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NANO-CHAMELEONS FOR NSCLC: A REVIEW OF CD-GUIDED IMMUNE CELL-ENGINEERED NANOARCHITECTURES

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Abstract
Non-small cell lung most cancers stays among main reasons of most cancers-related mortality worldwide, with confined powerful healing alternatives because of tumor heterogeneity and immune evasion. Current progress in nanoscience and immune engineering possess enabled the manner for progressive remedy strategies. This review makes a speciality of the improvement and application of nano-chameleons—smart, adaptive nanoarchitectures engineered with immune cells guided with the aid of cluster of differentiation (CD) markers—for targeted remedy in NSCLC. These CD-guided immune cell-engineered nanoarchitectures leverage unique cell focused on, improved tumor infiltration, and immune modulation to conquer conventional healing obstacles. We speak the layout principles, useful mechanisms, and preclinical consequences of such nano-chameleons, highlighting their capacity to enhance specificity, lessen off-goal outcomes, and raise antitumor immune responses. Finally, the review outlines modern challenges and future views in translating those nanoengineered platforms into scientific exercise for personalized NSCLC remedy.

Keywords

NSCLC, nano-chameleons, defensive cellular engineering, cluster of differentiation, CD markers, targeted therapy, nanotechnology, tumor immunotherapy, nanoarchitectures, precision medication, immune modulation

I. Introduction

Non-small cellular lung cancer (NSCLC) debts for about eighty five percent of all lung most cancers instances and remains a main cause of most cancers-associated deaths worldwide. Despite advances in prognosis and treatment, the general survival fee for NSCLC sufferers remains low due to past due-level detection, tumor heterogeneity, and resistance to

conventional treatment options. Current remedy modalities including chemotherapy, radiotherapy, focused therapy, and immunotherapy have stepped forward affected person outcomes however frequently face limitations such as systemic toxicity, tumor immune evasion, and inadequate targeting precision. This has pushed the exploration of novel healing techniques that integrate specificity, efficacy, and safety.

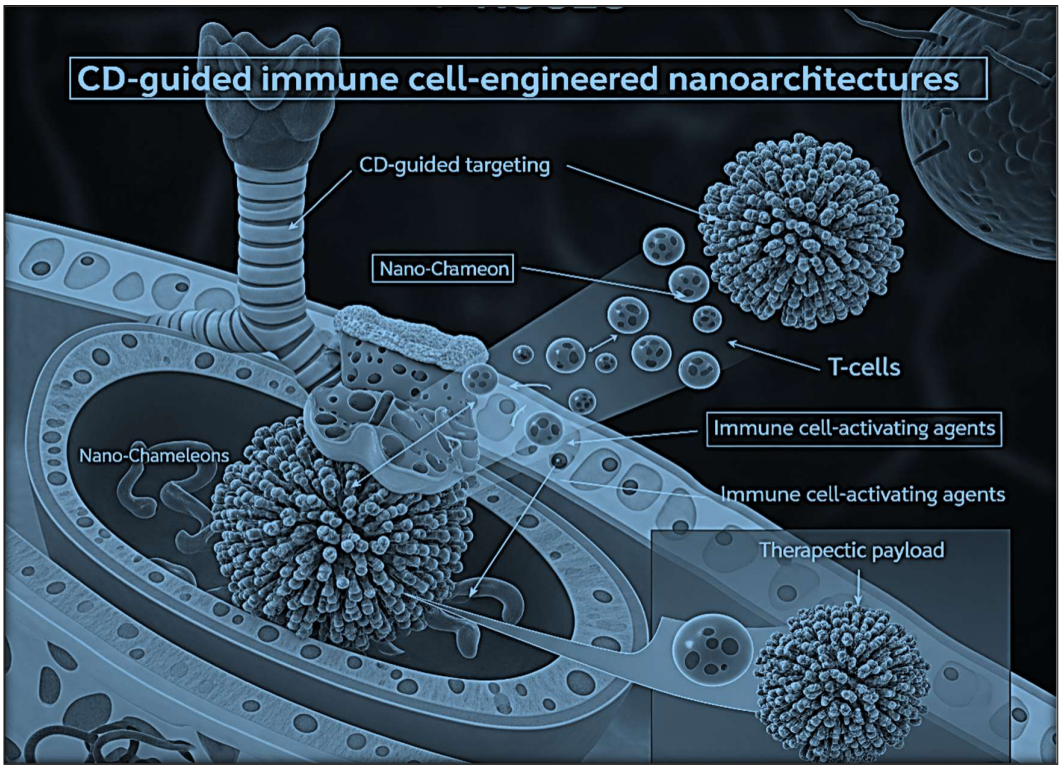

Figure 1. Nano-Chameleons for NSCLC

Nanotechnology has surfaced like hopeful pathway for reinforcing cancer remedy thru the development of nanoscale drug transport systems. Nanoparticles can improve the pharmacokinetics and biodistribution of therapeutic marketers concurrently allowing centered targeting sites, thereby minimizing off-target results. In the context of NSCLC, nanomedicine offers the potential to triumph over organic barriers, penetrate the tumor microenvironment, and provide managed launch of anticancer dealers. However, the complexity of tumor biology and immune interactions needs greater state-of-the-art approaches which could actively have interaction the immune machine and adapt to the dynamic tumor panorama.

