can extract and identify circulating tumor cells, which are tumor-specific biomarkers. Radiation sensitization and photothermal therapy are used to improve the therapeutic efficacy of Malignant tumors. In this review, nanosensors application to the diseases earlier and enhance the patient long term survival.

Keyword: Nanoparticles, Polymers, Brain disease, Cancer.

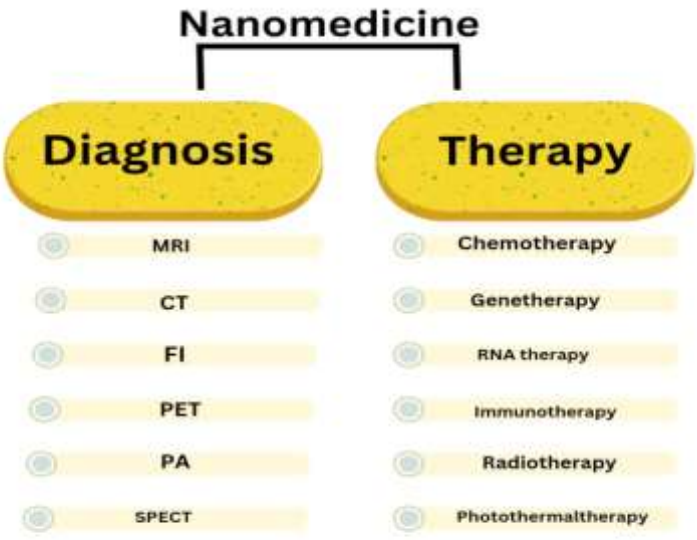
I. INTRODUCTION

BRAIN DISEASES:

Infections, tumours, traumas, and neurological anomalies are examples of illnesses that affect the brain under the title 'brain diseases and disorders'. They are the leading cause of mortality, accounting for more than 250.7 million fatalities. Brain diseases are transmissible and frequently caused by external forces, whereas disorders are non-transmittable and frequently inheritable as a result of birth defects or genetic malfunctions. The intricate and sensitive nature of the brain makes treatment for certain diseases difficult. Nanoparticles (NPs)-based treatments have emerged as a promising therapy for brain diseases and disorders because of their unique properties such as tiny size, selectivity, low toxicity, biodegradability, and solubility. NPs are the tiniest particles, often ranging in size from 1 to 100 nm but less than 1000 nm. Particles are formed through the natural or purposeful manipulation of chemicals or metals. Various types of nanoparticles (NPs) have been created, including metal and metal oxides, liposomal, polymeric, fullerenes, nanoemulsions, solid-lipid (SL), and polylactide-co-glycoside (PLGA)[49,19].Nanoparticles (NPs) are used to diagnose and treat serious diseases such metastatic cancer, brain tumours, and neurological problems[83]. Given the challenges connected with effective and efficient medicine administration in such conditions, NPs appear to be a significant discovery that could improve the effectiveness and efficiency of future treatments. This review will detail the use of NPs in the treatment of brain diseases and disorders, as well as the challenges that this novel discovery faces. Metal, lipid, polymeric, coffee, SL, chitosan (CS), magnetic, rare earth (RE), fullerenes, poly(butyl cyanoacrylate) (PBCA), PLGA, betulinic, and liposomal nanoparticles will all be covered.



International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494



NANOTECHNOLOGY IN BRAIN DISEASES AND DISORDER:

These can be classified into 2:

1. Nanoparticles used for diagnosis
2. Nanoparticles used for treatment

NANOPARTICLES USED FOR DIAGNOSIS:

1.Molecular imaging (MI):

MI is a critical field in biomedical science that studies molecular pathogenesis and bodily function. It employs advanced techniques such as ultrasound, x-ray radiography, magnetic resonance imaging, and positron emission tomography[79]. MI methods are beneficial for evaluating and characterising a variety of brain diseases, including infections, brain tumours, and neurological disorders[43]. MI specificity is increased by the addition of contrast beacons known as probes[59].Targetable probes connect to specified targets, whereas activatable probes respond to indicators to produce a visible signal. A previous work discovered that oligopeptide nanoparticles can function as activatable probes, emitting fluorescence when activated by low pH in the tumour microenvironment45. NPs are also employed for fluorescence imaging.

2. Biomarkers detections:

Biomarkers are substances that may be detected and linked to specific illnesses or states, making them important for disease management. NPs have demonstrated remarkable efficacy in identifying important indicators of brain illnesses and disorders [56].For example, surface plasmon resonance of Au NPs can detect UCH-L1 in traumatic brain injury patients with 100% sensitivity and specificity. Aβ levels are linked to dementia and associated illnesses. Modified magnetic nanoparticles may safely detect Aβ plaques in AD models, while anti-cholesterol antibody-bound magnetic nanoparticles can detect high cholesterol levels [68,76].

