Ingenious Brain

InnoFeb 2024:

Monthly Top Innovations in Life Sciences & Healthcare

1st FEBRUARY

Utilizing Nanotechnology for Precise CRISPR/Cas9 Delivery in Cancer Genome Editing

In a MedComm—Biomaterials and Applications study, Professor Changyang Gong and Ph.D. student Shiyao Zhou explore the mechanics of the CRISPR/Cas9 system in genome editing for cancer treatment. The CRISPR/Cas9 system, comprising Cas9 protein and sgRNA, induces DNA double-strand breaks in target regions, leading to site-specific genomic changes. The study details three CRISPR/Cas9 delivery forms—plasmids, mRNA/sgRNA, and RNP complexes—each with advantages and challenges. Overcoming the difficulty of CRISPR/Cas9 penetration into target cells, nanotechnology-based delivery methods, including cationic lipid-based nanoparticles, offer promising solutions. These smart delivery systems enhance tumor therapeutic capabilities and minimize off-target effects. The research suggests a bright future for personalized cancer therapy using CRISPR/Cas9 nanotechnology.

2nd FEBRUARY

Environmentally Friendly Sensor Measures Pesticide Levels through Direct Contact with Fruits and Vegetables

Scientists from the University of Sao Paulo (USP) and the Federal University of Vicosa (USV) in Brazil have created an eco-friendly sensor, termed a "plant-wearable," capable of directly detecting pesticides on the surface of fruits or vegetables. Constructed from cellulose acetate derived from wood pulp, this innovative device offers a promising solution for ensuring food safety amid global concerns over food shortages and the adverse environmental and health impacts of excessive agrochemical use.

4th FEBRUARY

Researchers Create First-Ever Functional 3D-Printed Brain Tissue Resembling Human Brain

The nerve cells within the 3D-printed brain tissue effectively communicate, transmitting signals and engaging in interactions facilitated by neurotransmitters. Additionally, these cells establish intricate networks with the support cells incorporated into the printed tissue. According to Su-Chun Zhang, professor of neuroscience and neurology at UW–Madison's Waisman Center, the team successfully printed sections like the cerebral cortex and the striatum. Notably, even when different cells from distinct brain regions were printed, they demonstrated a remarkable ability to communicate with each other in a unique and specific manner.

5th FEBRUARY

Cutting-Edge Technology Deciphers Microbial Conversations

Researchers at UC San Diego, in collaboration with scientists across the globe, have introduced a novel search tool to enhance the comprehension of microorganism metabolism. Current methods to investigate microbial metabolism hinder the decoding of microorganisms' interactions and environmental systems.

Published in Nature Microbiology on February 5, 2024, the research directly tackles these constraints, potentially revolutionizing our understanding of human health and the environment. Highlighting the significance of microbes in our ecosystems, Senior study author Dr. Pieter Dorrestein emphasizes the lack of knowledge regarding the metabolites produced by these microbes.

The newly developed technology, termed microbe MASST, enables the identification of microbial metabolic signatures without prior knowledge, marking a significant advancement in studying microorganisms and their intricate relationships with humans and ecosystems. The innovative tool, created by scientists at UC San Diego's Collaborative Microbial Metabolite Centre, known for building an internationally curated respiratory of microbial metabolomics data, is named Microbe MASST. This initiative, supported by the NIH, seeks to aid researchers in exploring the complex interaction between microbes and humans.

Cheese Revolution: Scientists Crafted Stunning New Shades of Blue Cheese.

At the University of Nottingham, experts have unlocked the secret to crafting a spectrum of blue cheese colors. Investigating the formation of the traditional blue grain veining, a dedicated team from the School of Life Sciences has successfully developed various fungal strains. These strains offer a palette of colors, allowing for cheese creation in hues ranging from white and yellow-green to red-brown-pink and an array of light and dark blues.

Exploring Cell Identities through Computer-Engineered DNA for Research Purposes

Researchers at the Max Delbruck Centre for Molecular Medicine in Germany have developed an algorithm that designs tools to distinguish between cells based on synthetic locus control regions(sLCRs) within DNA segments. These tools can aid scientists in the real-time identification of cells, providing valuable insights into their diverse functions and disease states, including inflammation, infections, and cancers. Dr. Gaetano Gargiulo, leading the Molecular Oncology Lab, emphasizes the algorithm's capability to create precise DNA markers, offering a more accessible and scalable approach to studying and manipulating cells.

