Annexin V-Based Bead System for Apoptotic Cell Detection and Depletion

1. Overview

Brief Description: This technology provides a cost-effective, multiplatform-compatible bead-based system specifically designed for the detection and depletion of apoptotic cells, particularly by utilizing Annexin V fluorescent conjugates to identify apoptosis through the quantification of phosphatidylserine on apoptotic cell surfaces.

Development Stage: The technology is currently at a commercially available stage, having been tested and validated for practical applications in various biological studies and clinical products.

2. Key Features

i. **Multiplatform Compatibility** – The technology is adaptable for use with multiple platforms including fluorescent microscopy and flow cytometry, allowing researchers to choose the method that best suits their needs.

ii. **Dual Functionality**– This system not only detects apoptotic cells but also allows for their effective depletion, enhancing utility in various biological applications and cell-based therapies.

iii. **Immunomagnetic Approach** – Utilizes non-fluorescent Annexin V combined with biotin and magnetic beads for efficient dead cell elimination, which is a unique feature not commonly found in other apoptosis detection kits.

3. Benefits

Economic Impact: This technology offers cost savings through the efficient identification and removal of apoptotic cells, thereby reducing waste and increasing the effectiveness of research and clinical applications.

Social Impact: It has the potential to enhance the safety and efficacy of cell-based therapies, positively impacting patient outcomes in medical treatments.

Environmental Impact: By improving the efficiency of biological research processes, the technology may reduce the overall consumption of reagents and materials, leading to less environmental waste.

4. Applications:

i. **Healthcare** – The technology can be applied in clinical settings for the improvement of cell-based therapies, contributing to better management of diseases and personalized medicine.

ii. **Pharmaceuticals**– It can be utilized in drug discovery and cytotoxicity testing, allowing for more accurate assessments of drug effects on cell viability.

iii. **Research Opportunities:** Further research could explore enhancements in the detection of apoptosis in different cell types or the development of new fluorescent dye conjugates for expanded analytical capabilities.

5. Case Studies:

i. A successful trial demonstrated the system's effectiveness in identifying and depleting apoptotic cells from hematopoietic stem cell populations, leading to improved yields in therapy applications.
ii. In cancer research, this technology provided significant insights into the cellular effects of chemotherapeutic agents by allowing researchers to simultaneously evaluate apoptosis and eliminate dead cells from analyses.

6. IP Status:

Intellectual Property: The technology has a filed patent in India, Application No: 2020541102567, dated April 15th, 2020, with potential for extension to other jurisdictions.

7. Support Offered:

Licensing Options: A Non- exclusive licensing option is available for interested parties.

Technical Support: Comprehensive technical support includes training resources and guidance on the use of the technology for optimal outcomes.

Collaboration Opportunities: Opportunities exist for partnerships and joint development projects focusing on advanced applications of the technology.

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Uttroside B and Derivatives as Therapeutics for Hepatocellular Carcinoma

1. Overview:

Brief Description: Uttroside B is a novel plant-derived compound that has shown significant cytotoxicity against hepatocellular carcinoma (HCC) cells, demonstrating greater efficacy than the currently available standard treatment, Sorafenib. It works by inducing apoptosis and down-regulating key survival pathways, offering hope in a field with limited therapeutic options.

Development Stage: The compound has received U.S. FDA Orphan Drug Designation and has been granted patents in the USA, Japan, Canada, South Korea, and Europe. Preclinical testing is currently underway to support an Investigational New Drug (IND) application.

2. Key Features:

1: High Potency – Uttroside B exhibits an IC50 of 0.5 μM against HepG2 liver cancer cells, showcasing more than 11.6 times greater potency compared to Sorafenib (IC50 of 5.8 μM).

2: Apoptosis Induction – The compound effectively induces apoptosis in cancer cells while demonstrating biological safety in normal hepatocytes, indicating a promising therapeutic profile.

3: Multi-Patent Coverage – Patented in multiple jurisdictions (USA, Canada, Japan, South Korea, Europe), the technology offers broad intellectual property protection for its use in treating liver cancer.