NANOPARTICLES USED IN TREATMENT

Radiosensitization:

Radiosensitization is a potential approach to treating chronic and progressive disorders that involves sensitising tissues or cells to radiation. Resistance to potential treatments presents a significant challenge in treating chronic and progressive disorders. Radiosensitization is a feasible solution for this situation. Radiation sensitisation can occur through physical, chemical, or pharmacological methods, affecting both tissues and cells[21].

Treatment with folate-targeted NP-mediated kringle. In glioblastoma mice, the 1 domain of the hepatocyte growth factor gene increases sensitivity to ionising radiation by promoting checkpoint kinase-1-induced cell cycle arrest, inhibiting tyrosine kinase receptor activation, ataxia telangiectasia mutated-checkpoint kinase-2 pathway activation, and Ki-67 expression.

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494

NPs encapsulating lipid-poly(hypoxic radiosensitized polyprodrug), IO linked with epidermal growth factor receptor (EGFR), and RE have been demonstrated to enhance radiation sensitivity in glioma cells by increasing oxidative stress[83].Co-treatment with radiation increases sensitivity and DNA damage[29].Compared to Au NPs, Ag NPS have a greater sensitisation effect[41].

THE APPLICATION OF NPs IN THE TREATMENT OF BRAIN DISEASES AND DISORDER:

Brain tumor

Brain tumours can be both malignant and benign. Several studies have revealed the therapeutic benefits of nanoparticles in delivering potential anticancer medicines. The delivery of short interfering RNA by targeting various genes including sodium-potassium chloride cotransporter 1, related protein 1, EGFR, and survivin utilising polymeric NPs can drastically limit the growth and migration of glioblastoma cells in a selective manner.[7,16,20,35,42]

Ischemic stroke

Stroke is among the leading causes of death and disability worldwide. Selenium nanoparticles can effectively decrease neurodegenerative characteristics in murine IS models by modulating autophagy, inflammation, and oxidative stress. Betulinic NPs promote the transit of glyburide in the BBB, resulting in enhanced antiedema and antioxidant effects in IS mice.[24,18,40,77]

Amnesia

It is a medical illness that causes memory loss as a result of brain disease or injury. In a mouse model of scopolamine-induced amnesia, the treatment with PS-80-coated rivastigmine CS NPs reduced amnesic activities and improved cognitive performance in amnesia rat models.[48,37,2]

Multiple Sclerosis

MS is a neurological condition that causes impairment in young people. Nano-curcumin combined with ω 3 fatty acids can lessen recurring headaches. AgNPs improve the patient's condition in acute occlusive hypocephalus.[4,41,52]

Huntington diseases

It is an autosomal dominant neurodegenerative disease that causes motor, cognitive, and mental deficits. Treatment with low concentrations of se NPs improves oxidative state while decreasing huntingtin protein aggregation.[63,36]

CANCER:

Cancer is a major health concern that increases the mortality rate by around 10 million. Surgery, radiation, and chemotherapy are currently used to treat this condition, however standard chemotherapy has numerous obstacles such as instability, insolubility, drug resistance, and tissue damage.[66,72]Nanotechnology aims to lessen side effects and prevent this disadvantage by trapping medications in small compartments, absorbing them into well-designed pores, creating a stable microenvironment, and releasing drugs after transit. Nanomedicine has been investigated for its potential utility in several illnesses, including anticancer treatment delivery, diagnostics, and imaging.[28,32, 55,64]Combining nanotechnology with conventional tumour therapy can improve the efficacy of chemoradiotherapy drugs while reducing side effects such as poisoning.[39,47-58] These nanoparticles can swiftly traverse the human biological membrane, even when targeted.[3,26,39]

While nanomedicines have numerous benefits, there are also drawbacks to consider. There are two outstanding concerns in nanomedicine. Although EPR has been found to lessen side effects and improve efficacy in preclinical trials and animal models, patient survival rates have not improved considerably.[27]

This review summarises the application of nanomedicines in cancer diagnosis and treatment. The article discusses many types of nanomedicine, including polymeric nanoparticles, liposomes, micelles, hydrogels, exosomes, natural membrane nanoparticles, viruses, and inorganic nanoparticles. It also addresses their morphology, applications, and recent developments. The article discusses how nanomedicine can cure a variety of tumours, including digestive, lung, intracranial, haematological, genitourinary, skeletal, skin, and thyroid. The pros and cons of employing nanomedicine to treat certain cancers are examined. Finally, we investigate the advantages and disadvantages of nanotechnology in malignant tumours.