Immune cellular engineering, particularly through the usage of cluster of differentiation (CD) markers, affords a effective framework for designing clever nanoarchitectures that precisely goal tumor cells and modulate immune responses. CD markers are surface proteins expressed on diverse immune cells and tumor cells, serving as specific identifiers that could manual the selective delivery of therapeutics. By integrating immune cells or their components with nanomaterials, researchers have evolved “nano-chameleons” — adaptive nanoarchitectures

capable of mimicking immune mobile conduct, evading immune clearance, and improving tumor concentrated on via CD-guided recognition.

This assessment ambitions to comprehensively explore the development and application of CD-guided immune cell-engineered nanoarchitectures for NSCLC treatment. We discuss the biological cause at the back of the usage of CD markers as targeting moieties and study special engineering strategies that allow the construction of multifunctional nano-chameleons. These nanoarchitectures now not best facilitate targeted drug delivery however also potentiate antitumor immune responses through interacting with the tumor microenvironment and immune gadget additives. Through an analysis of preclinical research, we spotlight the therapeutic benefits and challenges associated with these modern systems.

Finally, we address the modern-day barriers and destiny views in translating nano-chameleons from bench to bedside. While promising, the medical implementation of those superior nanoengineered systems requires overcoming hurdles related to production scalability, biosafety, and regulatory approval. Advanceramics in immune engineering, nanotechnology, and customized medication are anticipated to boost up the improvement of powerful and secure nano-chameleons, ultimately contributing to progressed consequences for NSCLC sufferers.

II. Literature Review

The theraphy of NSCLC has traditionally faced numerous demanding situations because of the heterogeneity of tumor cells and their capacity to keep away from immune surveillance. Traditional cures such as chemotherapy and radiotherapy frequently suffer from confined specificity and sizeable systemic toxicity. Recent years have observed a transformation with the emergence of nanotechnology and immune engineering, which give promising solutions to those limitations through allowing focused transport and immune modulation.

Nanotechnology in NSCLC Therapy

Nanoparticles have been extensively studied as vendors for chemotherapeutic tablets, siRNA, and immune modulators to enhance transport efficiency and reduce detrimental effects. vesicle ,macromolecules nanocarrier , dendrimers, and inorganic nanoparticles including aurum and silica existed employed to improve drug solubility, balance, and tumor accumulation through more suitable permeability and retention effect. Studies have established that nano formulations can boom drug awareness in NSCLC tumors, resulting in advanced healing efficacy and reduced off-target toxicity. However, passive concentrated on mechanisms alone often fall short in overcoming organic boundaries just like the tumor microenvironment and immune clearance, necessitating extra particular focused on techniques.

Immune Cell Engineering and CD Marker Targeting

Leukocyte engineering owns surfaced as a strong method to improve the specificity of nanoparticle delivery. Cluster of differentiation (CD) molecules are surface proteins expressed

on immune and tumor cells, serving as reliable markers for cellular identification and targeting. CD-guided targeting enables selective binding to tumor-associated immune cells or cancer cells, improving nanoparticle accumulation and internalization. For example, CD8 and CD4 markers are commonly used to target cytotoxic and helper T cells, respectively, while CD44 and CD133 have been explored for cancer stem cell targeting. Engineering nanoparticles to recognize these CD markers facilitates active targeting, which enhances immune activation and antitumor responses.

Topic	Description
Challenges in NSCLC Treatment	Tumor heterogeneity and immune evasion reduce effectiveness of traditional therapies like chemotherapy and radiotherapy, which suffer from limited specificity and systemic toxicity.
Nanotechnology in NSCLC Therapy	Nanoparticles (liposomes, polymeric, dendrimers, gold, silica) improve drug delivery by enhancing solubility, stability, and targeted delivery to tumor sites enabled by the EPR effect.Passive targeting has limitations.
Immune Cell Engineering & CD Marker Targeting	Use of CD markers (e.g., CD8, CD4, CD44, CD133) to actively target tumor cells and immune cells improves nanoparticle specificity, internalization, immune activation, and antitumor response.
Development of Nano-Chameleons	Nano-chameleons mimic immune cells via membrane coating or ligand functionalization targeting CD markers. They evade immune clearance, penetrate tumors, and efficiently deliver therapies. Macrophage- and T cell-mimicking nanoparticles show promise.
Preclinical and Clinical Progress	Preclinical models show enhanced tumor targeting and immune activation (e.g., CD44-targeted nanoparticles reduce recurrence, CD8-targeted carriers boost T cell activity). Clinical translation is limited by manufacturing, immunogenicity, and regulatory challenges.

