IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Research Study On Platinum-Based Medications Used In Cancer Therapies And Anti-Tumor Methods

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Abstract

Cisplatin, carboplatin, and oxaliplatin are common platinum-based medicines used to treat cancer through chemotherapy. Platinum medicines' side effects, including low selectivity, significant systemic toxicity, and drug resistance, severely limit their clinical use. Recent breakthroughs in nanotechnology and chemical synthesis have led to significant progress in the treatment of cancer with Pt-based medicines. Several tactics, comparable to cisplatin's anti-cancer action, have been successful in altering current platinum medicines. Platinum nanoclusters, a type of nanodrug, have demonstrated promising clinical results in tumor-targeted therapy due to their new anti-cancer actions. This review analyzes the clinical development of first-line platinum chemotherapy medicines and their anti-cancer mechanisms. These treatments are frequently used in conjunction with other anticancer therapies. For example, colorectal cancer is frequently treated with the FOLFOX regimen. This regimen combines oxaliplatin with two other drugs: fluorouracil and folinic acid, Cisplatin was the first drug of this class to be identified. It has been used to treat cancer for over 40 years (Trusted Source). More recently, the Food and Drug Administration (FDA) approved oxaliplatin and carboplatin to treat a wide range of malignancies.

Researchers are still investigating the potential benefits of newer platinum-based chemotherapy drugs including nedaplatin and lobaplatinTrusted Source. Researchers believe that future medications can reduce the side effects.

Keywords: platinum compounds, side effects , anticancer , chemotherapy

Introduction and discussion

Chemotherapy is a highly efficient anti-tumor treatment. Prior to the 1960s, cancer treatments relied solely on chemical molecules Cisplatin, a simple coordination chemical with anti-cancer capabilities, was accidently discovered in the late 1960s. Its cytostatic property inhibited bacterial development, This research presents a new option for cancer chemotherapy, Platinum-based anti-cancer medicines, such as cisplatin , carboplatin , and oxaliplatin, have proven therapeutic efficacy and well-defined mechanisms of action, making them frequently employed in clinical settings. Cisplatin, the first platinum anti-cancer medicine, has proven effective in treating several malignant tumors, including breast, ovarian, and colon cancer. However, cisplatin is a non-specificchemotherapeutic drug, causing systemic toxicity besides killing tumor cells , Platinum anti-cancer medications include negative side effects such as dose-limiting toxicity, nephrotoxicity, neurotoxicity, ototoxicity, and myelosuppression . Additionally, long-term use of cisplatin can cause significant damage to normal tissues . Cisplatin and other first-line clinical platinum medicines have a significant therapeutic effect on tumor tissues, hence techniques such liposome encapsulation have been used to minimize damage to normal tissues. Nanomaterial carriers are used for medication delivery , while bioconjunction targets highly expressed protein moieties on malignancies Recently, several novel platinum anti-cancer medicines have been developed and reported.

Cisplatin :is a first-line treatment for a variety of malignancies, including:
Leukemia and Lymphoma ,Breast cancer,testicular cancer ,Ovarian cancer,Head and neck cancer ,Cervical cancer,Sarcoma is cancer that begins in bone and soft tissue.
Oxaliplatin :is used to treat several types of malignancies, including:
Bowel cancer ,Stomach cancer,Pancreatic cancer,Breast cancer,Oesophageal cancer
Carboplatin can be used to treat several cancers, including ovarian, lung, head and neck, uterine, esophageal, bladder, breast, cervical, brain, and sarcoma.