TYPES OF NANOPARTICLES

1. POLYMERIC NPs
2. LIPOSOMES
3. MICELLES
4. HYDROGELS

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494

5. INORGANIC NPs

POLYMERIC NANOPARTICLES:

Polymeric nanoparticles are biomaterials that range in size from 10 to 100 nm and can be classified into natural and manmade polymers.[11,54, 55]

1.Natural polymers

Natural polymers, such as polysaccharides and protein nanoparticles, can be easily obtained from organisms and employed in medication delivery systems.[33] Chitosan is the most widely used polysaccharide-based biomaterial in nanomedicine architecture. Chitosan is a water-soluble, biocompatible, and biodegradable polymer made from crab shells.[34,54,81]Chitosan-based biomaterials are widely employed in drug delivery systems via numerous epithelia, including the eye and the intestine. They can "permeabilize" the mucosa epithelium, allowing medications to pass through and act on cancerous tissue. Chitosan has inspired other scientists to create new biomaterials, such as AuNP-siRNA-glycol chitosan-taurocholic acid nanoparticles (AR-GT NPs), which have the potential to treat colorectal cancer liver metastases. Chitosan can also boost the immune system during tumour treatment, increasing Th1 sensitivity.[34]

2.Synthetic polymers

Because of their biocompatibility and biodegradability, synthetic polymers like polylactic acid (PLA) and poly(lactic-co-glycolic acid) (PLGA) are commonly utilised in tumour treatment. PLA is a biocompatible and biodegradable polymer whose monomer, lactic acid, is a safe molecule utilised in carbohydrate metabolism.[30] The most widely used FDA-approved polymer is PLGA, which is derived from the structure of PLA. PLGA became famous after the discovery of PLGA-PEG NPs in 1994. PLGA offers the advantages of PLA, such as a long circulation half-life and continuous release, making it a superior choice over other synthetic polymers.[64]PLGA is a potentially useful material for chemotherapeutic medication delivery, immunotherapy, and photothermal therapy. R837-αOVA-ApoE3-HNP is a nanovaccine that directly increases antigen into DCs, resulting in powerful immune responses. Rapamycin in PLGA can partially block B cell activation while enhancing Treg cell function, boosting efficacy and reducing hypersensitivity during therapy. Dendrimers, a three-dimensional, repetitively branching form, offer exceptional hydrophilicity and compact size, guiding scientists in addressing the TME challenge.Dendrimers, named after the Greek word meaning 'tree-like', are three-dimensional, repetitively branching structures. This sets them apart from other synthetic polymers. Dendrimers' hydrophilicity and small size (less than 20 nm) enable them to easily pass through biological barriers such as mucosa, endothelium, and epithelium.[30,46]Dendrimers have a variety of advantages, including nontoxicity, bioavailability, medication stability, improved biological activity, and superior transmembrane capability. Dendrimers are remarkable for their multidirectional uniformity.[14,18,58]

Liposomes:

Liposomes are spheres with two lipid layers surrounding an aqueous centre that range in size from 50 to 450 nm and are employed in pharmaceutical applications.They are capable of transporting both hydrophilic (in aqueous solution core) and hydrophobic (in lipid bilayer) substances.[6]Alec Bangham created liposomes in 1961, making them one of the first lipid-based medicine delivery techniques used in clinical settings.[1]Liposome-formulated anti-cancer drugs, including Myocet liposomal, liposomal doxorubicin (DOX), and Marqibo, are already on the market. Clinical investigations for further liposomal formulations are now underway.[10,65]

There are four types of liposomes: There are four types of liposomes: traditional (mostly phospholipids), bilayer PEGylated (liposomes with a PEG coating for longer circulation), ligand-target (liposomes with targeting ligands like peptides, monoclonal antibodies, vitamins, or carbohydrates), and theranostic (liposomes with targeting ligands, imaging agents, and drugs).[60] Liposome-based delivery systems offer advantages such as focused and precise drug distribution, less systemic toxicity, stable drug environment throughout transit, and avoidance of bio-clearance when delivering gene therapy agents to the cytosol.

Micelles

Micelles are spheres of self-aggregated amphiphilic molecules, ranging from 10 to 100 nm in diameter.[22,61]They form a hydrophilic surface in aqueous solutions and separate a hydrophobic core in the centre. Both synthesized polymers and natural molecules can be used for micelle formation, but conditions like critical micelle concentration, chemical group structure, Krafft temperature should be considered. Micelles can be

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494

encapsulated into a variety of materials, alleviating drug toxicity and facilitating easier drug transportation.[70,73,74] polymers has shell forming part and core forming part having different properties.[8]

