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From Diagnosis to Prediction: The Role of AI in Cancer detection

By Shruti Shah, Grade 10, Dhirubhai Ambani Int School, Mumbai

AI algorithms can detect patterns in large amounts of data and identify different correlations between pieces of data, which cannot be perceived by the human brain. In recent years, advances in training AI models and access to large volumes of cancer data such as imaging, genomics and clinical data have emerged leading to promising new applications of AI in cancer research.

These new applications include understanding and predicting bodily functions and biochemical pathways in clinical data to improve patient outcomes. By examining medical images such as X-Rays, MRIs and biopsy samples AI systems are now able to identify subtle patterns and abnormalities that may not be easily detected by human practitioners and clinicians. This
accelerates the speed and enhances the accuracy of early cancer detection.

Additionally, AI can combine imaging data with genetic information and the patient's medical history to assess the individual's risk of developing cancer in the future. This new use of technology will also help cancer drug discovery and development. As a result, it has the potential to shift healthcare to another level, it's a proactive model centred on prediction and prevention. While the theoretical potential of AI is vast, several applications are already demonstrating success in clinical and research settings. For example, Computer- Aided Detection in Mammography, where AI algorithms assist radiologists by flagging suspicious areas on mammograms, double checking them and ultimately reducing false negatives in breast cancer screenings. Furthermore, AI systems also accelerate the analysis of massive next generation sequencing datasets, identifying specific genetic mutations that could drive tumor growth muchaster than other methods.

Moreover, AI has also aided digital pathology and grading. By analysing digital slides of tissue biopsies, deep learning models can classify cell morphology and even grade tumors with high reproducibility. This helps reduce inter-observer variability among pathologists.However, despite these advancements, integrating AI into routine oncology still presents significant challenges that must be addressed before widespread adoption can occur.

Primarily, many of these advanced deep learning models operate with high complexity, making it difficult for clinicians to trace the exact rationale behind a specific prediction or diagnosis. This lack of interpretability hinders clinical trust. Additionally, AI models are highly dependent on the datasets used to train them. If the training data lacks demographic, geographic or socioeconomic diversity, the resulting algorithm may exhibit reduced accuracy when applied to broader real-world patient populations.

Lastly, training these robust models requires aggregating massive amounts of patient health information. Hence, ensuring data security and navigating frameworks remains to be a complex hurdle for many researchers.

In conclusion, the future of oncology does not involve AI replacing medical professionals, rather it relies on collaborative intelligence. While AI excels at rapid data processing, image analysis and identifying correlations across datasets, only human clinicians supply contextual judgement, ethical oversight and, most importantly, emotional patient care. Together, this advancement in AI promises to make cancer care more precise.

Octopus-Inspired Soft Robot for Underwater Lithium Mining Using Electrodialysis

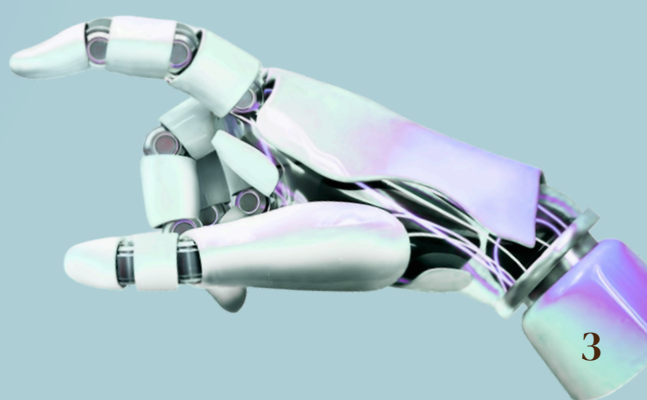
By Ritisha Bansal, Undergrad student, University of Illinois Urbana-Champaign

The global shift towards electric transportation and renewable energy storage has increased the demand for lithium. By 2030, annual consumption is expected to hit 2.5 million metric tonnes. Current land reserves are unevenly distributed and environmentally harmful. This situation has sparked interest in the ocean's potential lithium reservoir, estimated at 230 trillion tonnes. This paper presents the Jelly-Litho-Bot, an autonomous soft robotic platform designed for underwater lithium extraction, featuring three main innovations: selective electrodialysis, jellyfish-inspired jet propulsion, and a distributed control system. T

he extraction subsystem uses an electrically driven membrane pumping technique that focuses on a dense glass type (LLTO) membrane. This solid electrolyte selectively transports Li^+ ions while blocking larger competing cations like Na^+, K^+, Mg^{2+}, and Ca^{2+} through crystallographic size exclusion. The system achieves up to 43,000 times lithium enrichment, which allows for the precipitation of battery-grade Li_3PO_4 at 99.94% purity. This membrane process is highly efficient, offering up to 90% energy savings compared to traditional separation methods such as thermal evaporation. For movement, the Jelly-Litho-Bot mimics the energy-efficient jet propulsion of jellyfish. Its structure includes a rhombic triacontahedron origami flexiball, which hydrodynamic simulations show offers the best lift-to-drag performance.

