هيئة تنمية البحث والتطوير والابتكار
Research Development and Innovation Authority

رؤية VISION 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

Emerging Innovative Technologies in Health & Wellness

The Research, Development and Innovation Authority
(RDIA)

October 2024

Emerging Innovative Technologies in Health & Wellness

2024

The Research, Development & Innovation Authority (RDIA)

Table of Contents

01 INTRODUCTION

Technology foresight is a strategic process that involves the systematic anticipation of future technological developments and their potential impact on society, the economy, and the environment. By analyzing current trends, emerging innovations, and potential future scenarios, foresight empowers organizations, governments, and industries to make informed decisions today, driving sustainable, resilient, and economically competitive growth that adapts to future challenges and opportunities. It goes beyond mere prediction, involving a collaborative exploration of the future through a combination of expert insights, stakeholder engagement, and scenario planning.

In an era marked by rapid technological advancements, technology foresight has become crucial for navigating the complexities and uncertainties of the modern world. It allows decision-makers to identify emerging opportunities, mitigate risks, and align technological innovation with broader societal goals, such as sustainability, equity, and economic resilience.

For businesses, technology foresight can serve as a competitive advantage by helping to anticipate disruptions and stay ahead of market shifts. For governments, it is a tool for policy-making, ensuring that regulation keeps pace with innovation while safeguarding public interests. Overall, technology foresight is about preparing for the future by understanding the driving forces of change and strategically positioning organizations to thrive in an uncertain world.

Based on the Saudi's four national priorities for the research, development and innovation sector, which are: Health and Wellness; Sustainable Environment and Supply of Essential Needs; Energy and Industrial Leadership; and Economies of the Future; Research, Development and Innovation Authority (RDIA) presents this report, which is dedicated to the latest technological advancements and recent innovations in the field of human health for the year 2024.

Emerging technologies in health and wellness are transforming how individuals and healthcare systems approach prevention, diagnosis, treatment, and overall well-being. This convergence of technology and healthcare is driven by advancements in areas such as digital health, biotechnology, wearable devices, artificial intelligence (AI), and personalized medicine. These innovations are not only enhancing medical practices but are also empowering individuals to take a more active role in managing their health.

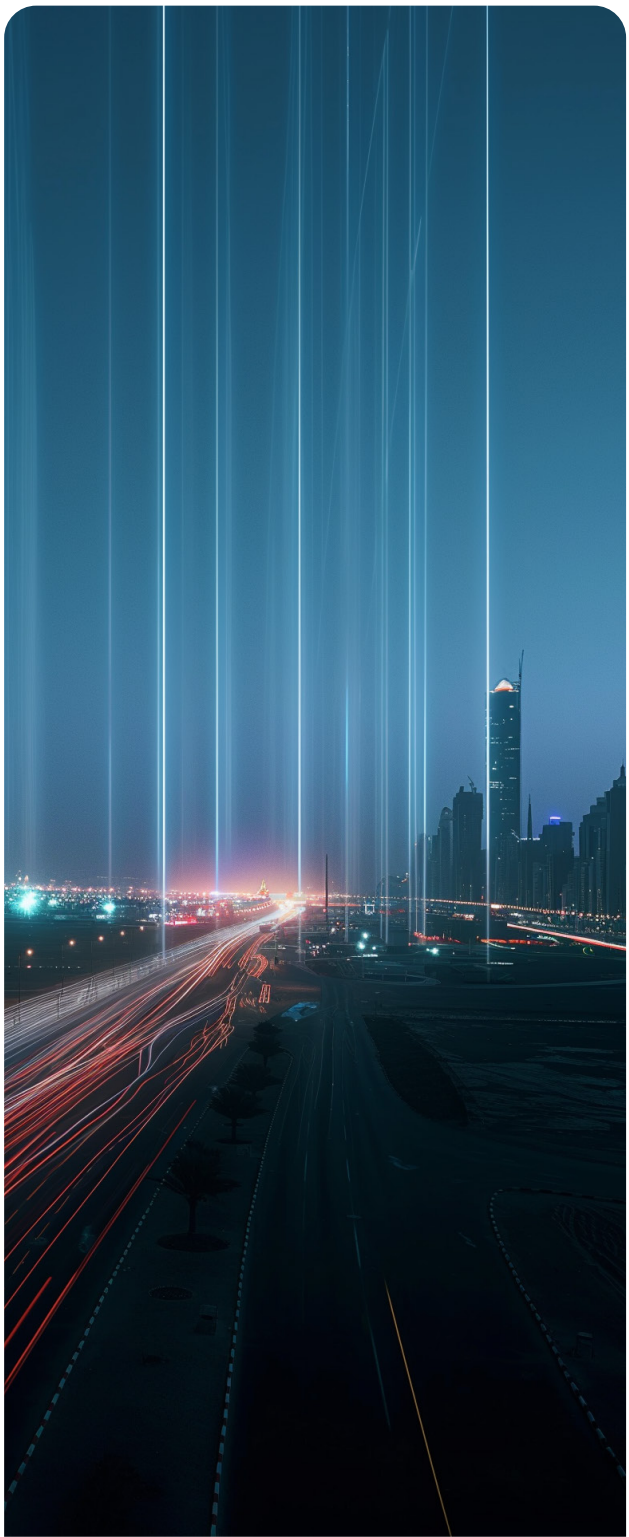
One of the most significant breakthroughs in this field is AI's application to health. Machine learning algorithms are being used to analyze vast amounts of medical data to provide more accurate diagnostics, predictive analytics, and personalized treatment plans. AI-driven tools enable early detection of diseases like cancer and cardiovascular conditions, improving patient outcomes while reducing healthcare costs. Additionally, biotechnology innovations, such as CRISPR gene editing and regenerative medicine, are opening new possibilities for curing previously untreatable diseases and extending human longevity.

Emerging technologies in health and wellness are reshaping the healthcare landscape, driving more personalized, efficient, and proactive healthcare systems. These innovations not only enhance the quality of care but also hold the potential to reduce healthcare disparities by making advanced healthcare services more accessible to diverse populations.