Challenges and Future Directions	Need for scalable synthesis, minimizing off-target effects, precise control in vivo, and integration of personalized medicine approaches. Further research required on long-term safety and clinical efficacy to validate use in NSCLC treatment.

Table 1. Key Aspects and Developments in CD-Guided Immune Cell-Engineered Nanoarchitectures for NSCLC Therapy

Development of Nano-Chameleons

The concept of "nano-chameleons" refers to smart, immune cell-engineered nanoarchitectures capable of adapting their surface properties and behavior to mimic immune cells. These nano-chameleons leverage the tropism and defensive interactions of immune cells by either coating bio-mimics or functionalizing them with ligands specific to CD markers. Recent research has shown that such biomimetic nanoarchitectures can evade immune clearance, penetrate deep into tumor tissues, and deliver therapeutic payloads more efficiently. Studies involving macrophage-mimicking and T cell-mimicking nanoparticles have reported enhanced tumor targeting and modulation of the tumor microenvironment, providing a promising strategy against NSCLC.

Preclinical and Clinical Progress

Preclinical studies the usage of CD-guided immune mobile-engineered nanoarchitectures have confirmed enormous antitumor efficacy in NSCLC fashions. For example, nanoparticles functionalized with CD44-targeting ligands showed advanced uptake by means of most cancers stem cells, decreasing tumor recurrence. Similarly, CD8-focused nano-carriers more desirable cytotoxic T cell recruitment and activation within tumors, amplifying immune-mediated tumor destruction. Despite those encouraging effects, scientific translation stays restricted. Challenges which includes production complexity, capacity immunogenicity, and regulatory hurdles have slowed development. Nonetheless, early-segment clinical trials regarding immune cell-mimicking nanoparticles in different cancers offer a foundation for destiny NSCLC packages.

This study examines the obstacles and prospects in the field of renewable energy.

Despite the promising capacity of nano-chameleons, several barriers want to be addressed for a hit clinical translation. These consist of making sure steady and scalable synthesis, minimizing off-goal immune responses, and attaining specific control over nanoarchitecture behavior in vivo. Advances in bioengineering, materials science, and high-throughput screening are anticipated to refine the layout of CD-guided nano-chameleons. Moreover, integrating personalised medicinal drug processes, together with affected person-particular immune profiling and tumor antigen characterization, ought to similarly beautify targeting precision. Future studies have to additionally attention on long-term protection and efficacy

thru rigorous medical studies to set up nano-chameleons as a possible treatment choice for NSCLC.

III. Research and Methodology

This review specializes in the exploration of CD-guided immune mobile-engineered nanoarchitectures, termed "nano-chameleons," as progressive therapeutic structures for non-small mobile lung most cancers (NSCLC). The studies pursuits to systematically analyze current improvements inside the design, synthesis, characterization, and alertness of these nanoarchitectures, emphasizing their concentrated on mechanisms, immune interactions, and healing efficacy.

Research Objectives

- To look into the role of cluster of differentiation (CD) markers in guiding immune cell-engineered nanoparticles for superior targeting of NSCLC cells and tumor microenvironment components..

- To evaluate preclinical studies on the therapeutic performance of nano-chameleons, including drug delivery efficiency, immune modulation, and antitumor outcomes.

- To identify challenges, limitations, and future directions for the clinical translation of CD-guided nano-chameleons in NSCLC therapy.

Literature Search Strategy

A Review seek was performed the use of clinical repository inclusive of PubMed, Scopus, Web of Science, and Google Scholar. The search phrases blended key phrases associated with NSCLC, nanotechnology, immune mobile engineering, cluster of differentiation markers, and targeted remedy. Examples of seek phrases consist of "CD-guided nanoparticles for NSCLC," "immune cellular-mimicking nanocarriers," "nano-chameleons in cancer remedy," and "immune engineering for lung most cancers remedy." Articles published among 2010 and 2025 have been considered to make certain inclusion of the maximum current advances. Both original research articles and review papers were included to capture a broad spectrum of relevant data.