Additive Manufacturing of Microbes Enables Synthesis of Plant-Based Chemicals

A group of 10 undergraduate students from the University of Rochester, known as Team RoSynth, tackled the challenge of synthesizing plant-based compounds more efficiently to counter the threats posed by climate change, invasive pests, and farming limitations. Employing low-cost 3D printing technology, the team developed a unique method involving genetically modified yeast and bacteria within hydrogels to produce beneficial chemicals. Their project earned them recognition in the 2023 International Genetically Engineered Machine competition, where they won a gold prize and were nominated for Best Hardware and Best Biomanufacturing Project. The team's innovative approach not only addressed the climate crisis but also aimed to make bioprinting technology accessible and affordable for labs worldwide. They successfully created an open-source bioprinter under $500, offering a platform for scientists to experiment with producing various synthetic plant-based compounds by modifying genes and pathways in microorganisms.

7th FEBRUARY

Scientists Unearth a Novel Memory Cell Responsible for Allergies

Researchers at McMaster University and ALK-Abello have identified a novel type-2 memory B cell (MBC2) associated with allergy memory. This breakthrough, detailed in Science Translational Medicine, opens avenues for potential immunotherapies to address allergies. B cells, responsible for antibody production, can also trigger allergies. MBC2, distinguished by unique characteristics and gene signatures, contributes to the immune system's memory of allergies, prompting increased production of antibodies upon repeated exposure. The discovery offers a promising target for developing therapeutics to treat allergies, potentially leading to new immunotherapy approaches.

8th FEBRUARY

Researchers Created Synthetic Worm Gut for Plastic Degradation

Scientists at Nanyang Technical University, Singapore, have devised an artificial worm gut to expedite plastic biodegradation. By harnessing bacteria from the *Zophobas atratus* worms' gut, known for consuming plastics, they bypass the challenges of slow feeding and complex worm maintenance. This method eliminates the need for large-scale worm breeding and focuses on enhancing the microbes in the gut, presenting a promising nature-inspired solution to address global plastic pollution.

Advanced Screening Identifies Cancer Signature in Dogs

Cancer is prevalent in dogs, especially among certain breeds, and nearly half of dogs over ten may develop it.

Researchers from various colleges, including Engineering and Veterinary Medicine, have introduced a non-invasive, swift urine test for potentially early cancer detection in dogs. Unlike existing genomic blood tests, this method offers a rapid and non-invasive alternative for identifying tumor or cancer proteins. The study's findings were published in Veterinary Science.

12th FEBRUARY

Revolutionizing Joint Repair: 3D Printing Unveils Innovative Method for Synthetic Cartilage Production

Researchers at TU Wien (Vienna) have significantly advanced in creating replacement tissue in the lab using a unique 3D printing process. The technique involves producing tiny, porous spheres from biocompatible and degradable plastic, which are then populated with cells. These spheroids can be arranged in various configurations, and the cells seamlessly merge to form a uniform living tissue. This breakthrough, demonstrated with cartilage tissue, addresses challenges in controlling the shape of resulting tissues, a common issue with stem cell clumps. The technique utilizes cage-like structures created with laser-based high-resolution 3D printing systems. Stem cells introduced into these mini-cages lead to the formation of tissue elements with even cell distribution and high cell density, a notable improvement over previous methods. The 3D-printed scaffolds, which provide mechanical stability, degrade over time, leaving behind mature tissue. This approach holds promise for medical applications, potentially aiding in creating tailor-made cartilage tissue for injuries.

3D Ice Printing Enables the Creation of Artificial Blood Vessels in Engineered Tissue

A novel technique for crafting artificial blood vessels involves 3D-printed ice structures as templates, according to researchers at Carnegie Mellon University. The method utilizes 3D ice printing with a unique continuous process, maintaining a liquid phase on top for a smoother structure. By embedding the ice templates in a gelatin-based material and subjecting it to ultraviolet light, realistic blood vessel channels are formed as the ice melts away. This approach holds potential for organ transplants and drug testing on blood vessels, offering a step forward in tissue engineering.

13th FEBRUARY

By-Product of Sandalwood Oil Shows Promise in Preventing Prostate Cancer in Mice

Sandalwood oil, derived from the core of sandalwood trees, has been historically used for various purposes. Researchers from Florida Atlantic University's Schmidt College of Medicine have demonstrated the chemo-preventive properties of alpha-santalol, a key component of sandalwood oil, against prostate cancer development in mice. The study revealed that alpha-santalol decreased the incidence of prostate tumors without causing side effects, showcasing its potential as a preventive agent. Prostate cancer is a significant health concern, and identifying agents like alpha-santalol that can selectively target cancerous cells is crucial for developing effective prevention strategies.