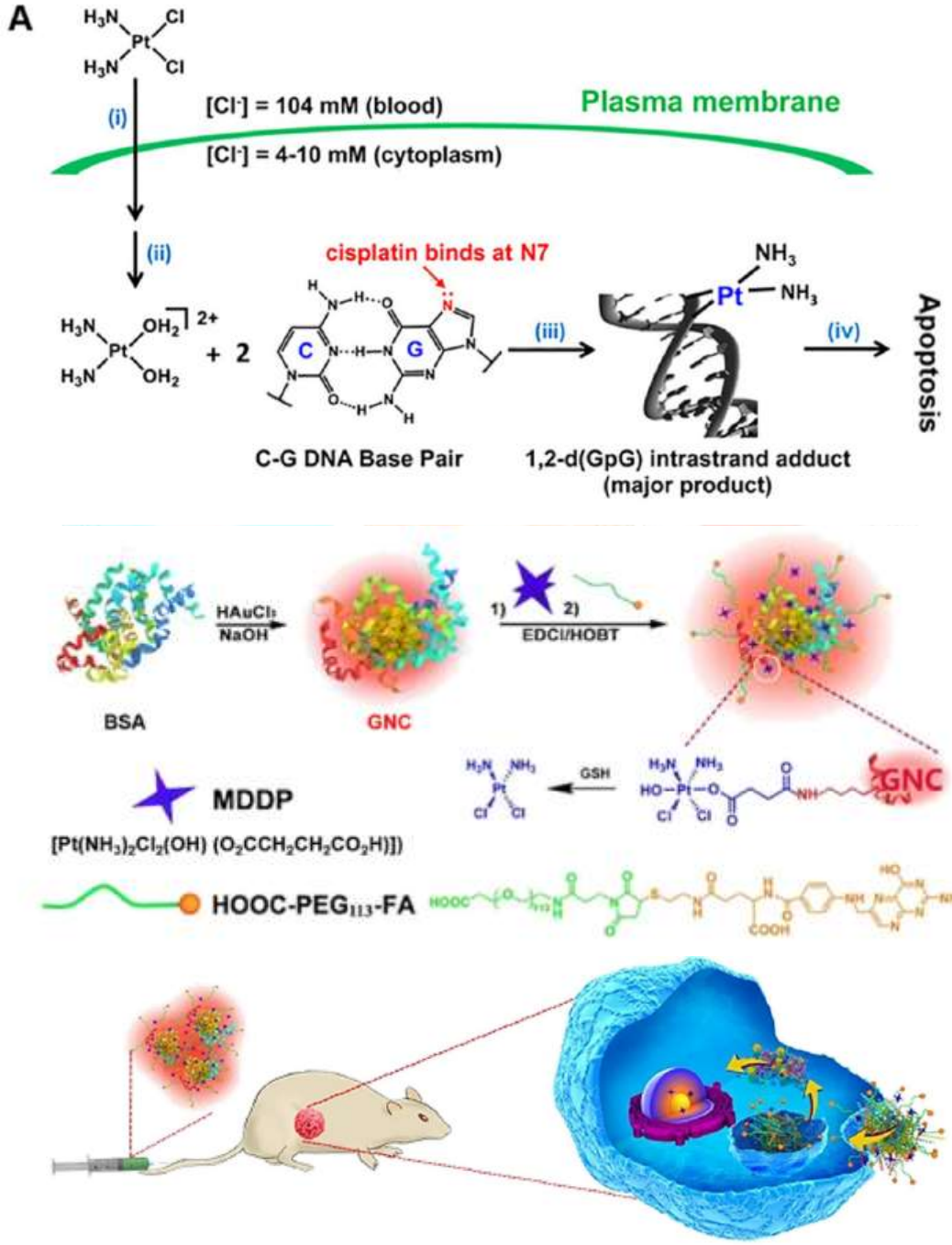
Platinum-based chemotherapeutic medicines are classified as alkylating agents. They are particularly successful in treating slow-growing tumors.
The Platinum moleculeTrusted Source platinum-based medicines attach to cancer cells' DNA. This binding is believed to cause DNA damage and cell death.
Platinum-based medicines may also cause immunogenic cell death, according to recent research. Chemotherapy is used to eradicate cancer cells, and as the cells die, they instruct the immune system to fight the remaining cancer cells. OxaliplatinTrusted Source appears to have the strongest ability to trigger this process.