3. Benefits:

Economic Impact: By providing a more effective treatment option for HCC, Uttroside B could potentially reduce healthcare costs associated with advanced liver cancer treatments and improve patient outcomes.

Social Impact: The availability of a new therapeutic option for HCC could significantly enhance the quality of life for patients suffering from this aggressive cancer, making it a vital advancement in oncology.

Environmental Impact: The use of a plant-derived compound minimizes reliance on synthetic chemicals, aligning with a growing trend towards sustainable and natural therapeutics.

4. Applications:

1: Pharmaceuticals – Uttroside B can be used in the development of novel therapies for liver cancer, addressing a significant unmet medical need in oncology.

5. Case Studies:

1: Preclinical research demonstrated that Uttroside B significantly reduces tumor growth and metastasis in orthotopic HepG2-xenograft models and tail-vein metastasis model in NOD-SCID mice, supporting its anticancer efficacy against liver cancer.

2: Preclinical research also demonstrated that Uttroside B significantly reduces MASH and conversion of MASH to HCC, in High fat diet -induced MASH model and STAM-mouse model, respectively in C57BL/6 mice

3: A pharmacological Safety evaluation revealed that consumption of *S.nigrum* leaf powder containing IC50 dose of Uttroside B is safe in healthy volunteers and stabilizes the Liver Function and Lipid Profile in Patients undergoing Ayurveda and Naturopathy treatment against various liver ailments including fatty liver, NASH, Chronic Liver Disease and HCC.

6. IP Status:

Intellectual Property: Patents granted in the USA (US 11,607,422 B2, March 21, 2023), Japan (6830153, January 27, 2021), Canada (3026426, April 13, 2021), South Korea (10-2293156, August 18, 2021), and Europe (EP3463382, August 30, 2023) ensure protection of the invention.

7. Support Offered:

Licensing Options: Licensing agreements are available for the development and commercialization of Uttroside B, facilitating partnerships with pharmaceutical companies.

Technical Support: Comprehensive support will be provided, including scientific guidance and resources to help maximize the therapeutic potential of Uttroside B.

Collaboration Opportunities: There are avenues for collaboration with academic and research institutions, enhancing the development of Uttroside B through joint clinical trials and studies.

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Building Sophisticated Trans-membrane Pores for Nanotechnology and Medicine

1. Overview

Brief Description: This invention involves the creation of synthetic transmembrane peptide pores formed from short α-helical peptides, specifically derived from porinACj from *Corynebacterium jeikeium*. This technology enables single-molecule sensing and has significant implications for nanopore technology in biotech applications.

Development Stage: The patent for this innovative technology has been granted in India (Indian Patent No. 407575, dated September 26, 2022).

2. Key Features

1: Unique Architecture – The developed pore is the first large synthetic transmembrane pore to be constructed entirely from short synthetic α-helical peptides, showcasing original design in protein nanopore technology.

2: Ion Selectivity – The peptide pore demonstrates ion-selective properties, allowing it to conduct ions effectively while being capable of binding blockers like cyclic sugars.

3: Functional Analysis – Comprehensive investigations reveal the pore's assembly pathway and structural properties, offering insights into its subunit composition and dynamics.

3. Benefits

Economic Impact: This technology paves the way for advanced sensing applications, potentially leading to novel diagnostic tools and therapies, thus benefiting the biotech industry economically.

Social Impact: By enhancing the capability for single-molecule sensing, this invention could improve disease detection and characterization, contributing to better healthcare outcomes.

Environmental Impact: The use of synthetic peptides for nanopore construction presents a more sustainable and controlled approach compared to natural peptide utilization, minimizing ecological impact.

4. Applications

1. This invention enhances the field of nanopore technology by providing a stable platform for applications such as DNA sequencing and macromolecule characterization.

2. The pore's unique properties offer various applications, including drug delivery systems and ion-selective sensors.

3. Research Opportunities: Further exploration is encouraged to harness this technology for diverse applications in biomedicine and molecular research.

5. Case Studies

1. Through high-resolution single-channel electrical recordings, the RGCB has successfully defined the structural properties of the synthetic pore, providing foundational data for future applications in molecular sensing.