Hydrogels

Hydrogels are biocompatible, controlled, and adaptable polymer chains with a wide range of characteristics.[9,15,84] They can be made from natural or synthetic polymers, making them biodegradable and easy to excrete.[25]Nanohydrogels show promise as carriers for anticancer medications due to their controlled release, increased permeability, and protective properties. They can also be used as topical drug delivery devices to improve drug absorption via the skin and treat skin disorders.[80]Recent research has demonstrated encouraging results in targeting immune checkpoint blockers (ICBs) in cancer immunotherapy, including hydrogels tailored to improve penetration and retention. Combining hydrogels with different nanoparticles may give a more versatile platform for combining nanomedicines to combat tumour multidrug resistance.[78]

INORGANIC NANOPARTICLES

Inorganic NPs as a drug carriers with definite physical, chemical properties, great biocompatibility and stability

GOLD NPs

It has broad range of application in treatment of cancer and its treatment.[47,68]Method of synthesis is also easy.[6] when gold NPs enters into the body it bind with the protein such as albumin and transferrin called as protein complex. Due to their chemical modification its has negative potential on their surface so they cannot be recognized by the immune system[51]Gold NPs play an important role in photothermal application [57]

NANOMEDICINES USED IN GI CANCER:

Nanotechnologies offer great sensitivity, specificity, and permeability and have been predominantly used for tumor detection and GI tract imaging in MRI-based clinical applications. Nanotechnology-based medication delivery will be important in future medical treatment, particularly useful for boosting therapeutic efficacy due to their great biocompatibility. Nanoparticles can be loaded with various medications for targeted and controlled release

NP type	GI Cancer	Application
Carbon nanotubes	Colorectal; liver	Detection of lymph node and node metastasis; tumor localization
Gold NPs	Gastric; pancreatic; oesophageal	Photothermal effect; hyperthermia and cellular destruction; X-ray and CT contrast agents
Dendrimers	Pancreatic; colorectal	Dual targeting imaging; targeted drug delivery and gene therapy
Nanoshell	Gastric	Contrast agents; targeted drugs delivery and gene therapy

NANOMEDICINES IN LUNG CANCER:

Lung cancer is a significant malignant neoplasm with a high incidence and unsatisfactory mortality rate. It is categorized into small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC). The molecular mechanism of lung cancer is complex with DNA damage causing the transformation of lung epithelial cells into tumor cells.[3,66,67,75]

Diagnosis:

Bronchoscopy is an effective tool for evaluating lesions in the central airways, but it is an intrusive operation. CT, MRI, SPECT, and PET are among clinical imaging techniques used to diagnose lung cancer. These approaches have limitations, such as ineffective identification of tiny lesions and short blood circulation times. Biomarkers are critical diagnostic tools for lung cancer, and as molecular biology and related technologies advance, new tumour biomarkers are identified. Nanotechnology has enhanced tumour

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494

detection by breaking down biological and chemical barriers, enhancing therapeutic efficacy while decreasing invasiveness, and optimising biocompatibility. Nanoscaled extracellular vesicles (EVs), such as exosomes, produced by numerous cell types, can provide crucial information for early lung cancer diagnosis.[66,68]

Treatment:

Chemotherapy is successful at treating cancer, however suppressing drug-resistant cells is difficult. Nanotechnology is advancing cancer treatment by transporting small-molecule chemotherapeutic medicines via nanoparticles. Recent study on nanotechnology in lung cancer chemotherapy has showed potential in improving the therapeutic effects of cisplatin and curcumin. Metformin is an antidiabetic medicine that inhibits tumour growth and promotes apoptosis in a variety of cancers. So it is used in conjunction with cisplatin to treat NSCLC.[62]

II. CONCLUSION:

In conclusion, advancements in diagnostics and treatment for brain diseases and cancer have made remarkable strides, bringing new hope to patients and healthcare providers alike. Emerging technologies, such as AI-driven imaging, liquid biopsies, and precision medicine, are enabling earlier and more accurate diagnoses, which is critical for effective treatment. Additionally, novel therapies—ranging from targeted drugs to immunotherapy and advanced surgical techniques—are making treatments more personalized, minimizing side effects, and improving outcomes. However, continued investment in research, collaboration among medical and technological fields, and addressing disparities in access to these innovations are essential for maximizing their benefits. Together, these efforts represent a promising future in the fight against brain diseases and cancer, with the potential to significantly improve survival rates and quality of life for millions of patients worldwide.

REFERENCE:

[1]. Bangham, A. D. & Horne, R. W. Negative staining of phospholipids and their structural modification by surface-active agents as observed in the electron microscope. J. Mol. Biol. 8, 660–668 (1964).

[2]. Basel, A. A., Petrov, V. E., Trofimov, S. S., Voronina, T. A., and Aliautdin, R. N.(2005). [Antiamnesic activity of nerve growth factor adsorbed on poly(butyl)cyanoacrylate nanoparticles coated with polysorbate-80]. Eksp. Klin. Farmakol.68

[3]. Blanco, E., Shen, H. & Ferrari, M. Principles of nanoparticle design for overcoming biological barriers to drug delivery. Nat. Biotechnol. 33, 941–951 (2015).