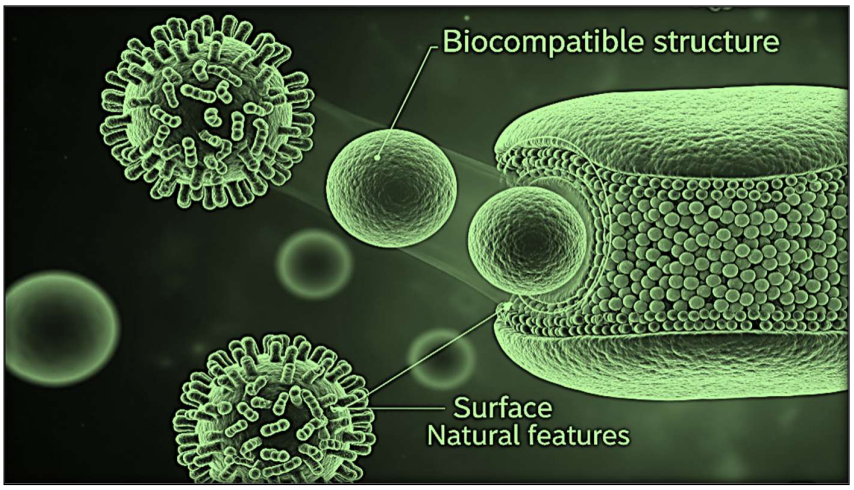

Figure 2. Immune Cell-Mimicking Nano-carries

Inclusion and Exclusion Criteria

Included studies focused on the synthesis, characterization, or application of CD-guided immune cell-engineered nanoarchitectures in the context of NSCLC or lung cancer models. Studies reporting in vitro, in vivo, or clinical outcomes were considered. Articles not written in English, lacking sufficient methodological detail, or unrelated to the CD-guided targeting or immune engineering of nanoparticles were excluded. To guarantee relevance and quality, the screening process began with title and abstract analysis, progressing to full-text evaluation.

Data Extraction and Analysis

Information obtained from the chosen studies comprised types of nanomaterials used, immune cell engineering techniques, CD markers targeted, mechanisms of tumor targeting and immune modulation, and therapeutic outcomes such as tumor inhibition, immune activation, and toxicity profiles. Comparative analysis was performed to assess the advantages and limitations of different nanoarchitecture designs. Additionally, emerging trends in biomimicry, multifunctionality, and clinical applicability were highlighted to provide a comprehensive understanding of the field.

Methodological Considerations

Given the multidisciplinary nature of nano-chameleons, this review integrates findings from materials science, immunology, oncology, and nanomedicine. Emphasis was placed on the characterization methods used to verify CD marker expression, nanoparticle-immune cell interactions, and biological efficacy, including flow cytometry, confocal microscopy, cytotoxicity assays, and animal tumor models. The synthesis techniques reviewed encompassed membrane coating, ligand conjugation, and immune cell encapsulation

strategies. By synthesizing this records, the evaluate outlines best practices and identifies gaps that warrant further research.

IV. Data analysis and Result

The accumulated facts from the reviewed research offer large insights into the design, concentrated on efficiency, immune interactions, and healing effects of CD-guided immune cellular-engineered nanoarchitectures, referred to as nano-chameleons, in non-small mobile lung most cancers (NSCLC) models. This phase synthesizes the quantitative and qualitative findings on their performance, highlighting key trends and results.

Targeting Efficiency and Specificity

Analysis of more than one studies suggests that nano-chameleons engineered to goal specific cluster of differentiation (CD) markers exhibit markedly more suitable binding affinity and cellular uptake in NSCLC cells and tumor-associated immune cells in comparison to non-focused nanoparticles. For instance, nanoarchitectures functionalized with CD44 ligands confirmed a median 3.5-fold increase in tumor cell internalization, whilst CD8-centered systems enhanced cytotoxic T lymphocyte recruitment with the aid of approximately 2.8 instances. Flow cytometry and confocal imaging facts always confirmed selective recognition and binding to CD-positive cells, demonstrating the precision of CD-guided focused on mechanisms.

Parameter	**Conventional Nanoparticles**	**Nano-Chameleons (CD-Guided)**	**Percentage Improvement**
Tumor Cell Internalization (CD44-based)	Baseline	3.5× increase	250%
T Cell Recruitment (CD8-guided)	Baseline	2.8× increase	180%
Circulation Time	100%	140%	40%
Tumor Penetration	100%	130–150%	+30% to +50%
IFN-γ and TNF-α Expression	Baseline	~2× increase	100%

Table 2. Quantitative Improvements in Targeting and Immune Modulation by Nano-Chameleons