2. The study explores the interaction of the pore with cyclodextrins, elucidating the functional properties and blocking mechanisms, vital for further advancements in drug delivery and molecular interaction studies.

6. IP Status:

Intellectual Property: Indian Patent No. 407575, protecting the synthesis and application of transmembrane peptide pores for various biotechnological uses.

7. Support Offered:

Licensing Options: Opportunities are available for non-exclusive licensing this innovative technology, inviting collaboration with biotech and pharmaceutical companies for further development.

Technical Support: RBCB will provide scientific guidance and assistance in navigating the applications of synthetic trans-membrane pores, enabling effective utilization of the invention.

Collaboration Opportunities: Potential partnerships with academic and research institutions to explore novel applications and enhance the understanding of this technology through further research.

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Cefotetan in Cancer Therapy

1. Overview:

Brief Description: Cefotetan is an FDA-approved antibiotic being repurposed for targeting b hCG in BRCA1 defective breast cancers, addressing significant challenges in cancer treatment and potential drug resistance.

Development Stage: The technology is in the preclinical testing phase, with promising results from *in vitro* studies and further research needed before clinical applications.

2. Key Features:

1. Cefotetan demonstrates selective cytotoxic effects in BRCA1 defective cell lines, indicating its potential as a targeted treatment.

2. Being an FDA-approved antibiotic, cefotetan has a well-documented safety and pharmacokinetic profile.

3. Advanced computational methods have identified specific binding sites and interactions between cefotetan and bhCG, supporting its therapeutic potential.

3. Benefits:

Economic Impact: Potential to reduce healthcare costs associated with ineffective treatments and enhance patient outcomes in BRCA1 related cancers.

Social Impact: Improved treatment options for patients with limited responses to traditional therapies, promoting better quality of life and survival rates.

Environmental Impact: Repurposing existing drugs helps to streamline development efforts and reduce waste in pharmaceutical production.

4. Applications:

1. Utilized in treating breast cancers, particularly those associated with BRCA1 mutations.

2. Further research could explore combinatorial therapies and refine methodologies for targeting bhCG pathways in other cancer types.

5. Case Studies:

1. *In vitro* testing showed cefotetan reduced cell proliferation in BRCA1 hypermethylated cell lines by over 50% in MTT assays.

2. Binding studies confirmed significant interaction between cefotetan and bhCG, supporting its use as a promising therapeutic agent.

6. IP Status:

Intellectual Property: Provisional patent filed in USA vide 63/799,963 dated 5 May, 2025

7. Support Offered:

Licensing Options: Opportunities for licensing the use of cefotetan in cancer therapy may be available to pharmaceutical companies.

Technical Support: Comprehensive research documentation and findings are provided to support further studies and application development.

Collaboration Opportunities: Open to partnerships for continued research and development in cancer therapeutics.

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Stem Cell Activator (SCA) Protein

1. Overview

- **Brief Description**:

  Stem Cell Activator (SCA) is a novel, synthetic, codon-optimized protein expressed from synthetic DNA designed specifically for mammalian cells. It acts as a potent *stem cell activator* that triggers multiple survival and stemness pathways, including PI3K, Erk, GSK3, Wnt signaling, and Yamanaka factors (Oct3/4, Sox2, Klf4, c-Myc). By doing so, it promotes cell survival, sustains proliferation, and enhances or maintains stemness, with potential to generate adult stem cells in large quantities without viral vectors or permanent genetic manipulation.

- **Development Stage**:

  The technology is at the TRL - 4 stage, **experimentally validated in vitro** with detailed sequence information, methods of production, and in vitro experimental validation (cell lines, primary mouse embryonic fibroblasts, reporter assays, iPSC reprogramming experiments). It has been demonstrated in cell culture and 3D tissue models.

2. Key Features

Synthetic, Codon-Optimized Protein: Fully synthetic DNA construct for efficient expression in mammalian cells and *E. coli*, ensuring controlled and scalable production.

Multi-Pathway Activation: Simultaneously activates PI3K, Erk, GSK3, Wnt signaling, and Yamanaka factors, promoting cell survival, proliferation, and stemness without multiple growth factors or viral transgenes.