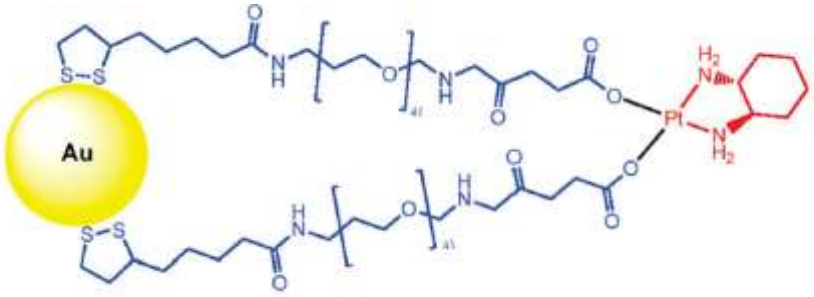
Platinum-based chemotherapy medicines can harm healthy cells in the body and induce a variety of side effects include:
Symptoms included constipation and fever. Symptoms: cough, headache.
Allergic responses. Nausea and vomiting.
Low blood cell counts increase the risk of infection. Kidney poisoning.
Hearing loss ,Peripheral neuropathy, usually in the toes and fingers, can cause:
Feeling numb or tingly. Loss of sensation
Loss of appetite, Taste changes. Hair loss
Mouth ulcers Abdominal discomfort ,Central neurotoxicity can induce a variety of symptoms, including: Cognitive impairment. seizures
Memory Loss ,Electrolyte imbalances ,Cardiovascular issues.

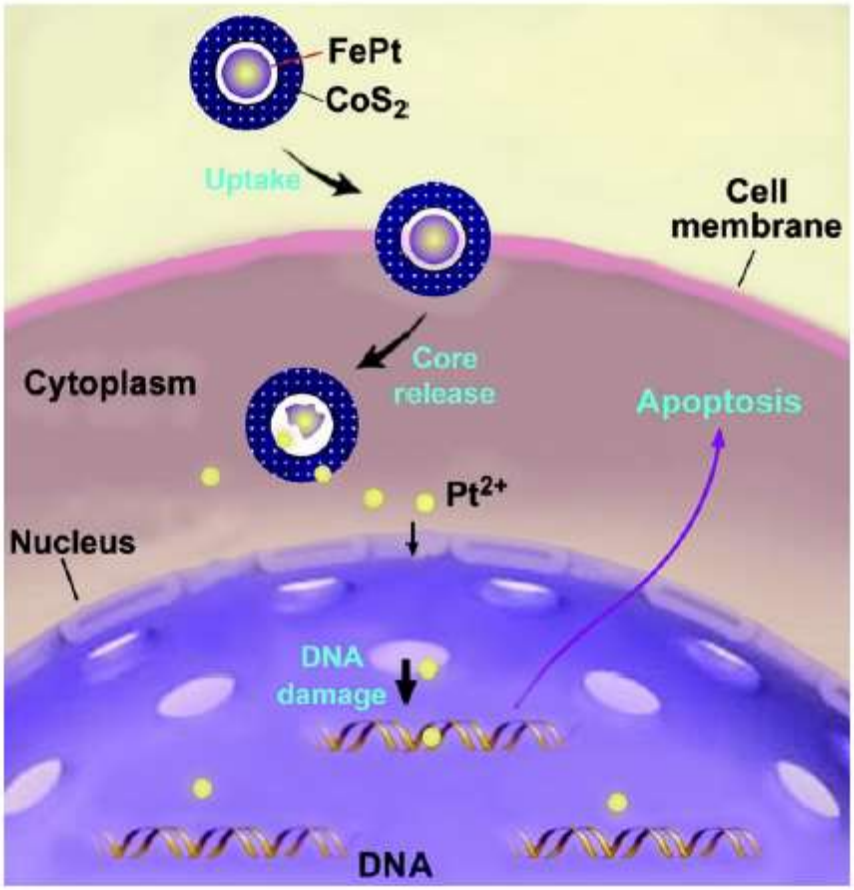
Most platinum-based chemotherapy is delivered intravenously (IV) through a vein in your hand or arm. Cisplatin and carboplatin are also occasionally injected directly into the space in your abdomen that houses your internal organs, a procedure known as intraperitoneal or IP chemotherapy.
Each session could last anything from a few minutes to several hours.
Chemotherapy is typically delivered in cycles, with the medicine given only on specific days of the cycle.
Multifunctional high-performance platinum nanocluster-based (Pt NC-based) nanodrugs have gained attention for cancer-specific therapy and drug delivery due to their flexible design and use of biocompatible materials
Pt NC-based nanodrugs outperformed typical first-line clinical platinum drugs in terms of stability, water dispersibility, and solubility. They also had reduced systemic toxicity and biocompatibility in vivo, The unique advantages of Pt NC-based nanodrugs for controllable fabrication, biosafety, and anti-tumor activity provide a broad prospect for their anti-cancer applications.
Cisplatin can treat several malignant tumors, including breast, ovarian, and colorectal cancer.