02

METHODOLOGY

The technical foresight methodology at the National Research, Development and Innovation Observatory (NRDIO) consists of four main axes: monitoring, analysis, evaluation, and alignment. These are explained below.



1. Monitoring

When forecasting emerging technologies, the National Research, Development and Innovation Observatory (NRDIO) incorporates proactive and reactive monitoring to enhance the accuracy and responsiveness of analysis. Below are both approaches explained:

1.Proactive Monitoring

Proactive monitoring involves anticipating trends, innovations, and breakthroughs before they gain mainstream attention. This helps in identifying emerging technologies early on, allowing for strategic preparation and planning.

- Horizon scanning: NRDIO regularly reviews scientific literature, patent filings, venture capital funding reports, technology roadmaps, and expert opinions. Tools like artificial intelligence and text mining are utilized to identify trends from large datasets.
- Delphi method: A panel of experts was established to gain foresight into potential technological advances. This iterative consultation helps forecast new developments.
- Trend analysis: NRDIO examines historical data on similar technologies to predict growth curves and tipping points. This includes analyzing adjacent technologies and potential convergences.
- Technology readiness level (TRL) tracking: The development stage of technologies is continuously evaluated based on their TRL, helping to understand when they might mature into scalable solutions.

2. Reactive Monitoring

Reactive monitoring focuses on responding to real- world developments as they happen. It involves tracking the real-time progress of technologies that have already been identified as emerging, and adjusting forecasts based on new data. It is performed by the following methods:

- Continuous real-time data collection: Systems are implemented to track real-time developments such as new product launches, regulatory changes, mergers and acquisitions, and shifts in the competitive landscape.
- Signal detection: Key indicators are monitored (e.g., breakthroughs, government policy shifts, industry adoption rates) that suggest when a technology is gaining momentum or encountering barriers.

- Social media and news analysis: Sentiment analysis and media monitoring tools are used to capture public and industry reactions to technological developments.
- Post-launch evaluation: Once an emerging technology reaches the market, its performance is evaluated through user feedback, financial performance metrics, and industry reviews.

Utilizing the above methods, the next steps follow:

- Strategic adjustment and reflection: Based on the real-time insights gathered through reactive monitoring, NRDIO continuously adjusts its strategic forecasts, and priorities to ensures that NRDIO remains adaptable, making course corrections where necessary to capitalize on opportunities or mitigate risks.
- Interdisciplinary stakeholder engagement: Engaging Interdisciplinary experts from the industry and academia to gain a holistic view and qualitative feedback that complements quantitative data.

2. Analysis

The analysis activity in the technical foresight methodology followed at NRDIO consists of the following elements:

- Technical analysis: This includes providing an overview of the field under which the tech signal falls to place it in a broader context. The technical analysis also includes providing an overview of the tech signal in terms of describing it, explaining its principles and advantages, and its points of superiority over competing and alternative technologies.
- Economic analysis: This includes estimating the size of the global market, the size of the local market, the factors driving the technology market, the most prominent companies involved, their market values, and analyzing the effects of emerging technology on other technologies; as new markets full of economic opportunities may be created, but they may negatively affect other markets to the point of excluding them from competition, which is usually caused by disruptive technologies.
- Risk analysis: The risks and challenges associated with emerging technologies are analyzed, whether ethical, legal, environmental, social, or otherwise. This also includes suggesting how to address potential obstacles, which leads to improving the chances of success of the emerging technology and achieving its desired goals.

3. Evaluation

Technological signals are evaluated quantitatively and qualitatively by a scientific committee of experts specialized in various fields, through several main criteria that aim to measure the extent of their impact and feasibility from different aspects, as follows:

1. Strategic Impact: This criterion shows the role of technology in solving global challenges, and evaluates the importance of technology in dealing with the major challenges facing the world, such as climate change, food security, renewable energy, public health, and others.
2. Long-term impact: This criterion measures the sustainability of the impact of technology in the long term in different sectors, and determines the extent of the technology's ability to bring about permanent change or a long-term impact on individuals, companies, or industries.
3. Need within the sector: This criterion determines the extent to which a technology is considered in demand within the technology sector itself or within related industries. The need for technology is determined based on current gaps in the sector, whether in manufacturing, services, or other technical systems.
4. Consumers' attitude towards technology: This criterion measures the extent to which consumers or end users are interested in the new technology, whether at the individual or corporate level.
5. Economic impact and commercial benefit: This criterion assesses the expected economic benefit of the technology, including commercial profits and market growth, the potential market size, and the value of commercial returns.
6. Technology Readiness Level (TRL): This criterion determines the extent to which the technology has progressed in its development cycle, from research and development to commercialization. The closer the technology is to commercial readiness, the more important it is in terms of investment and adoption.

In order to achieve a broader, more diverse, and more accurate perspective on emerging technologies and their various impacts. A score of (05-) is given to each of the six aspects aforementioned; 5 refers to the highest importance, while 0 refers to the lowest importance. The "Evaluation" activity also involves stakeholders (such as academics, companies, regulators, and other parties related to research, development, and innovation) engagement through a questionnaire dedicated to technology foresight.

4. Alignment

The results of technology foresight are aligned to strategic plans and implementation steps that can be taken at the policy or investment level, where the results of monitoring, analysis and evaluation are translated into practical recommendations that can be implemented at the policy and regulatory level or the strategic plans of institutions. The aim is to ensure that technology foresight does not remain within the scope of theory or research only, but is transformed into concrete steps to stimulate innovation and support the knowledge-based economy.