Built-In Variability and Customizable Variants: A variable region allows for tailored SCA variants for diverse applications and cell types, uniquely combining Wnt and Yamanaka activation for efficient, non-viral stemness induction.

3. Benefits

Economic Impact: Reduced production costs and simplified processes due to recombinant bacterial production of SCA, leading to lower cell therapy manufacturing expenses.

Social Impact: Enhanced access to stem cell-based therapies, fostering regenerative medicine development, enabling safer reprogramming methods, and accelerating scientific discovery.

Environmental Impact: Lower resource consumption (media, plastics, reagents) and potential for defined, xeno-reduced media systems due to SCA's fully synthetic design.

4. Applications

i. Regenerative Medicine and Cell Therapy

ii. Drug Discovery, Toxicology, and Research Tools

Research Opportunities:

1. ***In Vivo* Proof-of-Concept**: Evaluating safety, biodistribution, immunogenicity, and efficacy of SCA in animal models for tissue regeneration.

2. **Bioprocess & Formulation Development**: Optimizing recombinant production, purification, stability, and formulation of SCA for scalable manufacturing.

5. Case Studies

i. **Activation of Survival Pathways and Proliferation in Epithelial Cells and 3D Models**: Demonstrates SCA's role as a general survival and proliferation enhancer that can support high-density cell and tissue culture.
ii. **Wnt Pathway Activation, Yamanaka Factor Induction, and Enhanced iPSC Generation in MEFs**: Provides strong in vitro proof that SCA is a potent Wnt and Yamanaka activator, and a powerful enhancer of somatic cell reprogramming to iPSCs.

6. IP Status

Intellectual Property**:** Filed Indian patent vide application number 202341056900 dated 24 August, 2023.

7. Support Offered

i. Licensing Options**:** Exclusive or Non-Exclusive Licenses **for companies or institutions interested in therapeutic, diagnostic, or research-tool development.**

- **Technical Support:** Experimental protocols and optimization guidance and assistance in setting up SCA-based assays or reprogramming workflows.
- **Collaboration Opportunities: Co-development of therapeutic applications** (e.g., combining SCA with specific stem cell types, scaffolds, or delivery systems), **Research collaborations** to explore new cell types, in vivo models, or variant optimization and **Industry partnerships** for scaling up recombinant production and moving toward regulatory development.

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IL6Rα-Targeting Apoptosis-Inducing Peptide (SSTP1)

1. Overview

- **Brief Description**: SSTP1 is a novel anti-carcinogenic peptide derived from the skin secretion of the frog *Indosylvirana aurantiaca*. It functions by specifically targeting cancer cells that overexpress the Interleukin 6 Receptor alpha (IL6Rα) and inducing apoptosis. This peptide modulates the IL6 pathway, actively promoting cell death in a targeted manner, offering a new strategy for cancer treatment.
- **Development Stage**: It is in the advanced research and pre-clinical development stage, with a focus on understanding its pharmacological effects and therapeutic potential. Extensive experimental data and in silico analyses, demonstrating its mechanism of action, cytotoxicity, and safety in *in vitro* settings and in specific cell lines.

2. Key Features

- **Targeted Apoptosis Induction**: SSTP1 selectively induces programmed cell death in cancer cells overexpressing IL6Rα, minimizing harm to healthy cells.
- **Modulation of IL6 Pathway**: It downregulates the JAK/STAT pathway (reducing STAT3 phosphorylation) and activates the JNK/AP1 pathway, disrupting pro-survival signals and initiating apoptosis.
- **Non-Membranolytic Activity**: SSTP1 induces apoptosis through a non-membranolytic mechanism, internalizing via receptor-dependent endocytosis for targeted intracellular action without general membrane disruption.

3. Benefits

- **Economic Impact**: Potential for reduced treatment costs due to targeted therapy and cost-effective production as a small peptide.
- **Social Impact**: Offers a safer, more effective treatment for cancers like triple-negative breast cancer, improving patient outcomes and quality of life with fewer side effects.
- **Environmental Impact**: Derived from a natural source, suggesting potentially more sustainable sourcing than synthetic alternatives, though further assessment is needed.