14th FEBRUARY

Researchers Create Hybrid Food by Cultivating Animal Cells in Rice Grains

Korean scientists introduced an innovative approach, growing animal muscle and fat cells inside rice grains to create cultured beef rice. The method, detailed in the journal Matter, results in a nutritious and flavorful hybrid food, offering a potentially affordable protein alternative with a reduced carbon footprint. The rice's porous and structured nature serves as a scaffold for cell growth, providing a unique platform for cultivating cell-cultured meat.

Innovative AI Tool Anticipates Functions of Unidentified Proteins

KAUST bioinformatics researchers Maxat Kulmanov and the team have developed an AI tool, Deep GO-SE, surpassing existing methods for predicting unknown protein functions. Using logical entailment, such as language models like Chat-GPT, the tool analyzes protein without clear dataset matches. It empowers computers to logically process outcomes based on common sense and reasoning, presenting applications for reasoning over data and hypotheses generated by machine learning models. The research is featured in Nature and Machine Intelligence. Delve into the potential role of AI in the healthcare sector in 2024 by checking our recent blog.

15th FEBRUARY

Innovative Inhalable Therapy Marks Significant Progress in Lung Cancer Research

Lung cancer, known for its low survival rates, faces a potential breakthrough as researchers from Columbia University School of Engineering and Applied Science, led by Biomedical Engineering Professor Ke Cheng, employ nanobubbles (exosomes) to deliver interleukin-12 (IL-12) messenger RNA (mRNA) directly to the lungs. In contrast to traditional methods involving injections, inhaling IL-12 mRNA in exosomes proved highly effective, concentrating the treatment in the lungs and minimizing side effects. The inhaled therapy triggered immune cells in the lungs, transforming them into powerful defenders capable of recognizing and eliminating tumor cells. This innovative approach demonstrated tumor suppression and increased resistance in mice, offering a promising strategy for lung cancer treatment. Cheng's team aims to translate these findings into clinical applications in collaboration with Columbia University Irving Medical Center oncologists.

Nanodiamonds Unveil Potential for Innovative Cooling Clothing

RMIT University researchers are leveraging nanodiamonds to develop smart textiles with enhanced cooling properties. By coating cotton with nanodiamonds through electrospinning, the fabric exhibited a 2°C–31°C reduction in temperature during the cooling process compared to untreated cotton. The nanodiamonds, known for their exceptional thermal conductivity, draw out body heat and release it from the fabric. The fabric's potential applications include sportswear and protective clothing for firefighters. Additionally, nanodiamonds increase the UV protection of cotton, making it suitable for outdoor summer clothing. The research team anticipates energy savings of 20%–30% in clothing use due to reduced reliance on air conditioning. The method involves a straightforward electrospinning approach, demonstrating strong commercial potential, though further research will assess the durability of the nanofibers, especially during washing.

16th FEBRUARY

Innovative Toolbox Enables Genome Engineering Without CRISPR

Belgian researchers at the VIB-KULeuven Center for Microbiology and VIB-UGent Center for Plant Systems Biology have introduced a novel toolbox featuring 16 short DNA sequences for controlled and specific recombination in any genome. This toolbox complements and, in certain applications, surpasses CRISPR technology. Site-specific recombinases, a key component of the toolbox, allow efficient cutting and pasting of DNA at specific genomic locations without some of the challenges associated with CRISPR, such as toxicity and low editing efficiency. The researchers expanded the toolbox to recognize, cut, and paste multiple DNA sites, offering a versatile solution for simultaneous genomic edits or marker recycling in various organisms. The toolbox demonstrated efficiency in yeast, bacterial cells, and plant cells, showcasing its potential for applications in research and industry, including optimizing gene expression in metabolic pathways and enhancing production yields of industrially relevant molecules.

Recently Uncovered Bacterial Defense Mechanism Acts as a Self-Destruct Mechanism

Wageningen researchers have identified a self-destruct mechanism in a seaweed-dwelling bacterium as part of the CRISPR-Cas bacterial immune system. This system sacrifices the infected bacterium to prevent viral replication, acting as a defense mechanism. The process involves recognizing foreign genetic material, triggering a molecular domino effect leading to the destruction of essential biomolecules, ultimately killing the bacterium. The precision of this CRISPR-Cas system holds promise for developing diagnostic tests for diseases. Collaborating with TNO and Scope Biosciences, researchers plan to create tests capable of detecting multiple targets simultaneously. The first diagnostic test is expected by 2025.