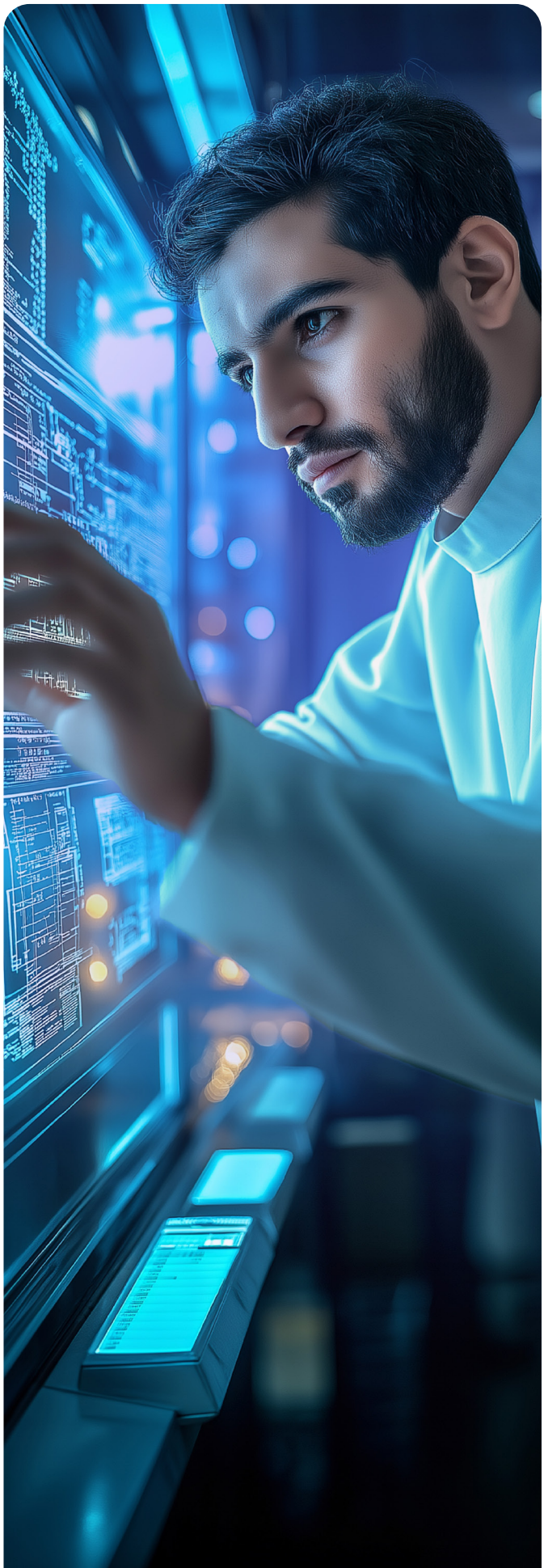
The technology signals highlighted in this report are aligned with the following National RDI Missions in Health and Wellness:

1. "Increase healthy life expectancy by 5 years by 2040".
2. "Reduce prevalence of non-communicable diseases by 50% through prevention, better management, and treatment by 2035".
3. "Reduce incidence of infectious diseases significant to KSA by 50% by 2035".
4. "Genetic therapies for at least 2 out of KSA's top 10 rare diseases are in development by 2035".
5. "40% of population has had an intervention with a digital therapeutic developed by Saudi-based scientists by 2035".

In the next pages, this report will show selected emerging innovative technologies in health and wellness, as follows:

1. Protein Synthesis and Modeling
2. AI-Driven Drug Discovery
3. Continuous Glucose Monitoring
4. Early Cancer Detection
5. CRISPR Gene Editing
6. Robotic Surgery
7. Circular RNA
8. Precision Psychiatry
9. Personalized Medicine

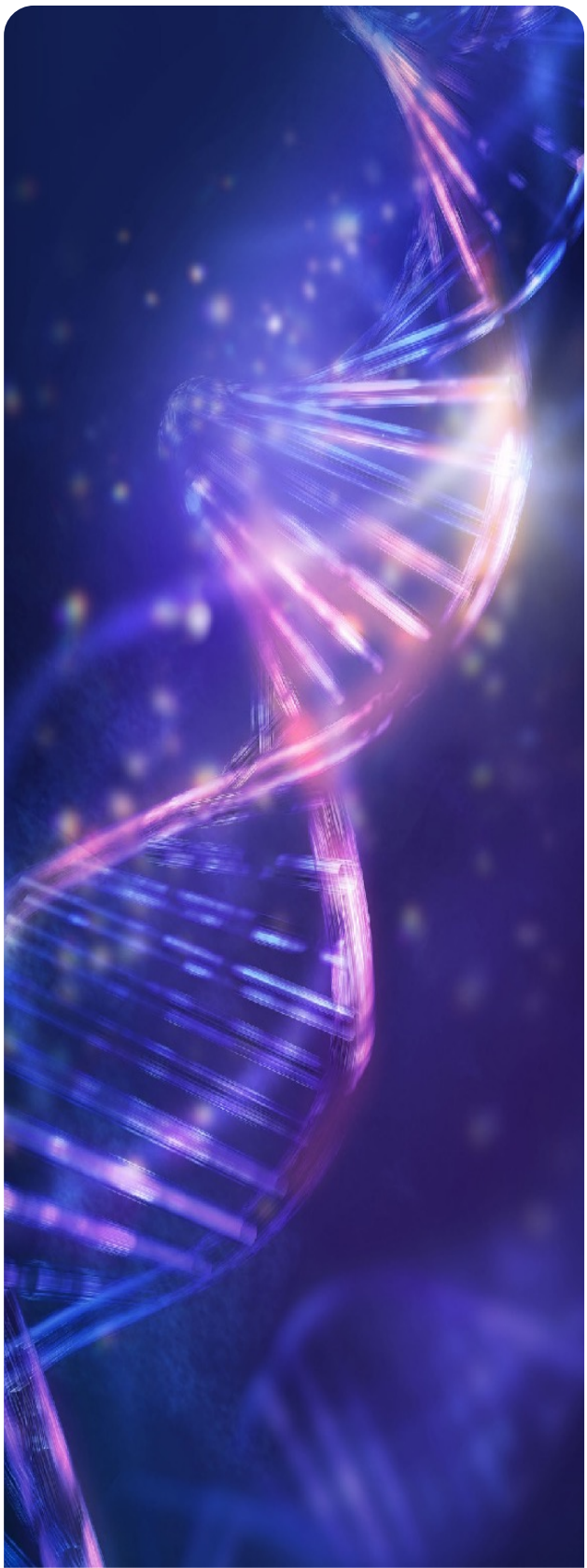
This report provides a brief overview of each of these fields, followed by a review of some of the tech signals/ advancements that fall under them, with an economic overview of the current and future global market size estimate for these technologies, and an assessment of their importance through several quantitative and qualitative criteria, according to the perspective of the experts of the Scientific Committee of the National Research, Development and Innovation Observatory (NRDIO).