4. Applications

- **Healthcare (Cancer Therapy)**: Primarily for treating cancers with IL6Rα overexpression, including triple-negative breast cancer, multiple myeloma, and rheumatoid arthritis.
- **Biotechnology (Drug Development)**: Potential for designing SSTP1 derivatives as new drugs and pharmaceutical compositions.

- **Research Opportunities**: Requires further research, including clinical trials, combination therapies, and optimization for broader applications and improved delivery.

5. Case Studies

- **MDA-MB-231 Cells**: Demonstrated 91% growth inhibition in triple-negative breast cancer cells (IC50 of 4.5 µM) with minimal hemolytic activity and no adverse effect on human leukocytes, showcasing targeted action and safety.
- **HSC-4 Oral Cancer Cells**: Induced apoptosis (IC50 of 10.22 µM) through the mitochondrial pathway, involving active cleavage of Caspases 3, 7, and 9, and PARP, confirming effectiveness and mechanism across different cancer types.

6. IP Status

Intellectual Property: Filled Indian patent vide application number 202041016382 dated April 15, 2020 and US patent application no. 17/919,130 dated October 14, 2022.

7. Support Offered

- **Licensing Options**: Exclusive, non-exclusive licensing options are available.
- **Technical Support:** Experimental protocols and optimization guidance will be provided.
- **Collaboration Opportunities:** Co-development of therapeutic applications**,** Research collaborations **and** Industry partnerships**.**

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An Antifungal Synthetic Peptide Derived from Osmotin Protein

1. Overview

Brief Description: This invention describes a novel 9-mer short cyclic peptide (sequence: CCNSGSCSP) derived from the osmotin protein of *Piper colubrinum*. It functions as a potent antifungal agent, specifically effective against *Phytophthora capsici*, the oomycete pathogen responsible for foot rot disease in black pepper (*Piper nigrum*). The peptide also acts as a plant defense inducer and priming agent, offering a greener and environment-friendly option for fungicide.

Development Stage: The document outlines detailed experimental procedures for synthesizing the peptide, testing its antifungal activity *in vitro* and *in vivo* on *Piper nigrum* leaves and seedlings, and analyzing its effect on gene expression. This indicates that the technology is in a robust research and development phase, with strong experimental validation, likely at the pre-commercialization stage.

2. Key Features

Potent Antifungal Activity: The synthetic 9-mer peptide (CCNSGSCSP) demonstrates significant antifungal activity against *Phytophthora capsici*, which is a major threat to crops like black pepper. It shows inhibitory effects on both hyphae and sporangia, leading to hyphal breakage and malformed sporangia at higher concentrations.

Plant Defense Elicitor and Priming Agent: At lower concentrations (e.g., 1 µg/mL), the peptide effectively induces innate immunity in susceptible plants by significantly upregulating key genes in secondary metabolite (phenyl propanoid) and Reactive Oxygen Species (ROS) signaling pathways. This "priming" effect offers long-term protection against pathogens.

Synergistic Effect with Glycol Chitosan: The peptide, when combined with glycol chitosan (a known plant defense elicitor), shows an additive inhibitory effect against *Phytophthora capsici*, leading to a more pronounced reduction in necrotic lesions than either component alone.

3. Benefits

Economic Impact: By providing an effective solution against *Phytophthora capsici*, the technology can significantly reduce crop losses, particularly in black pepper cultivation. This can save farmers substantial money on disease management and prevent economic losses due to reduced yields and poor quality produce.

Social Impact: The invention offers a "greener" and environment-friendly fungicide option, reducing reliance on chemical oomyceticides that cause serious environmental pollution and drug resistance. This can contribute to safer food production and

potentially be developed as a therapeutic agent for antimicrobial applications in higher organisms, including humans.

Environmental Impact: The peptide is derived from a natural plant defense protein, providing an eco-friendly alternative to chemical fungicides. Its use can help mitigate environmental pollution caused by conventional pesticides and support sustainable agricultural practices.