Chameleons Inspire Innovative Multicolor 3D Printing Technology

Researchers at the University of Illinois Urbana-Champaign and Beckman Institute for Advanced Science and Technology have developed a sustainable 3D-printing technique inspired by chameleons' color-changing ability. The method allows for the production of multiple dynamic colors from a single ink during the printing process. By modulating structural color through specially designed crosslinking polymers and tuning light, the team achieved color gradients from deep blue to orange in the visible wavelength spectrum. This innovative approach relies on nano-textured surfaces rather than traditional chemical pigments, offering vibrant and potentially more sustainable colors. The collaborative effort highlights the molecular-level design of the system.

18th FEBRUARY

Exploring Novel Therapeutic Avenues: Targeting 'Undruggable' Proteins Offers a Promising Strategy for Neurodegenerative Disease Treatment

Northwestern University and the University of Wisconsin-Madison researchers have introduced an innovative approach to combat neurodegenerative diseases like Alzheimer's, Parkinson's, and ALS. Their study focuses on enhancing the body's antioxidant response, which is crucial for cellular protection against oxidative stress in these diseases. By disrupting the Keap1/Nrf2 protein-protein interaction, the research introduces protein-like polymers (PLPs) as a breakthrough solution, offering high specificity, stability, and cellular penetration. PLPs inhibit Keap1 from marking Nrf2 for degradation, enhancing the cellular antioxidant response and providing a promising therapeutic strategy for neurodegenerative diseases. The collaboration between disciplines highlights the potential of interdisciplinary research in developing new therapeutic modalities, advancing the field of medicinal chemistry. The technology's modularity and efficacy underscore its potential impact in treating challenging neurodegenerative diseases, offering new hope for patients.

20th FEBRUARY

Birds Non-Coding DNA Hold Promise for Safe and Efficient Gene Therapy.

A novel gene therapy technique named PRINT utilizes a retrotransposon from a bird to insert genes into the human genome safe harbor. Unlike CRISPR-Cas, which primarily disabled genes, PRINT efficiently inserts entire genes without disrupting essential functions or risking cancer development.

Developed by UC Berkeley's Professor Kathleen Collins, PRINT involves delivering RNA that encodes a retroelement protein, facilitating the insertion of new DNA into cells. This promising method, described in the journal Nature Biotechnology, offers a potential breakthrough for gene therapy by avoiding disruptions and enhancing precision in gene insertion.

Innovative Biosensor: A Reliable Method for Swift and Accurate Meat Freshness Assessment

Researchers from the Vietnam Academy of Science and Technology, VNU University of Science, Hanoi University of Science and Technology, and the Russian Academy of Sciences have developed a biosensor using graphene electrodes modified by zinc oxide nanoparticles to measure hypoxanthine (HXA) in meat. HXA indicates meat freshness as it forms during the decomposition of adenosine triphosphate (ATP) after an animal stops breathing. This biosensor, created from polyimide film converted into porous graphene, showed over 98% accuracy in testing pork tenderloins, demonstrating its practicality for monitoring meat quality. This portable and time-efficient biosensor offers advantages over other costly and time-consuming methods, making it a valuable tool for the food industry.

21st FEBRUARY

A new technique was developed for targeted protein degradation.

Researchers at Karolinska Institute have developed a groundbreaking technique for targeted protein degradation within mitochondria, addressing a longstanding challenge in understanding cellular functions. Using a bacterial protease from mollicute, they achieved mitochondria–specific protein degradation in yeast and human cells. This method allows time-resolved analysis and disengages mitochondrial function from the cell, which is crucial for studying neurodegenerative diseases and cancer linked to mitochondrial dysfunction. The team plans to explore this technique further to identify mitochondria-specific functions of DNA-maintaining enzymes, aiding in understanding mitochondrial dysfunction.

Innovative RNA editing Tool Holds Potential for Advancing Cancer Treatment.

A recent study at Stanford University introduced a promising CRISPR RNA-editing platform called Multiplexed Effector Guide Arrays (MEGA) to enhance cell therapies for cancer.

Unlike traditional CRISPR-Cas9, MEGA modified RNA, allowing reversible change to gene expression in T cells. This approach improves chimeric antigen receptor (CAR) T cell therapy by addressing cell exhaustion issues, making the engineered cells perform significantly better in reducing tumor growth and sustaining long-term proliferation. The researchers identified 24 genes related to T cell exhaustion and successfully tuned metabolic genes to transform T cells into endurance-focused marathon runners.