Emerging Innovative Technologies in Health and Wellness

01 Protein Synthesis and Modeling
02 AI-Driven Drug Discovery
03 Continuous Glucose Monitoring
04 Early Cancer Detection
05 CRISPR Gene Editing
06 Robotic Surgery
07 Circular RNA
08 Precision Psychiatry
09 Personalized Medicine

01
Protein Synthesis and Modeling



One of the important advancements in 2024 in protein synthesis and modeling using machine learning algorithms is the continued refinement and application of AI-based protein structure prediction tools, particularly AlphaFold and its successors. In 2024, new machine learning algorithms have significantly advanced the accuracy and scalability of protein modeling, enabling researchers to predict not only the static structure of proteins but also their dynamic interactions and folding pathways under various biological conditions.

An important breakthrough has been the integration of machine learning models with molecular dynamics simulations, which allows for more accurate predictions of protein behavior over time. This has opened up new avenues for de novo protein design, enabling scientists to create novel proteins with specific functions, such as catalysts for industrial processes or therapeutic agents in drug development.

In parallel, AI-driven protein synthesis has seen advancements in optimizing codon usage and expression levels, improving the efficiency of producing synthetic proteins in different organisms. This technology is particularly impactful in accelerating drug discovery, bio-manufacturing, and synthetic biology by significantly shortening the time required to design and produce functional proteins.

These advancements are revolutionizing the fields of biotechnology, pharmaceuticals, and materials science by making the design and synthesis of novel proteins faster, more efficient, and highly customizable.

In this context, the 2024 Nobel Prize in Chemistry focuses on proteins, which are essential chemical tools for life. David Baker achieved the remarkable task of designing entirely new proteins, while Demis Hassabis and John Jumper developed an AI model to solve the long-standing challenge of predicting protein structures. These groundbreaking discoveries have vast potential for advancing science and technology.

In 2020, Demis Hassabis and John Jumper introduced AlphaFold2, an AI model capable of predicting the structures of nearly all 200 million known proteins. This breakthrough has been widely adopted, with over two million users across 190 countries. The tool has revolutionized scientific research, enabling deeper insights into issues like antibiotic resistance and helping scientists visualize enzymes that can break down plastic, among many other applications.

For more information, click here

Tech Signal

Predicting Protein Dynamics Using Machine Learning

Researchers at Brown University have developed an advanced artificial intelligence (AI)-driven technique to predict how proteins change over time, marking a significant leap in the field of drug discovery. Traditional methods, like AlphaFold2, focus on predicting static structures of proteins, which has been useful but limited, as proteins are not static entities. The new approach from Brown introduces a way to visualize and model proteins dynamically, capturing their changes in shape and structure over time, which has profound implications for understanding their function in biological processes and potential drug interactions.

Proteins are complex molecules that adopt various shapes as they perform different functions within cells. These shape changes can influence how proteins interact with other molecules, such as drugs. Existing computational models, while revolutionary, often fail to account for the dynamic nature of proteins. Brown's innovative method incorporates the "fourth dimension" by predicting not just what a protein looks like at one moment, but how it moves and shifts in real time. This allows researchers to identify new, previously hidden targets for drug development, offering insights into why certain treatments work or fail based on the protein's dynamic behavior.

Moreover, this technique promises to drastically cut the time and cost of drug discovery. What previously took years to compute can now be done within hours, providing a faster pathway to explore treatments for diseases like cancer, where protein shape-shifting plays a key role in drug resistance. By offering a more comprehensive understanding of protein dynamics, this breakthrough could accelerate the development of precision medicine and tailored therapies for complex diseases.

For more information, click here

The paper published in Nature Communications explores an enhanced method for using AlphaFold2 to predict not only static protein structures but also the relative populations of different conformations. The study introduces a subsampling approach using multiple sequence alignments, which predicts the conformational landscapes with over 80% accuracy. Tested on Abl1 kinase and granulocyte- macrophage colony-stimulating factor, the method proved effective, especially in predicting the effects of mutations. It offers a fast, cost-efficient tool for applications in pharmacology, experimental analysis, and evolutionary studies, providing deeper insights into protein behavior.

For more information, click here

Market Size

The global protein expression market size was valued at USD 3.35 billion in 2023 and is projected to grow at a CAGR of 10.22% from 2024 to 2030, to reach around USD 6.63 billion in 2030.

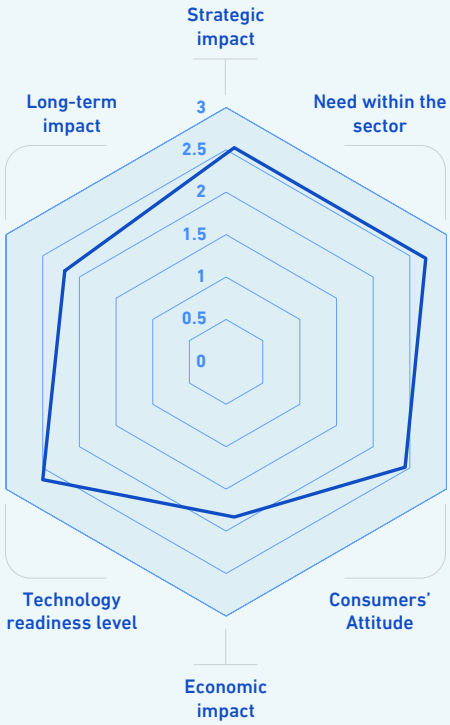
For more information, click here

Alignment with the National RDI Missions

This technology signal can be aligned with the National RDI Mission:

"40% of population has had an intervention with a digital therapeutic developed by Saudi-based scientists by 2035".