Although it can destroy tumor cells, it is a non-specific therapeutic agent that can cause systemic toxicity and damage to normal organs over time . Following the success of the first-generation platinum medication cisplatin, the second-generation platinum chemotherapy drug carboplatin took almost a decade to enter clinical trials. Carboplatin has a lower hydration rate than cisplatin due to its bidentate cyclobutane dicarboxylic acid ligands . Additionally, it has a good biosafety and little systemic toxicity, including hepatotoxicity, nephrotoxicity, neurotoxicity, and ototoxicity . Carboplatin's low toxicity allows for high-dose chemotherapy for aggressive cancers. However, Pt medication resistance remains the primary issue, Cisplatin and carboplatin eventually produce drug resistance during treatment.
Therefore, the third generation of platinum clinical drug oxaliplatin was developed.
Extensive research indicated that the killing effect of Pt-based drugs on cancer cells could be improved by integrating the cancer cell-targeting moiety into Pt(IV) prodrugs. Notably, peptide-based drug delivery systems can enhance drug targeting properties and significantly reduce side effects due to their bioactivity and low immune response of peptides specifically expressed on tumor cell membranes .
Peptide sequences have specific Pt(IV) can be modified to recognize overexpressed proteins or other receptors.
Prodrugs can achieve the desired function Polypeptide sequences can be created for various targeting functionalities.
Our research group has made tremendous progress in designing functional targeted peptides and studying their biological effects To improve the effectiveness and minimize negative effects of Pt-based medicines, various functional polypeptide-modified platforms have been created.