4. Applications

Industry 1 (Agriculture - Crop Protection): The primary application is as an antifungal agent and priming agent for crop protection, particularly in preventing foot rot disease caused by *Phytophthora capsici* in *Piper nigrum*. It can be used alone or in combination with other defense elicitors and/or pesticides for enhanced biological control.

Industry 2 (Biotechnology - Antimicrobial Agents): The peptide and its derivatives have potential applications as antimicrobial and therapeutic agents in other higher organisms, including humans, due to their fungicidal activity. This opens avenues for broader biotechnological applications beyond plant protection.

Research Opportunities: Further research can focus on identifying the specific fungal cell wall proteins targeted by the peptide, developing optimized derivatives and formulations for various applications, and conducting advanced studies to validate its use as a therapeutic agent in humans.

5. Case Studies

1. **Inhibitory Effect on** *Phytophthora capsici* **Growth:** Experiments showed that pretreatment with osmotin peptide (1-200 µg/mL) significantly reduced the growth of *Phytophthora capsici* on *Piper nigrum* leaves. Higher concentrations led to hyphal disintegration and malformed sporangia, demonstrating direct fungicidal action. This effect was evident as early as 3 hours after treatment and sustained up to 72 hours post-infection.

2. Induction of Plant Defense Genes: Osmotin peptide pretreatment induced the expression of key genes in the phenyl propanoid pathway and ROS signaling pathways (e.g., CHS, COAMT, GST, AsPX, FPS2, GGPS, NAPDHO, CHOS, PAL, SOD, PRDX, PEX, RBOHD, GPX) in *Piper nigrum* leaves. This indicates that the peptide acts as a powerful defense elicitor, enhancing the plant's natural immune response.

6. IP Status

Intellectual Property: Indian patent granted for the invention vide patent number 548799 dated August 07, 2024. Brazilian patent is also applied vide application number BR 11 2022 020417 5 dated October 7, 2022.

7. Support Offered

Licensing Options: Exclusive, non-exclusive licensing options are available.

Technical Support: Experimental protocols and optimization guidance will be provided.

Collaboration Opportunities: Co-development of therapeutic applications**,** Research collaborations **and** Industry partnerships**.**

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Epigenetic Marker Panel for Breast Cancer

1. Overview

- **Brief Description:** This invention provides an epigenetic marker panel composed of three molecules—Aprataxin PNK-like Factor (APLF), H2BUb1, and Holliday junction recognition protein (HJURP)—for identifying the progression and subtype of breast cancer. Its purpose is to offer an efficient method for breast cancer detection, staging, and subtyping using a minimal number of markers. This panel aims to overcome the limitations of current methods that often rely on a larger number of genes, making them costly and potentially less efficient for identifying specific stages and types of cancer.
- **Development Stage:** Experimentally validated using immunohistochemistry (IHC) and Qpath software; a decision tree for diagnosis and subtyping has been formulated.

2. Key Features

- **Three-Marker Panel:** Utilizes only APLF, H2BUb1, and HJURP, offering a more minimal and potentially cost-effective approach than current multi-gene panels.
- **Dual Diagnostic Capability:** Capable of identifying both breast cancer progression stages (inflammation, benign, malignant, metastasis) and molecular subtypes (Luminal A/B, Her2, TNBC).
- **Immunohistochemistry-based Method:** Employs a reproducible IHC protocol with specific antibodies and Qpath software for histoscore analysis.

3. Benefits

- **Economic Impact:** Potential for reduced diagnostic costs due to the minimal marker panel.
- **Social Impact:** Aims for earlier and more accurate breast cancer detection, leading to better patient outcomes and targeted therapies.

4. Applications

Healthcare: This technology is directly applicable in breast cancer diagnostics for:

- Identifying the presence of cancer, inflammation, or benign conditions.
- Determining the stage of disease progression (benign, inflammation, malignant, metastasis).
- Classifying breast cancer into specific molecular subtypes (Luminal A/B, Her2, TNBC).

- **Research Opportunities:** Requires further extensive analysis of patient samples for clinical substantiation.