Multi-Dimensional Evaluation



02
AI-Driven Drug Discovery

Artificial Intelligence (AI) is rapidly transforming the field of drug discovery, offering a powerful new approach to revolutionize the way pharmaceuticals are developed. Traditional drug discovery processes are often time-consuming, expensive, and prone to high failure rates due to the complexity of biological systems and the challenges in predicting how new compounds will interact with the body. AI-driven drug discovery seeks to overcome these challenges by leveraging advanced machine learning algorithms, data analytics, and computational models to accelerate and optimize every stage of drug development.

Through AI, researchers can analyze vast datasets, such as genetic information, chemical libraries, and patient data, to identify patterns and predict which molecules are most likely to succeed as drug candidates. AI can also simulate drug-target interactions, reducing the need for extensive lab testing and speeding up the lead identification and optimization process. This technology enables the identification of novel drug compounds, the prediction of potential side effects, and the repurposing of existing drugs for new therapeutic uses.

The COVID-19 pandemic accelerated the adoption of AI technologies to speed up drug discovery processes. One striking example is an international research team that used crowdsourcing to identify a potential antiviral drug candidate within just 48 hours, a task that would typically require several months to complete.

In-silico trials involve the use of computer simulations instead of human participants to evaluate new drugs and therapies. These digital trials, driven by artificial intelligence, generate "digital twins" that replicate human biology and disease. By conducting thousands of virtual trials, researchers can rapidly and cost- effectively predict a drug's performance in human patients. This approach has the potential to significantly speed up and enhance the drug development process.

The primary appeal of AI in drug development is its ability to utilize deep learning for rapid data analysis and pattern recognition. While AI hasn't yet fully replaced laboratory science, it plays a crucial role in accelerating predictions, designs, and validation processes, ultimately shortening the time required for drug development.

AI-driven drug discovery is opening up new possibilities for personalized medicine, offering the potential for more targeted, efficient, and cost- effective treatments. This approach promises to not only reduce the time to market for new drugs but also improve the success rate of drug development, benefiting patients and the pharmaceutical industry alike.

These instances represent just a fraction of the widespread efforts to leverage AI in drug discovery across both academia and industry. Leading pharmaceutical companies like Johnson & Johnson, Novartis, and AstraZeneca have formed partnerships with AI startups to further these initiatives.

Tech Signal

In-Silico Trials to Evaluate New Drugs and Therapies

A research team at Ludwig-Maximilians-Universität München developed an AI model capable of predicting specific sites on molecules that can be chemically modified, which reduces the number of necessary experiments and supports more efficient and sustainable synthesis processes. At the University of Cambridge, another team created a platform that automates laboratory experiments and uses AI to predict chemical reactions, replacing the traditional trial-and-error approach that has been slow and resource-intensive.

By integrating extensive biological and medical knowledge with computational disease models, jinkō platform aimed to enhance the efficiency of clinical trials. Given that patients are a limited and valuable resource, traditional trials test only one hypothesis at a time. The jinkō platform allows for the testing, comparison, and optimization of trial protocols using thousands of digital patients before involving real human subjects. This approach informs and reduces risk in decision-making at every stage, ultimately enabling drug developers to bring innovative medicines to market more rapidly, cost-effectively, and efficiently

For more information, click here

Also, Novadiscovery utilized AI to accurately predict the outcomes of a Phase III clinical trial, highlighting the potential of this method. In-silico trials could eventually replace up to half of traditional human testing. Regulatory bodies are exploring ways to incorporate these virtual results into the drug approval process. Establishing new frameworks to validate in- silico trials will be crucial to ensure their reliability. By integrating AI and simulations into clinical trials, we can deliver innovative treatments to patients more quickly and affordably.

For more information, click here

The French company, Nova, has demonstrated the predictive capabilities of in-silico clinical trials in oncology through their jinkō platform, a cutting-edge simulation technology. In a significant collaboration with thoracic oncologist Prof. Michaël Duruisseaux and Janssen-Cilag France, Novadiscovery accurately predicted the outcomes of the Phase III MARIPOSA clinical trial for non-small cell lung cancer (NSCLC). The simulation, which involved over 5,900 digital patients,

predicted key metrics like the hazard ratio (HR) and median time to progression (TTP), aligning closely with the actual trial results presented at the 2023 European Society for Medical Oncology (ESMO) conference.

The study focused on comparing the combination treatment of Amivantamab + Lazertinib against Osimertinib, revealing a significant reduction in the risk of disease progression or death. Novadiscovery's in-silico predictions showed a hazard ratio (HR) of 0.60 with a median TTP of 26.3 months for the combination treatment, closely mirroring the clinical trial outcomes. This success underscores the potential of in-silico trials to enhance drug development by allowing researchers to run simulations that forecast clinical outcomes with high accuracy.

For more information, click here

Market Size

The global in silico clinical trials market size was valued at USD 2.7 billion in 2021 and is anticipated to expand at a compound annual growth rate (CAGR) of 7.4% during the forecast period.