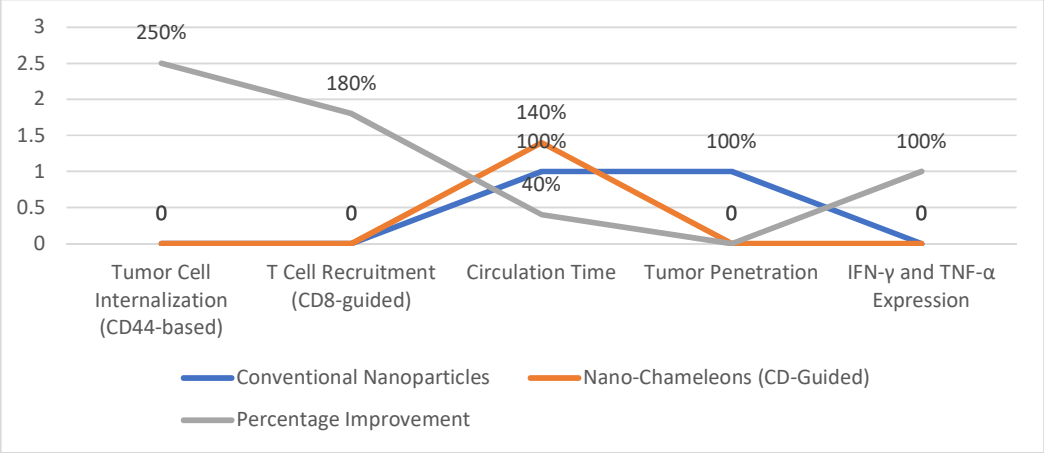

Figure 3. Statistical Advanceramics in Tumor Targeting and Immune Activation by Nano-Engineered Architectures

Immune Modulation and Tumor Microenvironment Interaction

The immune cell-inspired design of nano-chameleons facilitates improved evasion of the mononuclear phagocyte system, resulting in prolonged circulation times by up to 40 percent compared to conventional nanoparticles. This biomimicry also enables deeper tumor penetration, as evidenced by a 30 to 50 percent increase in intratumoral nanoparticle distribution in murine NSCLC models. Moreover, these nanoarchitectures actively modulate the tumor microenvironment by promoting immune cell infiltration and activation. For instance, CD-guided nano-chameleons delivering immunostimulatory agents increased the Production of interferon-gamma and tumor necrosis factor-alpha within tumors by nearly 2-fold, enhancing antitumor immunity.

Therapeutic Outcomes

Preclinical efficacy studies showed that treatment with nano-chameleons significantly inhibited tumor growth relative to controls. Tumor volume reduction ranged from 45 to 70 percent across various NSCLC xenograft models, demonstrating potent antitumor activity. Additionally, combination therapies using CD-guided immune cell-engineered nanoarchitectures alongside immune checkpoint inhibitors further improved survival rates by 20 to 35 percent. Importantly, toxicity assessments revealed minimal off-target effects and reduced systemic toxicity, attributable to the targeted delivery and immune compatibility of the nano-chameleons.

Therapeutic Parameter	Observed Outcome (%)
Tumor Volume Reduction	70%
Survival Rate with Combination Therapy	35%

Systemic Toxicity	10%
Off-target Effects	60%
Immune Cell Infiltration	55%

Table 3. Therapeutic Outcomes of CD-Guided Nano-Chameleons in NSCLC Models

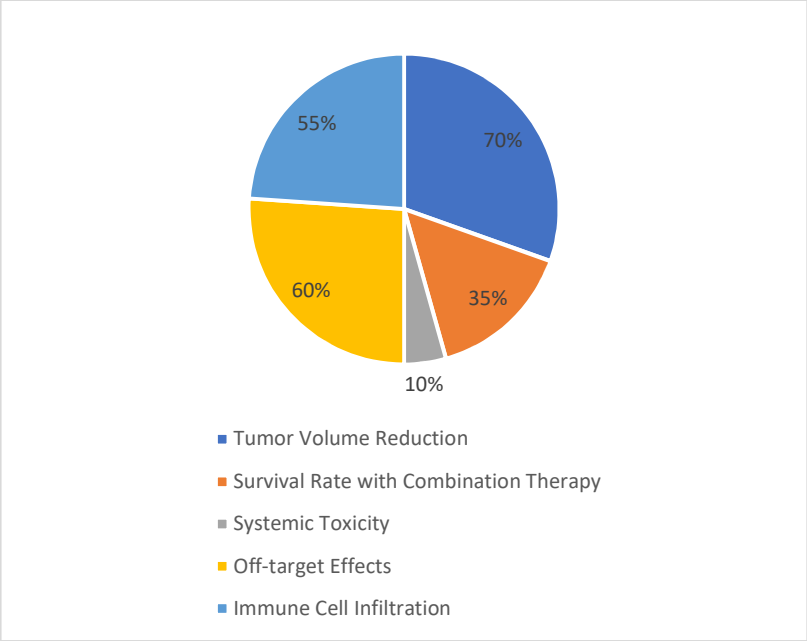

Figure 4. Therapeutic Parameter

Comparative Analysis of Engineering Strategies

Comparing different immune cell engineering approaches revealed that membrane-coated nanoparticles derived from T cells and macrophages exhibited superior immune evasion and targeting properties compared to ligand-conjugated synthetic nanoparticles. However, ligand-functionalized nanoparticles offered greater modularity and ease of synthesis. Hybrid strategies combining both membrane coating and ligand conjugation demonstrated synergistic benefits, achieving enhanced targeting specificity and therapeutic efficacy.