Large eddy simulation modeling found that a 15 mm nozzle diameter provides maximum thrust for swimming. Actuation comes from transparent dielectric elastomer actuators (DEAs) that use AgNW/PEDOT hybrid electrodes. These actuators operate silently and help keep the robot transparent, a biological method for passive camouflage. The control system is inspired by the decentralized nervous system of octopuses. Here, computation happens in the limbs rather than a central processor. The Jelly-Litho-Bot employs a soft mechanism made of bistable waterbomb origami units created from shape memory alloys. These units act as mechanical memory, responding to environmental changes like pressure or flow disturbances. This decentralized design lessens the need for complicated onboard electronics and makes the system more reliable in challenging deep-sea conditions.

The Jelly-Litho-Bot shows a promising route for environmentally friendly marine resource recovery. Future research will focus on long-duration trials to test hydrodynamic models, improve the integration of multi-stage extraction cells, and perform techno-economic modeling to evaluate its commercial viability against land-based mining.



The Impact of CRISPR Gene Editing on Modern Biology

By Aaditri Thakur, Grade 7 , Nita Mukesh Ambani Junior School

One of the most significant recent discoveries in the sphere of modern biology was the creation of CRISPR-Cas9 technology. This innovative technology allows conducting DNA editing and making necessary changes in genetic information. Since DNA contains the code of instructions for growth, development, and functioning of an organism, this technological innovation has become a great step forward in medicine, agriculture, and scientific research, which focus on studying biological processes. The emphasis in genetics has now moved from curing the symptoms of the diseases to correcting their actual causes.

CRISPR-Cas9 is the technique, inspired by natural defense mechanisms found in some bacteria. To defend themselves, the bacteria detect and destroy viruses with the help of CRISPR-Cas9. The process of genome editing allows for detecting and changing the specified DNA sequences. Scientists can use guide RNA to direct Cas9 enzymes at certain DNA sequences and delete or change them.

Technology is especially important in the field of genetic medicine. Most of the inherited diseases result from mutations. Thus, researchers can examine mutations and develop methods to correct them. For instance, the technique is used for creating treatment options for sickle cell disease, which is an inherited genetic condition, resulting from a mutation of the hemoglobin gene in red blood cells. Therefore, to cure the disease, scientists can edit the genes of the affected cells.

A major emerging trend is personalized medicine, where treatments are designed based on an individual's unique genetic information. Instead of using the same treatment for every patient, doctors may be able to create more specific therapies based on a person's DNA. This could improve treatment effectiveness and reduce unwanted side effects.

However, there are several ethical questions associated with CRISPR technology. Manipulation with genes, which could be transmitted to the next generation, requires discussing the issue of safety, equity, and the limits of genetic engineering.

Thus, scientists should be aware of possible risks like unwanted side effects and inequities related to accessibility of advanced treatments. CRISPR gene editing represents a major turning point in biology because it has changed how scientists understand and approach genetic conditions.

By allowing precise changes to DNA, this technology has the potential to improve healthcare and provide solutions for previously difficult-to-treat disorders. However, responsible use, ethical consideration, and continued research are essential to ensure that this powerful discovery benefits society safely and fairly.

GLP-1 Weight-Loss Drugs and Their Impact on Human Metabolism: A New Era in Obesity Treatment

By Alejandro Shroff Jimenez, Grade 7, Nita Mukesh Ambani Junior School

Abstract

Obesity is a major global health challenge associated with an increased risk of cardiovascular disease, type 2 diabetes, and metabolic disorders. Recent advances in pharmaceutical biology have led to the development of glucagon-like peptide-1 (GLP-1) receptor agonists, including semaglutide and tirzepatide, which have demonstrated unprecedented effectiveness in weight management. These drugs represent one of the most significant biomedical developments of the decade and have attracted widespread attention from researchers, healthcare professionals, and policymakers. This article examines the biological mechanisms underlying GLP-1 therapies, their recent clinical success, and their potential implications for the future of metabolic medicine.

Introduction

The prevalence of obesity has increased dramatically over the past several decades, creating a substantial public health burden worldwide. Traditional approaches to weight management, including dietary modifications and exercise interventions, often produce limited long-term success due to the complex biological mechanisms regulating appetite and energy balance. Recent breakthroughs in endocrinology and molecular biology have transformed obesity treatment through the development of GLP-1 receptor agonists. These medications, initially designed for the treatment of type 2 diabetes, have demonstrated remarkable effectiveness in reducing body weight, sparking significant interest within the scientific community.

Biological Role of GLP-1

GLP-1 is a hormone naturally produced by intestinal cells following food consumption. It plays a critical role in glucose regulation and appetite control by acting on multiple organs, including the pancreas, stomach, and brain. The hormone stimulates insulin secretion, suppresses glucagon production, slows gastric emptying, and promotes feelings of satiety. These physiological effects collectively contribute to improved blood glucose control and reduced food intake. Researchers have leveraged this biological pathway to develop synthetic GLP-1 receptor agonists that mimic the hormone's effects while remaining active in the body for extended periods.