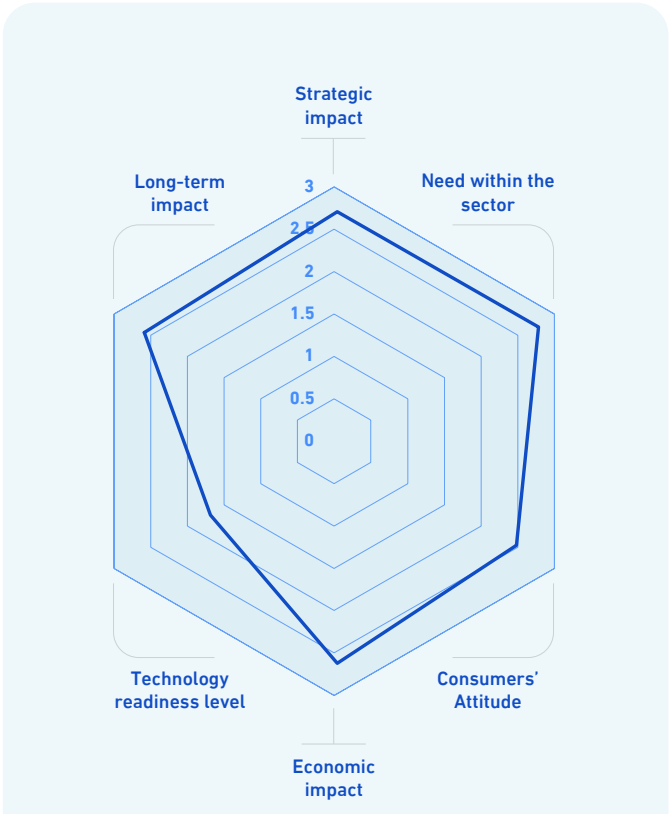
For more information, click here

Alignment with the National RDI Missions

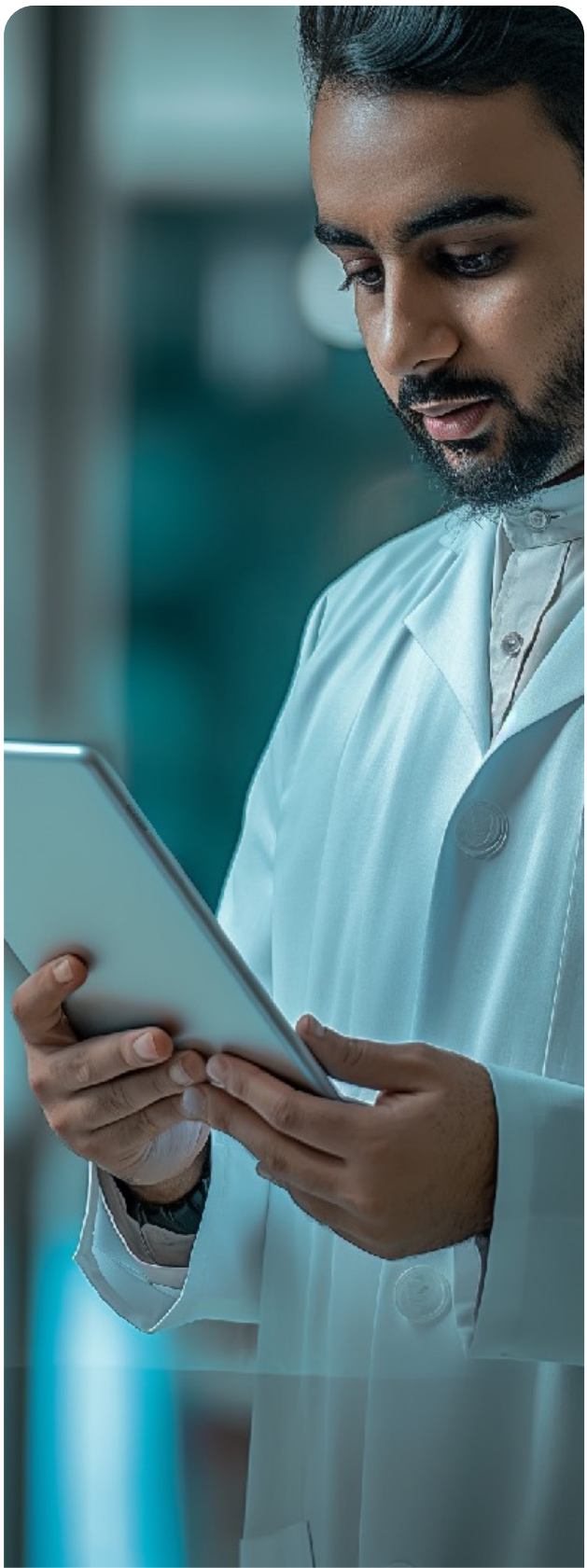
This technology signal can be aligned with the National RDI Mission:

"40% of population has had an intervention with a digital therapeutic developed by Saudi-based scientists by 2035".

Multi-Dimensional Evaluation



03
Continuous Glucose Monitoring (CGM) Devices



Diabetes affects about 537m adults worldwide. Around 90% of the diabetes population are diagnosed with type 2 diabetes. source Continuous glucose monitoring (CGM) devices have revolutionized the way individuals with diabetes manage their condition. These devices offer real-time, continuous readings of blood sugar levels, providing patients with a more comprehensive understanding of their glucose fluctuations throughout the day and night.

Traditional methods of blood sugar monitoring, such as finger pricks, require multiple daily checks and can be inconvenient and painful. CGMs eliminate the need for frequent finger pricks, allowing patients to live more active and flexible lifestyles. By continuously monitoring glucose levels, CGMs help individuals identify patterns, anticipate hypoglycemic or hyperglycemic events, and make informed decisions about their insulin dosages or dietary adjustments.

CGMs are equipped with sensors that are inserted beneath the skin, typically on the abdomen. These sensors measure interstitial fluid glucose levels, which closely correlate with blood sugar levels. The data is then transmitted wirelessly to a receiver or smartphone, providing patients with a constant stream of glucose readings. Modern CGMs often feature advanced features such as alarms for low or high glucose levels, trend arrows to indicate whether glucose levels are rising or falling, and integration with insulin pumps for automated insulin delivery.

While current CGMs require invasive insertion of sensors, researchers are actively developing non- invasive CGM technologies that aim to eliminate the need for skin punctures. These technologies include optical sensors that measure glucose levels through the skin, radar-based systems that detect changes in glucose concentrations, and even wearable devices that utilize sweat analysis. While still in the experimental stages, non-invasive CGMs hold the promise of providing continuous glucose monitoring without the discomfort or potential complications associated with invasive sensors. If successful, these technologies could revolutionize diabetes care by making it more accessible, convenient, and less burdensome for individuals with diabetes.