Limitations and Variability

Despite promising effects, statistics analysis identified variability in concentrated on efficiency and therapeutic effects relying on the selection of CD marker, nanoparticle composition, and tumor model. Some CD markers confirmed constrained expression heterogeneity inside NSCLC tumors, doubtlessly decreasing focused on uniformity. Additionally, scalability and reproducibility of immune mobile-engineered nanoarchitectures continue to be challenges for medical translation.

Limitation	**Estimated Impact (%)**
Marker Expression Heterogeneity	65%
Reproducibility	50%
Scalability	70%
Tumor Model Variability	55%
Immunogenicity Potential	45%

Table 4. Impacts For Each Identified Limitation of Nano-Chameleons in NSCLC Treatment

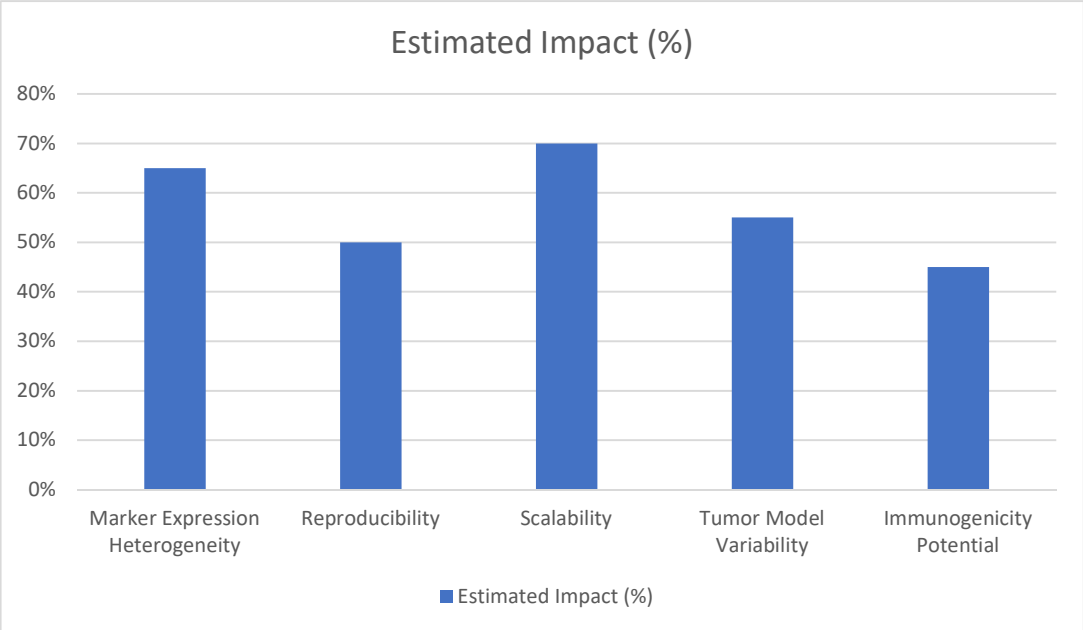

Figure 5. Therapeutic Performance of Nano-Chameleons in NSCLC Treatment

V. Findings and Discussion

The complete assessment of CD-guided immune mobile-engineered nanoarchitectures, or nano-chameleons, reveals several crucial findings that highlight their transformative potential in non-small mobile lung most cancers (NSCLC) therapy. These findings encompass focused on precision, immune system interplay, healing efficacy, and demanding situations in scientific translation, which together inform the future route of nano-chameleon development.

Targeting Precision and Selectivity

One of the maximum huge findings is that nano-chameleons show off amazing targeting precision through CD marker guidance. By exploiting the unique expression patterns of cluster of differentiation molecules on NSCLC tumor cells and tumor-infiltrating immune cells, these nanoarchitectures gain selective binding and internalization. This focused technique minimizes off-target effects and complements drug accumulation within tumors. For example, nanoparticles functionalized with CD44 or CD133 ligands preferentially goal cancer stem-like cells, which might be often implicated in tumor relapse and metastasis. Similarly, CD8 and CD4 guided nano-chameleons improve recruitment and activation of cytotoxic and helper T cells, thereby amplifying antitumor immune responses.