Strategies to Improve Anti-cancer Efficiency and Reduce Systemic Toxicity of Pt Drugs

Several research have addressed the limits of first-line platinum chemotherapy medicines, including potential toxicity and side effects, and established techniques to enhance anti-cancer efficacy while minimizing systemic toxicity , Research suggests that chemically modifying first-line platinum chemotherapy medicines for targeted therapy can increase drug use and reduce negative effects ,This section summarizes many techniques, including bioconjunction targeting moiety, nanomaterials as drug carriers, and glutathione-scavenging platinum medicines.



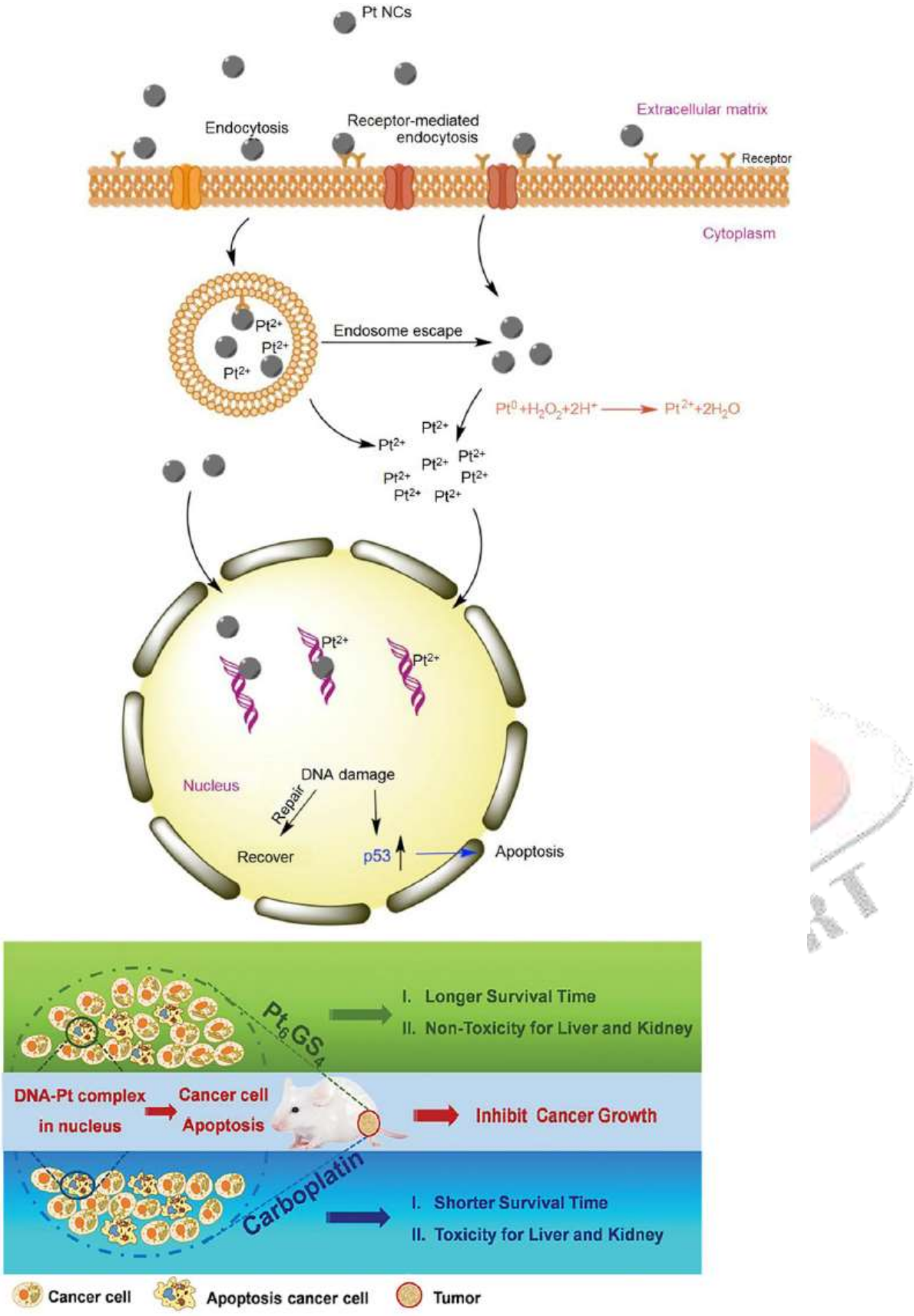


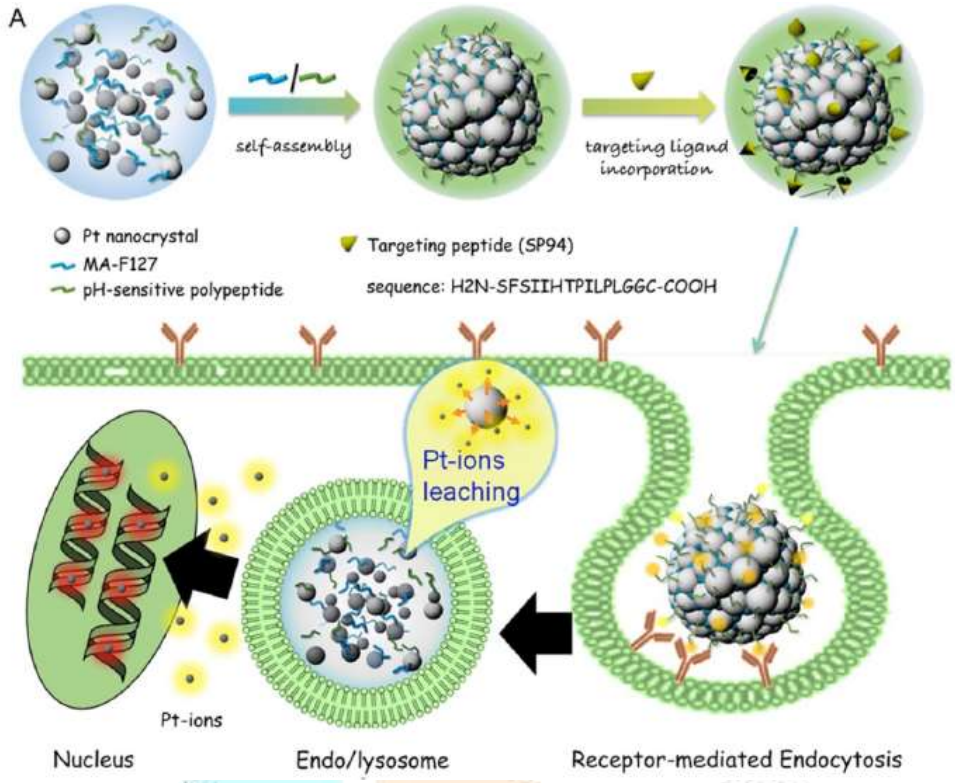


Application of Pt NC-based Drugs in CancerTherapy

Efforts to increase the anti-cancer efficacy of Pt(II) complex and modified Pt(IV) prodrugs have been unsuccessful, as they rely on comparable processes to cisplatin This section covers Pt NCs as anti-cancer medicines with various mechanisms for cancer treatment.

The cytotoxicity mechanism of Pt NCs remains unclear due to variances in particle size, shape, surface coatings, and purity Pt NCs' cytotoxicity is attributed to the leaching of excessive Pt2+ ions in low pH circumstances, such as in cell endosomes, which causes DNA damage.


Pt NCs
Endocytosis
Receptor-mediated endocytosis
Extracellular matrix
Receptor
Cytoplasm
Endosome escape
Pt^{2+}
$Pt^0+H_2O_2+2H^+ \rightarrow Pt^{2+}+2H_2O$
Nucleus
DNA damage
Repair
Recover
p53
Apoptosis
Pt_6GS_4
I. Longer Survival Time
II. Non-Toxicity for Liver and Kidney
DNA-Pt complex in nucleus
Cancer cell Apoptosis
Inhibit Cancer Growth
Carboplatin
I. Shorter Survival Time
II. Toxicity for Liver and Kidney
Cancer cell
Apoptosis cancer cell
Tumor



The challenges accompanying these advances provide us with future directions and efforts for designing and constructing more effective Pt-based drugs for possible clinical applications:
(1) For cisplatin and other platinum anticancer Systemic toxicity remains a major challenge for medications. Platinum medicines are modified by various.
To reduce toxicity, strategies include connecting target molecules and using medication delivery vehicles.