For more information, click here

The benefits of CGMs extend beyond improved blood sugar control. They can also help individuals with diabetes:

- **Reduce the risk of hypoglycemia:** By providing real-time glucose readings, CGMs allow patients to detect and treat low blood sugar episodes before they become severe.
- **Improve glycemic control:** CGMs can help individuals achieve better overall glycemic control, reducing the risk of complications associated with diabetes, such as heart disease, stroke, and kidney disease.
- **Enhance quality of life:** The ability to monitor glucose levels continuously can provide peace of mind and reduce stress for individuals with diabetes.

For more information, click here

Tech Signal

Approval of Innovative Devices for Continuous Glucose Monitoring (CGM) Devices for Diabetes

Continuous glucose monitoring (CGM) is one of the most rapidly expanding segments within diabetes care technology. For instance, in March 2024, Dexcom got FDA approval for its Stelo glucose biosensor, the first over-the-counter CGM.

For more information, click here

Medtronic is another major player in the CGM market. The company's Simplera CGM, which recently got FDA approval after receiving CE marking, represents a significant improvement over its previous models in terms of size, ease of use, and accuracy.

For more information, click here

While most CGM companies focus on reducing the size of their sensors to enhance aesthetic appeal, Senseonics has taken a different approach with its Eversense E3, which has been approved by the FDA. This device features an implanted sensor that lasts six months, a much longer duration than the patch-based devices offered by competitors like Dexcom and Abbott, which typically last only a few weeks. This makes Eversense E3 a compelling option for patients seeking a discreet, long-lasting solution that requires fewer sensor changes. Another innovation to mention is Glysens' fully implantable Eclipse ICGM system.

In addition to the innovations in traditional CGMs, a new wave of non-invasive CGM devices is emerging, potentially disrupting the market. One example is the KnowU system from Know Labs, which uses Bio-RFID technology to measure glucose levels. This system is expected to enter the pre-FDA approval process later in 2024. The KnowU system's simpler design and lower manufacturing costs make it a potentially more affordable option, as it eliminates the need for sensor implantation or insertion into the body. However, the accuracy of non-invasive devices, especially in detecting hypoglycemia, remains a significant hurdle for these new entrants, and extensive clinical trials will be necessary to verify their effectiveness.

Meanwhile, hybrid closed-loop systems are fueling further growth in the diabetes care technology market. These systems, such as Medtronic's MiniMed 780G and Insulet's Omnipod 5, integrate CGMs with insulin pumps to automate insulin delivery. Medtronic has

received FDA's approval for the MiniMed 780G, marking a major milestone in automated diabetes management. Insulet's Omnipod 5, the only tubeless patch pump on the market, has gained popularity for its convenience and effectiveness.

Looking ahead, fully closed-loop insulin delivery systems, like Beta Bionics' iLet Bionic Pancreas, which recently received FDA clearance, represent the future of diabetes management technology. These systems eliminate the need for manual insulin dosing by autonomously adjusting insulin levels based on CGM data. The iLet, in particular, stands out for its ability to calculate both basal and bolus insulin doses without user input, streamlining diabetes management.

For more information, click here

Market Size

The continuous glucose monitoring device market size accounted for USD 5.36 billion in 2024 and is predicted to reach around USD 10.65 billion by 2034, growing at a CAGR of 7% from 2024 to 2034.

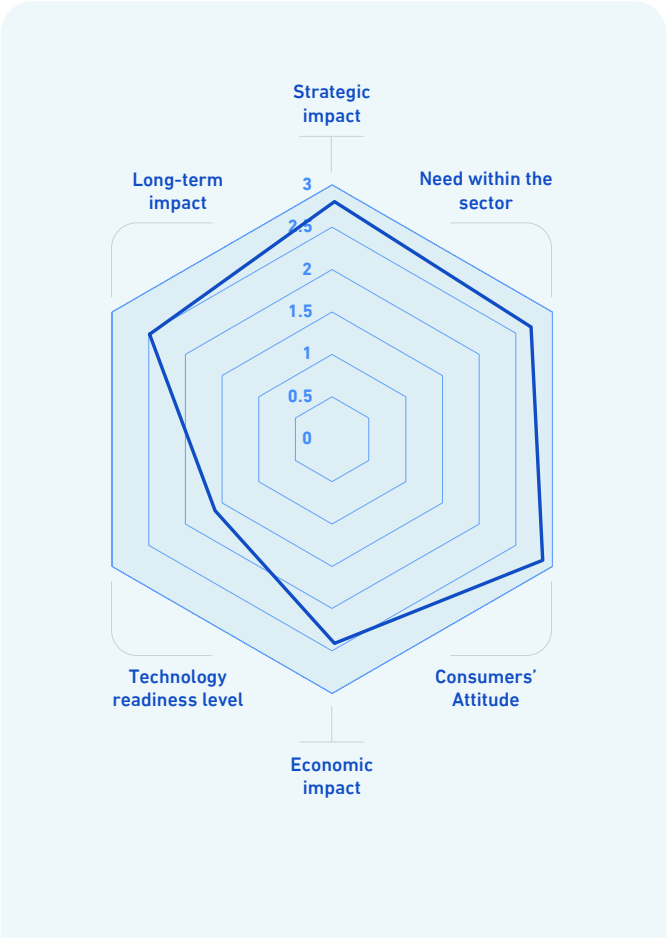
For more information, click here

Alignment with the National RDI Missions

This technology signal can be aligned with the National RDI Mission:

"Increase healthy life expectancy by 5 years by 2040".

Multi-Dimensional Evaluation



04
Early Cancer Detection

As cancerous tumors expand, they often release DNA fragments into the bloodstream. A liquid biopsy can detect this DNA, offering critical insights into the tumor's genetic makeup and helping determine whether a particular treatment is proving effective.

For more information, click here

Liquid biopsy (LBx) is a non-invasive diagnostic tool that involves analyzing biological fluids, mainly blood, to detect cancer-related biomarkers such as Circulating Tumor Cells (CTCs) or circulating tumor DNA (ctDNA).