22nd FEBRUARY

Unlocking Genetic Potential: Chromatin Accessibility Emerges as a Novel Frontier for Gene Editing

In a recent study published in Nature Genetics, researchers from Nano Life Science Institute (WPI-NanoLSI), Kanazawa University, investigated chromatin accessibility, the pathways that allow proteins to access genomic DNA. Using CRISPR screening and ATAC-see technologies, the team identified key genes involved in chromatin accessibility, including TFDP1, which negatively regulates it. Suppression of TFDP1 led to increased chromatin accessibility and facilitated gene editing using CRISPR/Cas9. The researchers uncovered that TFDP1 regulates genes responsible for histone protein production. This study not only revealed novel players in chromatin accessibility but also demonstrated potential biotechnological applications, enhancing gene editing processes by targeting TFDP1.

Decoding Mouse Neural Activity Reveals Location and Gaze Direction

Researchers have developed a novel approach by combining deep learning with experimental data to decode mouse neural activity, enabling accurate determination of the mouse's location and direction within an open environment based on neural firing patterns. This breakthrough, reported in Biophysical Journal, shed light on the function and behavior of individual neurons, particularly "head direction" and "grid cells" involved in navigation. The method outperformed previous approaches, offering potential insights for creating intelligent machines capable of autonomous navigation in unfamiliar environments without relying on GPS or satellite guidance. The study, conducted in collaboration with the US Army Research Laboratory, emphasizes the integration of biological information with machine learning for improved artificial intelligence systems. Explore how AI and Healthcare are interlinked.

Cell Aging Triggered by Damage to Cell Membranes: Unveiling a Novel Cellular Outcome

Researchers at the Okinawa Institute of Science and Technology (OIST), in collaboration with several Japanese universities, have made a significant discovery regarding cellular senescence, or cell aging. Contrary to the previous understanding that mechanical damage to the cell membrane results in either recovery or death, the study identified a third outcome – cellular senescence. The extent of damage and subsequent calcium ion influx determine cell fate. While minimal damage allows for easy repair and continued cell division, severe damage leads to cell death. Interestingly, moderate damage induces senescence, turning cells into senescent cells several days later. This finding challenges the belief that various stresses induce cellular senescence primarily via DNA damage response. The study suggests that cell membrane damage involving calcium ions and the tumor suppressor gene p53 can trigger cellular senescence, offering insights into potential future strategies to promote healthy longevity. Understand the cellular interactions, their organization, gene expression, pathogenicity, and therapeutic responses using spatial omics, which involves diversified analyses through genomics, proteomics, epigenomics, transcriptomics, lipidomic, and metabolomics.

23rd FEBRUARY

Scientists Create Hemostatic Solution Using Mussel and Silkworm Cocoon Materials to Halt Organ Bleeding

Researchers, led by Professor Hyung Joon Cha, have developed an innovative hemostatic agent from natural proteins found in mussels and silkworm cocoons. The bilayer nanofiber membrane hemostat utilizes mussel adhesive proteins for strong tissue adhesion and silk fibroin from silkworm cocoons. Unlike conventional agents, this solution proved effective in clotting blood and preventing infection in animal experiments. The hemostatic agent demonstrated rapid tissue adhesion and hemostasis, offering a biocompatible and biodegradable alternative for real-world medical applications. Professor Cha emphasizes further research to assess its suitability in patient care or surgical settings.

Scientists Develop Three-Dimensional Representation of Ribosome, Unveiling the Process of Its Formation

Researchers, led by Associate Professor Eva Kummer from Novo Nordisk Foundation Center for Protein Research, have used electron microscopy to create a 3D model of ribosomes, the cellular machines producing proteins. The study highlights key insights into ribosome assembly, focusing on the crucial initial stage involving the protein GTPBP10. Understanding this process is essential, as errors in ribosome assembly can lead to reduced protein production, contributing to diseases like neurodegenerative disorders and heart conditions. This research offers valuable insights that may aid in addressing and preventing such health challenges.

Groundbreaking Marine Plastic Pollution Study Unveils Bacterial Enzymes Actively Degrading Plastic, Paving the Way for Effective Removal Strategies

A recent University of Stirling-led study delves into the vital roles bacteria play in plastic debris, highlighting rare and understudied bacteria that could aid in plastic biodegradation. The research, titled "Novel functional insights into the microbiome inhabiting marine plastic debris," explores proteins in plastic samples from Gullane Beach in Scotland, revealing active enzymes degrading plastic. The study, led by Dr. Sabine Matallana-Surget, has pioneered methodologies for marine microbiology research, addressing critical gaps in understanding microorganisms in marine plastic pollution. The findings emphasize the urgent need for further research on microorganism functions in different geographic areas to enhance plastic degradation strategies and promote environmental sustainability in plastic production.

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