5. Case Studies

Case Study 1: Validation shown through IHC analysis of APLF, HJURP, and H2BUb1 expression in various tissue samples, demonstrating associations with cancer stages, tumor size, and node status.

Case Study 2: A molecular panel based on histone epigenetics was formulated, with a decision tree using the three markers to guide diagnosis and subtyping.

6. IP Status

Intellectual Property: Filed Indian Patent application vide no. 202241028767 dated May 19, 2022.

7. Support Offered

Licensing Options: Exclusive, non-exclusive licensing options are available.

Technical Support: Experimental protocols and optimization guidance will be provided.

Collaboration Opportunities: Co-development of therapeutic applications**,** Research collaborations **and** Industry partnerships**.**

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Aza-BODIPY-Biotin Conjugates DPR2a and DPR2b as Theranostic Agents

1. Overview

- **Brief Description:** Novel 2,6-Diiodo-aza-BODIPY-Biotin Conjugates (DPR2a, DPR2b) act as third-generation photosensitizers for cancer theranostics (imaging and photodynamic therapy). They selectively target cancer cells and exhibit excellent photophysical properties and PDT activity.
- **Development Stage:** Preclinical stage, with detailed synthesis, photophysical characterization, and in vitro photobiological evaluation, showing promising results in laboratory settings.

2. Key Features

- **NIR Absorption and Emission:** Strong Near-Infrared absorption (550-750 nm) and emission (640-850 nm) enable deep tissue penetration for both imaging and PDT.
- **High Singlet Oxygen Generation Quantum Yield:** High yields (0.72 for DPR2a, 0.75 for DPR2b) indicate potent photodynamic therapy efficacy.
- **Cancer Cell Targeting (Biotin Conjugation):** Biotin conjugation ensures specific targeting of cancer cells, potentially reducing side effects on healthy tissues.

3. Benefits

- **Economic Impact:** Potential to reduce overall cancer treatment costs through more effective and targeted therapies.
- **Social Impact:** Offers more precise diagnosis and treatment, minimizing damage to healthy tissues and improving patient quality of life.

4. Applications

Healthcare (Cancer Treatment and Diagnostics): Primarily used as theranostic agents for cancer.

Photodynamic Therapy (PDT): DPR2a and DPR2b can be used as photosensitizers to generate reactive oxygen species that kill cancer cells upon light activation. They have shown significant photocytotoxicity against various cancer cell lines, including breast, colon, liver, cervical, pancreatic, and oral cancer.

Bioimaging: Their strong NIR absorption and emission properties make them suitable for in vivo imaging applications, allowing for real-time monitoring and localization of cancer cells.

Research Opportunities: The compound has potential for clinical trials and further commercialization. Further studies could explore their efficacy in diverse cancer types and *in vivo* models.

5. Case Studies

Case Study 1 (In Vitro Photobiological Evaluation): In vitro studies on human breast cancer cell line MDA-MB-231 demonstrated that DPR2a and DPR2b are non-cytotoxic in the dark but exhibit remarkable photocytotoxicity under light exposure. The IC50 values were 3 µM for DPR2a and 7 µM for DPR2b in MDA-MB-231 cells. Cellular uptake was observed within 15 minutes of incubation, with localization in the cytoplasm.

- **Case Study 2 (Synergistic Effect)**: The conjugates showed excellent photocytotoxic effects across various cancer cell lines, with IC50 values ranging from 3.5 µM to 15 µM depending on the cell type. Furthermore, synergistic effects were observed in combination assays, leading to decreased cell viability, elevated reactive oxygen species (ROS), increased apoptotic induction, and G2/M arrest in cancer cells after PDT treatment with DPR2a and DPR2b.

6. IP Status

Intellectual Property: An Indian patent application has been filed jointly by Council of Scientific & Industrial Research and RGCB vide application Number 202111015510 dated March 31 2021.

7. Support Offered

Licensing Options: Exclusive, non-exclusive licensing options are available.

Technical Support: Experimental protocols and optimization guidance will be provided.

Collaboration Opportunities: Co-development of therapeutic applications**,** Research collaborations **and** Industry partnerships**.**

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