Recent Scientific Advances

The approval and widespread adoption of drugs such as semaglutide and tirzepatide represent a major milestone in metabolic medicine. Clinical trials have reported substantial reductions in body weight, with some patients achieving weight loss exceeding 15–20% of their initial body mass. Recent studies suggest that these medications influence neural pathways involved in hunger regulation, highlighting the intricate relationship between the digestive system and the central nervous system. This emerging understanding has contributed to a shift in how obesity is viewed—from a condition driven solely by lifestyle factors to one influenced by complex biological mechanisms.

Implications for Human Health

Beyond weight reduction, GLP-1 therapies have

demonstrated additional health benefits. Researchers have observed improvements in blood pressure, cholesterol levels, and insulin sensitivity. Emerging evidence also suggests potential protective effects against cardiovascular disease. These findings indicate that GLP-1 receptor agonists may play a broader role in preventing chronic diseases associated with metabolic dysfunction. Consequently, they have become one of the most discussed topics in contemporary biomedical research.

Challenges and Future Research

Despite their success, several challenges remain. Long-term safety data are still being collected, and researchers continue to investigate potential side effects and mechanisms of action. Furthermore, the high cost of treatment raises concerns regarding accessibility and healthcare equity. Future studies aim to develop next-generation metabolic therapies that provide similar benefits with improved affordability and fewer adverse effects.

Advances in molecular biology and pharmaceutical chemistry will likely drive continued innovation in this field.

Conclusion

The emergence of GLP-1 receptor agonists represents one of the most important biological and medical breakthroughs of recent years. By targeting fundamental mechanisms of appetite regulation and metabolism, these drugs have transformed obesity treatment and reshaped scientific understanding of metabolic disease. As research continues, GLP-1-based therapies may serve as a foundation for future innovations in precision medicine and public health.

Induced Pluripotent Stem Cell Research Hits Its 20-Year Anniversary

By Samika Jain, Undergrad student, Johns Hopkins University

2026 marks twenty years since the discovery of induced pluripotent stem cells (iPSCs), a breakthrough that changed the direction of stem cell research and regenerative medicine. Developed by Shinya Yamanaka and team, iPSC technology introduced the possibility that ordinary adult cells could be reprogrammed into cells with properties similar to embryonic stem cells. Over the past two decades, this discovery has influenced research in developmental biology, disease modelling, and medical treatment, while also reducing the ethical concerns linked to embryonic stem cell use.

In a recent reflection on the anniversary, Yamanaka looked back on the original discovery and discussed where the field may be heading in the future. He described how his team identified four transcription factors-Oct4, Sox2, Klf4, and c-Myc, now commonly known as the Yamanaka factors-which made it possible to reprogram differentiated somatic cells into pluripotent stem cells. In simple terms, these factors allowed specialised cells to return to a more flexible state where they could potentially develop into many different cell types.

At the time, this challenged one of the major assumptions in biology: that once a cell became specialised, its identity was fixed. The ability to reverse this process showed that cell fate was more adaptable than previously believed. This changed not only stem cell research but also broader ideas about development and cellular identity. One of the most significant effects of iPSC technology has been its ability to address ethical issues surrounding stem cell research. Before iPSCs, pluripotent stem cells were commonly obtained from embryos, which created ethical concerns and practical limitations. Since iPSCs can be generated from adult cells instead, researchers gained access to pluripotent cells without relying on embryonic material. This made stem cell research more widely accepted and opened opportunities for further scientific development.

Beyond ethics, iPSCs have become an important research tool. Scientists now use them to study early human development and understand how cells differentiate into specialised tissues. Because iPSCs can also be created from individual patients, they have become valuable for modelling diseases and testing treatments in a more personalised way. Rather than depending entirely on animal studies, researchers can observe disease processes using human-derived cells. The clinical potential of iPSCs has also become increasingly visible. Yamanaka highlighted regenerative therapies developed from iPSC research, particularly the use of iPSC-derived corneal epithelial cells to help treat blindness. This demonstrates how stem cell research has moved beyond laboratory experiments into medical applications. Although challenges such as long-term safety, efficiency, and cost remain, these developments suggest regenerative therapies may become more common.

Looking ahead, Yamanaka predicts that stem cell biology will increasingly combine with computational biology, synthetic biology, and translational medicine. Rather than existing as separate disciplines, they may improve cell engineering and treatments, allowing iPSC-based technologies to move from specialised laboratories into broader clinical use. Twenty years after their discovery, induced pluripotent stem cells continue to show how one scientific breakthrough can reshape an entire field.

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Note from the Editor:

Dear Readers,

Welcome to the inaugural issue of the StemSphere Journal! This is a platform created to celebrate curiosity, creativity, and scientific thinking. We believe every student has a unique perspective to share, and this journal is an opportunity for young minds to express their ideas, research, and discoveries with a wider audience.

Whether you're an aspiring researcher, a passionate innovator, or simply someone eager to explore new ideas, I encourage you to contribute your work. Every article published here reflects the enthusiasm and dedication of our student community, and we look forward to showcasing many more inspiring voices.

Happy reading, and I hope to see your article in a future edition!

Warm Regards,
Somya Jain
Editor of The Stemsphere Journal