[4]. Bø, L., Vedeler, C. A., Nyland, H. I., Trapp, B. D., and Mørk, S. J. (2003). Subpial demyelination in the cerebral cortex of multiple sclerosis patients.J. Neuropathol. Exp. Neurol. 62, 723–732. doi: 10.1093/jnen/62.7.723

[5]. Borys, N. & Dewhirst, M. W. Drug development of lyso-thermosensitive liposomal doxorubicin: combining hyperthermia and thermosensitive 152. drug delivery. Adv. Drug Deliver. Rev. 178, 113985 (2021)

[6]. Bozzuto, G. & Molinari, A. Liposomes as nanomedical devices. Int. J. Nanomed. 10, 975–999 (2015).

[7]. Bray, F., Ferlay, J., Soerjomataram, I., Siegel, R. L., Torre, L. A., and Jemal, A. (2018). Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J. Clin. 68, 394–424. doi: 10.3322/caac.21492

[8]. Cabral, H., Miyata, K., Osada, K. & Kataoka, K. Block copolymer micelles in nanomedicine applications. Chem. Rev. 118, 6844–6892 (2018).

[9]. Cao, H. et al. Current hydrogel advances in physicochemical and biological response-driven biomedical application diversity. Signal Transduct. Tar. 6, 426 (2021).

[10]. 155. Chen, W., Goldys, E. M. & Deng, W. Light-induced liposomes for cancer therapeutics. Prog. Lipid Res. 79, 101052 (2020)

[11]. Cheng, K. K., Chan, P. S., Fan, S., Kwan, S. M., Yeung, K. L., Wáng, Y. X.,et al. (2015). Curcumin-conjugated magnetic nanoparticles for detectingamyloid plaques in Alzheimer's disease mice using magnetic resonanceimaging (MRI). Biomaterials 44, 155–172. doi: 10.1016/j.biomaterials.2014.12.005

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494

[12]. 78. Cheng, Z., Li, M., Dey, R. & Chen, Y. Nanomaterials for cancer therapy: current progress and perspectives. J. Hematol. Oncol. 14, 85 (2021).
[13]. Chiang, Y. T., Yen, Y. W. & Lo, C. L. Reactive oxygen species and glutathione dual redox-responsive micelles for selective cytotoxicity of cancer. Biomaterials 61, 150–161 (2015).
[14]. Chowdhury, S., Toth, I. & Stephenson, R. J. Dendrimers in vaccine delivery: Recent progress and advances. Biomaterials 280, 121303 (2022).
[15]. Conde, J., Oliva, N., Zhang, Y. & Artzi, N. Local triple-combination therapy results in tumour regression and prevents recurrence in a colon cancer model. Nat. Mater. 15, 1128–1138 (2016).
[16]. Cramer, C. K., McKee, N., Case, L. D., Chan, M. D., Cummings, T. L., Lesser, G. J.,et al. (2019). Mild cognitive impairment in long-term brain tumor survivorsfollowing brain irradiation. J. Neurooncol. 141, 235–244. doi: 10.1007/s11060-018-03032-8
[17]. Deng, G., Ma, C., Zhao, H., Zhang, S., Liu, J., Liu, F., et al. (2019). Anti-edema and antioxidant combination therapy for ischemic stroke via glyburide-loaded betulinic acid nanoparticles. Theranostics 9, 6991–7002. doi: 10.7150/thno. 35791
[18]. Dey, A. D. et al. Dendrimers as nanoscale vectors: unlocking the bars of cancer therapy. Semin. Cancer Biol. 86, 396–419 (2022).
[19]. Djordjevic, A., Ignjatovic, N., Seke, M., Jovic, D., Uskokovic, D., andRakocevic,Z. (2015). Synthesis and characterization of hydroxyapatite/fullerenol nanocomposites. J. Nanosci. Nanotechnol. 15, 1538–1542. doi: 10.1166/jnn.2015.8671
[20]. Feng, Q., Shen, Y., Fu, Y., Muroski, M. E., Zhang, P., Wang, Q., et al. (2017). Selfassembly of gold nanoparticles shows microenvironment-mediated dynamicswitching and enhanced brain tumor targeting. Theranostics 7, 1875–1889.doi: 10.7150/thno.18985
[21]. Gallez, B. (2015). "Radiosensitization," in Encyclopedia of Cancer, ed. M. Schwab(Berlin: Springer), doi: 10.1007/978-3-642-27841-9_4924-2
[22]. Ghezzi, M. et al. Polymeric micelles in drug delivery: an insight of the techniques for their characterization and assessment in biorelevant conditions. J. Control. Release 332, 312–336 (2021).
[23]. Gonzalez-Molina, J. et al. Chemotherapy as a regulator of extracellular matrixcell communication: implications in therapy resistance. Semin. Cancer Biol. 86,224–236 (2022)
[24]. Guo, X., Deng, G., Liu, J., Zou, P., Du, F., Liu, F., et al. (2018). Thrombinresponsive, brain-targeting nanoparticles for improved stroke therapy. ACSNano 12, 8723–8732. doi: 10.1021/acsnano.8b04787
[25]. Hajareh Haghighi, F. et al. Peptide-hydrogel nanocomposites for anti-cancer drug delivery. Gels 9, 953 (2023).
[26]. Handa, M. et al. Recent advances in lipid-engineered multifunctional nanophytomedicines for cancer targeting. J. Control. Release 340, 48–59 (2021).
[27]. Jain, R. K. & Stylianopoulos, T. Delivering nanomedicine to solid tumors. Nat. Rev.Clin. Oncol. 7, 653–664 (2010).
[28]. Jiang, D. et al. Nanomedicines for renal management: from imaging to treatment. Accounts Chem. Res. 53, 1869–1880 (2020).
[29]. Joh, D. Y., Sun, L., Stangl, M., Al Zaki, A., Murty, S., Santoiemma, P. P., et al.(2013). Selective targeting of brain tumors with gold nanoparticle-inducedradiosensitization. PLoS One 8:e62425. doi: 10.1371/journal.pone.0062425
[30]. Kannan, R. M., Pitha, I. & Parikh, K. S. A new era in posterior segment ocular drug delivery: translation of systemic, cell-targeted, dendrimer-based therapies. Adv. Drug Deliver. Rev. 200, 115005 (2023).
[31]. Kansız, S. & Elçin, Y. M. Advanced liposome and polymersome-based drug delivery systems: Considerations for physicochemical properties, targeting strategies and stimuli-sensitive approaches. Adv. Colloid Interfac. 317, 102930 (2023).
[32]. Kopecek, J. & Yang, J. Polymer nanomedicines.
[33]. Kopeček, J. Polymer-drug conjugates: origins, progress to date and future directions. Adv. Drug Deliver. Rev. 65, 49–59 (2013).
[34]. Kou, S. G., Peters, L. & Mucalo, M. Chitosan: a review of molecular structure,