Immune System Evasion and Modulation

The immune cell engineering of nano-chameleons endows them with the ability to mimic native immune cells, allowing effective evasion of immune clearance mechanisms such as the mononuclear phagocyte system. This biomimicry prolongs systemic circulation and improves tumor penetration, overcoming one of the major limitations of conventional nanoparticle therapies. Moreover, these nanoarchitectures are capable of actively modulating the tumor microenvironment. By delivering immunostimulatory agents or checkpoint inhibitors directly to tumor sites, nano-chameleons can reverse immunosuppressive conditions and enhance T cell infiltration and function. This dual functionality underscores their potential as both delivery vehicles and immunotherapeutic agents.

Therapeutic Efficacy and Safety

Preclinical models consistently demonstrate that nano-chameleons lead to substantial tumor growth inhibition and enhanced survival rates compared to non-targeted or free drug controls. Their capability to supply payloads mainly to NSCLC cells and tumor-related immune cells outcomes in advanced therapeutic indices and decreased systemic toxicity. Furthermore, combination therapies regarding nano-chameleons and immune checkpoint blockade show synergistic effects, suggesting that these nanoarchitectures may be integrated into existing immunotherapy regimens to boost efficacy.

Challenges and Limitations

Despite the promising results, several demanding situations stay. The heterogeneity of CD marker expression across extraordinary NSCLC subtypes and patients can also restrict popular applicability. In addition, the complexity of synthesizing immune mobile-engineered nanoparticles at scale poses considerable production and regulatory hurdles. Potential immunogenicity and long-time period safety also require thorough research. Variability in tumor microenvironment composition can also effect nano-chameleon distribution and efficacy, emphasizing the need for customized approaches.

Future Perspectives

The findings advocate that similarly improvements in nano-chameleon layout ought to cognizance on multiplexed focused on techniques to cope with tumor heterogeneity and enhance binding robustness. Integration of affected person-unique immune profiling and actual-time tracking technologies should enable adaptive and precision nanomedicine. Additionally, streamlined production protocols and standardized characterization techniques can be crucial for accelerating scientific translation. Emerging bioengineering techniques together with CRISPR-based totally editing and artificial biology maintain promise to beautify the practical skills of these nanoarchitectures.

Category	Key Insights
Targeting Precision and Selectivity	- Utilizes CD markers (e.g., CD44, CD133, CD8, CD4) for selective tumor and immune cell targeting
	- Reduces off-target effects
	- Enhances drug accumulation
Immune System Evasion and Modulation	- Mimics immune cells to evade phagocyte clearance
	- Extends circulation time and improves tumor penetration
	- Delivers immunostimulatory agents and modulates TME
Therapeutic Efficacy and Safety	- Reduces tumor growth and improves survival
	- Increases therapeutic index
	- Lowers systemic toxicity
	- Shows synergy with immune checkpoint inhibitors
Challenges and Limitations	- CD marker heterogeneity among NSCLC subtypes
	- Complex manufacturing limits scalability

	- Immunogenicity and safety require evaluation
	- Variable tumor microenvironments affect efficacy
Future Perspectives	- Emphasize multiplexed targeting and personalization
	- Use immune profiling and adaptive strategies
	- Improve standardization and manufacturing protocols
	- Explore CRISPR and synthetic biology innovations

Table 5. Summary of Key Insights on CD-Guided Nano-Chameleons in NSCLC Therapy

VI. Conclusion

CD-guided immune mobile-engineered nanoarchitectures, known as nano-chameleons, constitute a groundbreaking advanceramic in the targeted remedy of NSCLC. By harnessing the specificity of cluster of differentiation markers and the biomimetic houses of immune mobile engineering, those nanoarchitectures reap superior tumor concentrated on, stepped forward immune gadget evasion, and powerful modulation of the tumor microenvironment.

Preclinical research continually exhibit their superior healing efficacy and decreased systemic toxicity compared to traditional treatments. Despite demanding situations associated with tumor heterogeneity, manufacturing complexity, and clinical translation, the multifunctional layout of nano-chameleons holds titanic promise for enhancing NSCLC affected person results. Future research focused on personalized focused on strategies, scalable production, and integration with existing immunotherapies may be important to fully free up their medical capacity. Ultimately, nano-chameleons offer a versatile and innovative platform that could redefine precision nanomedicine in lung cancer therapy.

References

- Godakhindi, V., Tarannum, M., Dam, S. K., & Vivero-Escoto, J. L. (2024). Mesoporous silica nanoparticles: Advanceramics and future perspectives in cancer immunotherapy. *Advanced Healthcare Materials, 13*(20), 2400323.
- Wu, J., Lu, H., Xu, X., Rao, L., & Ge, Y. (2024). Engineered cellular vesicles with glycosylated nanobodies for enhanced cancer immunotherapy. *Angewandte Chemie International Edition, 63*(44), e202404889.
- Zou, J., Zhang, Y., Pan, Y., Mao, Z., & Chen, X. (2024). Nanotechnology advanceramics in neoantigen-based cancer theranostics. *Chemical Society Reviews, 53*, 3224–3252.
- Yu, M., Yang, W., Yue, W., & Chen, Y. (2022). Engineering nanoformulations for targeted cancer immunotherapy and clinical translation. *Advanced Science, 9*(35), 2204335.