(2) Numerous novel platinum nanodrugs, including Pt NCs, have been produced. Pt NCs produce platinum ions in cells, causing irreversible DNA damage ,However, Pt NC-based medicines are still cytotoxic, and their potential hazardous mechanisms are not well known. Research suggests that the size of Pt NCs plays a significant influence in cytotoxicity, potentially influencing molecular pathways. Synchrotron radiation X-ray techniques may help understand nanomaterial biotransformation and the anti-tumor mechanism of Pt NCs.
(3) Pt NCs, a novel platinum anti-cancer medication, require additional improvement in their molecular composition. Mass spectrometric techniques like MALDI-TOF-MS and ESI-MS may identify the chemical formula and metal-to-ligand ratio of clusters. However, more precise structural characterisation approaches for cluster molecules are needed.
(4) Combining Pt-based nanodrugs with other therapies, such as synergistic chemoelectrodynamic therapy, can enhance the biofunction of Pt NCs and boost their anti-tumor activity (102, 134-136). Bimetallic composites, including platinum complexes with ruthenium, outperformed individual Pt-based medications in terms of anti-cancer activity.
(5) Nanotechnology has the potential to significantly improve these challenges. In addition to knowing the molecular makeup of Pt NCs, further research is needed to investigate their anti-tumor effect in relation to cisplatin and transplatin configurations. Nanotechnology in Pt NC-based nanodrugs has promise for enhancing anti-cancer treatments.

Conclusion

Chemo-drugs used in traditional cancer treatment can have significant adverse effects on normal cells and tissues Pt-based anticancer ,Drugs have proven effective in clinical cancer treatment. Cisplatin, a first-line clinical platinum anti-cancer medication, has a known molecular mechanism for treating malignancies and is quite ancient.
However, side effects severely limit the use of platinum anti-cancer medications. Modified Pt-based medicines have been studied to enhance anti-cancer efficacy while minimizing systemic toxicity. Pt NC-based nanodrugs have gained popularity due to their longer blood circulation duration, EPR effect, and easy surface functionalization.

Advances in nanotechnology and nanoscience have led to the production of Pt nanocrystals, a key research focus for platinum exploration.

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