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494

bioactivities and interactions with the human body and micro-organisms. Carbohyd. Polym. 282, 119132 (2022)

[35]. Kozielski, K. L., Ruiz-Valls, A., Tzeng, S. Y., Guerrero-Cázares, H., Rui, Y., Li, Y.,et al. (2019). Cancer-selective nanoparticles for combinatorial siRNA deliveryto primary human GBM in vitro and in vivo. Biomaterials 209, 79–87. doi:10.1016/j.biomaterials.2019.04.020

[36]. Langbehn, D. R., Brinkman, R. R., Falush, D., Paulsen, J. S., Hayden, M. R., andInternational Huntington's Disease Collaborative Group (2004). A new modelfor prediction of the age of onset and penetrance for Huntington's diseasebased on CAG length. Clin. Genet. 65, 267–277. doi: 10.1111/j.1399-0004.2004.00241.x

[37]. Langer, K. G. (2019). Early history of amnesia. Front. Neurol. Neurosci. 44:64–74.doi: 10.1159/000494953

[38]. Li, S. et al. Nanotechnology: breaking the current treatment limits of lungncancer. Adv. Healthc. Mater. 10, e2100078 (2021).

[39]. Li, H. et al. Polymeric Dendrimers as nanocarrier vectors for neurotheranostics. Small 18, e2203629 (2022).

[40]. Lindsay, M. P., Norrving, B., Sacco, R. L., Brainin, M., Hacke, W., Martins, S., et al.(2019). World Stroke Organization (WSO): global stroke fact sheet 2019. Int. J.Stroke 14, 806–817. doi: 10.1177/1747493019881353

[41]. Liu, C., Zhang, S., McClements, D. J., Wang, D., and Xu, Y. (2019).Design of Astaxanthin-loaded core-shell nanoparticles consisting of chitosanoligosaccharides and poly (lactic-co-glycolic acid): enhancement of watersolubility, stability, and bioavailability. J. Agric. Food Chem. 67, 5113–5121.doi: 10.1021/acs.jafc.8b06963

[42]. Mangraviti, A., Tzeng, S. Y., Kozielski, K. L., Wang, Y., Jin, Y., Gullotti, D., et al.(2015). Polymeric nanoparticles for nonviral gene therapy extend brain tumorsurvival in vivo. ACS Nano 9, 1236–1249. doi: 10.1021/nn504905q

[43]. Mankoff, D. A. (2007). A definition of molecular imaging. J. Nucl. Med. 48,

[44]. 18N–21N.