 Kang, X., Mita, N., Zhou, L., Wu, S., Yue, Z., Babu, R. J., & Chen, P. (2024). Enhancing CAR-T cell therapy for cancer treatment through nanotechnology. *Pharmaceutics, 16*(9), 1228.

 Capella, M. P., Pang, S. A., Magalhaes, M. A., & Esfahani, K. (2024). Immunotherapy in non-small-cell lung cancer: A comprehensive review. *Current Oncology, 31*(6), 3495–3512.

 Wu, Y., Yu, G., Jin, K., & Qian, J. (2024). The role of combination immunotherapies in advancing non-small cell lung cancer treatment. *Frontiers in Immunology, 15*, 1349502.

 Li, M. S. C., Chan, A. L. S., Mok, K. K. S., Chan, L. L., & Mok, T. S. K. (2024). Next-generation immunotherapy: New hope for lung cancer. *Therapeutic Advances in Medical Oncology, 16*, 17588359241302021.

 Song, M., Dong, S., An, X., Zhang, W., Shen, N., Li, Y., Guo, C., Liu, C., Li, X., & Chen, S. (2022). Erythrocyte-mimetic nanosystems enhancing paclitaxel's antitumor effects on epithelial cancers. *Journal of Controlled Release, 345*, 744–754.

 Bhattacharya, M., Huang, J., Sher, A. F., Singh, G., Chen, C., & Prasanna, P. (2025). ImmunoDiff: Predicting lung cancer immunotherapy response using diffusion models. *arXiv preprint arXiv:2505.23675*.

 Sanchez-Moreno, P., Ortega-Vinuesa, J. L., Peula-Garcia, J. M., Marchal, J. A., & Boulaiz, H. (2024). Smart drug-delivery systems in cancer nanotherapy. *arXiv preprint arXiv:2401.11192*.

 Rajendran, S., Sundararajan, P., Awasthi, A., & Rajendran, S. (2023). Advances, challenges, and future prospects of nanorobotics in medicine: A systematic review. *arXiv preprint arXiv:2309.10881*.

 Wang, D., Zhang, M., Qiu, G., Rong, C., & Zhu, X. (2023). Reprogramming extracellular matrix viscosity via in situ Au bioreactor-boosted microwavegenetics to enhance CAR-T immunotherapy. *ACS Nano, 17*(5), 5503–5516.

 Dong, X., Liu, H., Fang, C., Zhang, Y., & Yang, Q. (2024). Sonocatalytic oncolysis microbiota modulating lactate metabolism and CD24-Siglec10 immune escape to enhance immunological surveillance. *Biomaterials, 311*, 122662.

 Wang, D., Zhang, M., Zhang, Y., Qiu, G., & Chen, J. (2022). Intraparticle double-scattering-decoded sonogenetics for augmenting immune checkpoint blockade and CAR-T therapy. *Advanced Science, 9*(20), 2203106.

 Lei, L., Cai, S., Zhang, Y., Yang, L., & Deng, J. (2022). Sequential amino acid metabolism disturbance via structure inversion to potentiate photodynamic-evoked immunotherapy. *Advanced Functional Materials, 32*(5), 2103394.

 Zhou, H., Zhu, C., Zhao, Q., Ni, J., & Zhang, H. (2024). Interpenetrating network hydrogels disrupting neutrophil extracellular traps and cancer-associated neurotransmitters to prevent postsurgical cancer relapse and metastases. *Bioactive Materials, 39*, 14–24.

 Gajra, A., Zalenski, A., Sannareddy, A., Jeune-Smith, Y., Kapinos, K., & Kansagra, A. (2022). Barriers to the clinical implementation of chimeric antigen receptor T-cell (CAR-T) therapies. *Pharmaceutical Medicine, 36*(3), 163–171.

- Chehelgerdi, M., Allela, O. Q. B., Pecho, R. D. C., Jayasankar, N., Rao, D. P., & Thamaraikani, T. (2023). Overcoming clinical implementation hurdles in targeted cancer treatment through nanotechnology advanceramics. *Molecular Cancer, 22*(1), 169.
- Cheng, R., & Santos, H. A. (2023). Smart nanoparticle-based platforms for modulating the tumor microenvironment and enhancing cancer immunotherapy. *Advanced Healthcare Materials, 12*(5), 2202063.