[45]. Massoud, T. F., and Gambhir, S. S. (2003). Molecular imaging in living subjects: seeing fundamental biological processes in a new light. Genes Dev. 17, 545–580.doi: 10.1101/gad.1047403

[46]. Mignani, S. et al. Dendrimers in combination with natural products and analogues as anti-cancer agents. Chem. Soc. Rev. 47, 514–532 (2018).

[47]. Moreno-Alcántar, G., Picchetti, P. & Casini, A. Gold complexes in anticancer therapy: from new design principles to particle-based delivery systems. Angew. Chem. Int. Edit. 62, e202218000 (2023).

[48]. Nagpal, K., Singh, S. K., and Mishra, D. N. (2013a). Nanoparticle mediated braintargeted delivery of gallic acid: in vivo behavioral and biochemical studiesfor protection against scopolamine-induced amnesia. Drug Deliv. 20, 112–119.doi: 10.3109/10717544.2013.779330

[49]. Narayanan, K. B., and Sakthivel, N. (2011). Green synthesis of biogenic metal nanoparticles by terrestrial and aquatic phototrophic and heterotrophic eukaryotes and biocompatible agents. Adv. Colloid Interface Sci. 169, 59–79.doi: 10.1016/j.cis.2011.08.004338.

[50]. Nance, E., Zhang, C., Shih, T. Y., Xu, Q., Schuster, B. S., and Hanes, J. (2014). Brainpenetrating nanoparticles improve paclitaxel efficacy in malignant glioma following local administration. ACS Nano 8, 10655–10664. doi: 10.1021/nn504210g

[51]. Nguyen, V. H. & Lee, B. J. Protein corona: a new approach for nanomedicine design. Int. J. Nanomed. 12, 3137–3151 (2017).

[52]. Ojha, S., and Kumar, B. (2018). Preparation and statistical modeling of solid lipidnanoparticles of dimethyl fumarate for better management of multiple sclerosis.Adv. Pharm. Bull. 8, 225–233. doi: 10.15171/apb.2018.027

[53]. Ojha, S., Kumar, B., and Chadha, H. (2019). Neuroprotective potential of dimethylfumarate-loaded polymeric nanoparticles against multiple sclerosis. Indian J.Pharm. Sci. 81, 496–502. doi: 10.36468/pharmaceutical-sciences.535

[54]. Patra, J. K. et al. Nano based drug delivery systems: recent developments and future prospects. J. Nanobiotechnol. 16, 71 (2018).

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 448-458 www.ijprajournal.com ISSN: 2456-4494

[55]. Pelaz, B. et al. Diverse applications of nanomedicine. ACS Nano 11, 2313–2381(2017).
[56]. Posti, J. P., Takala, R. S., Runtti, H., Newcombe, V. F., Outtrim, J., Katila, A. J., et al. (2016). The levels of glial fibrillary acidic protein and ubiquitin C-terminal hydrolase-L1 during the first week after a traumatic brain injury: correlations with clinical and imaging findings. Neurosurgery 79, 456–464. doi: 10.1227/NEU.0000000000001226
[57]. Riley, R. S. & Day, E. S. Gold nanoparticle-mediated photothermal therapy:applications and opportunities for multimodal cancer treatment. WIREs. Nanomed. Nanobi. 9, e1449 (2017).
[58]. Sathe, R. Y. & Bharatam, P. V. Drug-dendrimer complexes and conjugates: detailed furtherance through theory and experiments. Adv. Colloid Interfac. 303, 102639 (2022)
[59]. Schocke, M. F., Seppi, K., Esterhammer, R., Kremser, C., Jaschke, W., Poewe, W.,et al. (2002). Diffusion-weighted MRI differentiates the Parkinson variant ofmultiple system atrophy from PD. Neurology 58, 575–580. doi: 10.1212/wnl.58.4.575173.
[60]. Sercombe, L. et al. Advances and challenges of liposome assisted drug delivery. Front. Pharmacol. 6, 286 (2015).
[61]. Sen, S. et al. Computational studies of micellar and nanoparticle nanomedicines. Chem. Soc. Rev. 47, 3849–3860 (2018).
[62]. Shakeri, S. et al. Multifunctional polymeric nanoplatforms for brain diseases diagnosis, therapy and theranostics. Biomedicines 8, 13 (2020).
[63]. Shin, J. Y., Fang, Z. H., Yu, Z. X., Wang, C. E., Li, S. H., and Li, X. J. (2005). Expression of mutant huntingtin in glial cells contributes to neuronal excitotoxicity. J. Cell Biol. 171, 1001–1012. doi: 10.1083/jcb.200508072
[64]. Shi, J., Kantoff, P. W., Wooster, R. & Farokhzad, O. C. Cancer nanomedicine:progress, challenges and opportunities. Nat. Rev. Cancer 17, 20–37 (2017).
[65]. Shi, X., Sun, K. & Baker, J. R. Spontaneous formation of functionalized dendrimerstabilized gold nanoparticles. J. Phys. Chem. C 112, 8251–8258 (2009).
[66]. Siegel, R. L., Miller, K. D., Wagle, N. S. & Jemal, A. Cancer statistics, 2023. CACancer J. Clin. 73, 17–48 (2023).
[67]. Siegel, R. L., Miller, K. D. & Jemal, A. Cancer statistics, 2019. CA-Cancer J. Clin 69, 7–34 (2019)
[68]. Singh, G. P., Nigam, R., Tomar, G. S., Monisha, M., Bhoi, S. K., Arulselvi, S., et al.(2018). Early and rapid detection of UCHL1 in the serum of brain-traumapatients: a novel gold nanoparticle-based method for diagnosing the severityof brain injury. Analyst 143, 3366–3373. doi: 10.1039/c8an00533h
[69]. Singh, P. et al. Gold nanoparticles in diagnostics and therapeutics for human cancer. Int. J. Mol. Sci. 19, 1979 (2018)
[70]. Sosnik, A. & Menaker Raskin, M. Polymeric micelles in mucosal drug delivery: challenges towards clinical translation. Biotechnol. Adv. 33, 1380–1392 (2015).
[71]. Su, X. et al. Advances in the application of nanotechnology in reducing cardiotoxicity induced by cancer chemotherapy. Semin. Cancer Biol. 86, 929–942 (2022).
[72]. Sung, H. et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA-Cancer J. Clin. 71,209–249 (2021).
[73]. Takeda, K. M. et al. Effect of shear stress on structure and function of polyplex micelles from poly(ethylene glycol)-poly(l-lysine) block copolymers as systemic gene delivery carrier. Biomaterials 126, 31–38 (2017)
[74]. Talelli, M. et al. Core-crosslinked polymeric micelles: principles, preparation, biomedical applications and clinical translation. Nano Today 10, 93–117 (2015).
[75]. . Thai, A. A. et al. Lung cancer. Lancet 398, 535–554 (2021).
[76]. van Steenoven, I., van der Flier, W. M., Scheltens, P., Teunissen, C. E., andLemstra, A. W. (2019). Amyloid-β peptides in cerebrospinal fluid of patientswith dementia with Lewy bodies. Alzheimers Res. Ther. 11:83. doi: 10.1186/s13195-019-0537-5
[77]. Virani, S. S., Alonso, A., Benjamin, E. J., Bittencourt, M. S., Callaway, C.

W.,Carson, A. P., et al. (2020). Heart disease and stroke statistics— 2020 update:a report from the American Heart Association. Circulation 141, e139–e596.doi: 10.1161/CIR.0000000000000757

[78]. Wang, F. et al. Supramolecular prodrug hydrogelator as an immune booster for checkpoint blocker-based immunotherapy. Sci. Adv. 6, eaaz8985 (2020). 180. Wilhelm, J., Wang, Z., Sumer, B. D. & Gao, J. Exploitingnanoscale cooperativity for precision medicine. Adv. Drug Deliver. Rev. 158, 63–72 (2020)

[79]. Weissleder, R., and Mahmood, U. (2001). Molecular imaging. Radiology 219,316–333. doi: 10.1148/radiology.219.r01ma19316

[80]. Yuniarsih, N., Chaerunisaa, A. Y., Elamin, K. M. & Wathoni, N. Polymeric nanohydrogel in topical drug delivery system. Int. J. Nanomed. 19, 2733–2754 (20240

[81]. Zaiki, Y., Iskandar, A. & Wong, T. W. Functionalized chitosan for cancer nano drug delivery. Biotechnol. Adv. 67, 108200 (2023)

[82]. Zhang, Z., Ma, R. & Shi, L. Cooperative macromolecular self-assembly toward polymeric assemblies with multiple and bioactive functions. Accounts Chem. Res.47, 1426–1437 (2014)

[83]. Zhang, M., Viennois, E., Prasad, M., Zhang, Y., Wang, L., Zhang, Z., et al. (2016).Edible ginger-derived nanoparticles: a novel therapeutic approach for theprevention and treatment of inflammatory bowel disease and colitis-associatedcancer. Biomaterials 101, 321–340. doi:10.1016/j.biomaterials.2016.06.018

[84]. Zhong, R. et al. Hydrogels for RNA delivery. Nat. Mater. 22, 818–831 (2023)