For more information, click here

Compared to traditional methods like tissue biopsies, LBx offers advantages such as faster turnaround times, better capture of tumor heterogeneity, and lower invasiveness. This technology has been adopted in therapy selection and monitoring, and is emerging as a promising tool for early cancer screening. LBx has three primary use cases in oncology:

Early Cancer Screening: Detecting cancer before symptoms emerge is crucial for improving survival rates. It's emphasized that screening for early- stage cancer can drastically reduce mortality rates. Despite this, traditional screening methods have limited sensitivity, are invasive, and are inconvenient, contributing to low screening rates. LBx, with its less invasive approach and the potential to replace traditional methods, could address these challenges.

Therapy Selection: LBx helps profile tumor types to determine the most effective treatment options. This is currently the most widely adopted use case, with 11 FDA-approved products used for 27 therapies across 14 tumor types. Reimbursement for these products is also more established compared to early screening.

Monitoring During and After Treatment: LBx can monitor patients' responses to treatment and detect relapses, especially after remission. For example, tests for minimal residual disease (MRD) can evaluate the likelihood of cancer recurrence after remission.

For more information, click here

Tech Signal

Liquid Biopsy: Innovation for Early Cancer Screening

Nature Scientific Reports published an article on: "Liquid Biopsy: From Concept to Clinical Application" that provides an in-depth exploration of the use of liquid biopsy as a minimally invasive method to monitor and detect cancer through circulating biomarkers in blood. These include circulating tumor cells (CTCs), cell- free tumor DNA (ctDNA), and RNA. Liquid biopsy has evolved to cover not just blood but also other fluids like cerebrospinal fluid and urine. Clinically, it is used for early cancer detection, tumor staging, monitoring treatment responses, and predicting metastatic progression. Notable advancements include the detection of minimal residual disease (MRD) earlier than imaging techniques, as well as new insights into metastatic competence through epigenomic studies of CTCs. Despite promising developments, the paper stresses the need for more clinical trials and standardized procedures to implement liquid biopsy widely in clinical practice.

For more information, click here

Nature Medicine recently published a paper on: "Turning the Tide of Early Cancer Detection" that discusses the transformative potential of next- generation liquid biopsy (LBx) technologies, which detect circulating tumor DNA (ctDNA) in cell-free DNA (cfDNA) from blood samples. These innovations could revolutionize early cancer detection by providing a less invasive alternative to traditional biopsies and potentially identifying multiple cancer types before symptoms emerge. However, it highlights that further clinical trials are necessary to validate its clinical utility and address concerns about false positives and overdiagnosis. The widespread adoption of LBx depends on resolving these issues and proving its efficacy in reducing cancer mortality.

For more information, click here

In July 2024, McKinsey Direct published a report on "Liquid Biopsy: Charting Innovation in Early Cancer Screening". The report discusses the transformative impact of liquid biopsy (LBx) in oncology diagnostics and its growing application, particularly for early cancer screening. The report highlights the growing body of clinical evidence supporting LBx's efficacy in early detection, noting that multicancer early detection (MCED) tests like Galleri could prevent approximately 26% of cancer-related deaths if implemented for adults aged 50 to 79 in the United States.

It has been shown that LBx holds great promise for expanding early cancer screening and improving patient outcomes. However, achieving widespread clinical adoption will require addressing affordability issues, improving physician acceptance, and demonstrating clear clinical utility. Diagnostics companies are encouraged to adopt innovative approaches and collaborate with various stakeholders, including healthcare providers, biopharmaceutical companies, and government entities, to accelerate the adoption of this potentially life-saving technology. This comprehensive strategy could lead to increased screening rates, improved early cancer detection, and better long-term outcomes for patients.

For more information, click here

Market Size

The Global Cancer Diagnostics Market Size was valued at USD 19.5 Billion in 2023, and it is expected to reach USD 54.6 Billion by 2032, growing at a CAGR of 12.1% during the forecast period (20232030-).

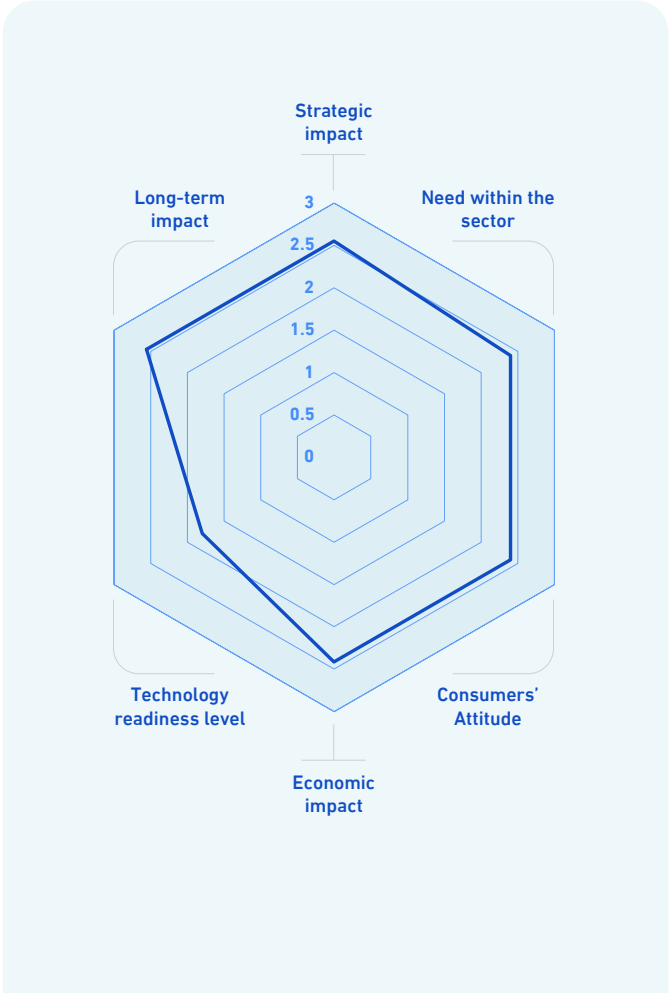
For more information, click here

Alignment with the National RDI Missions

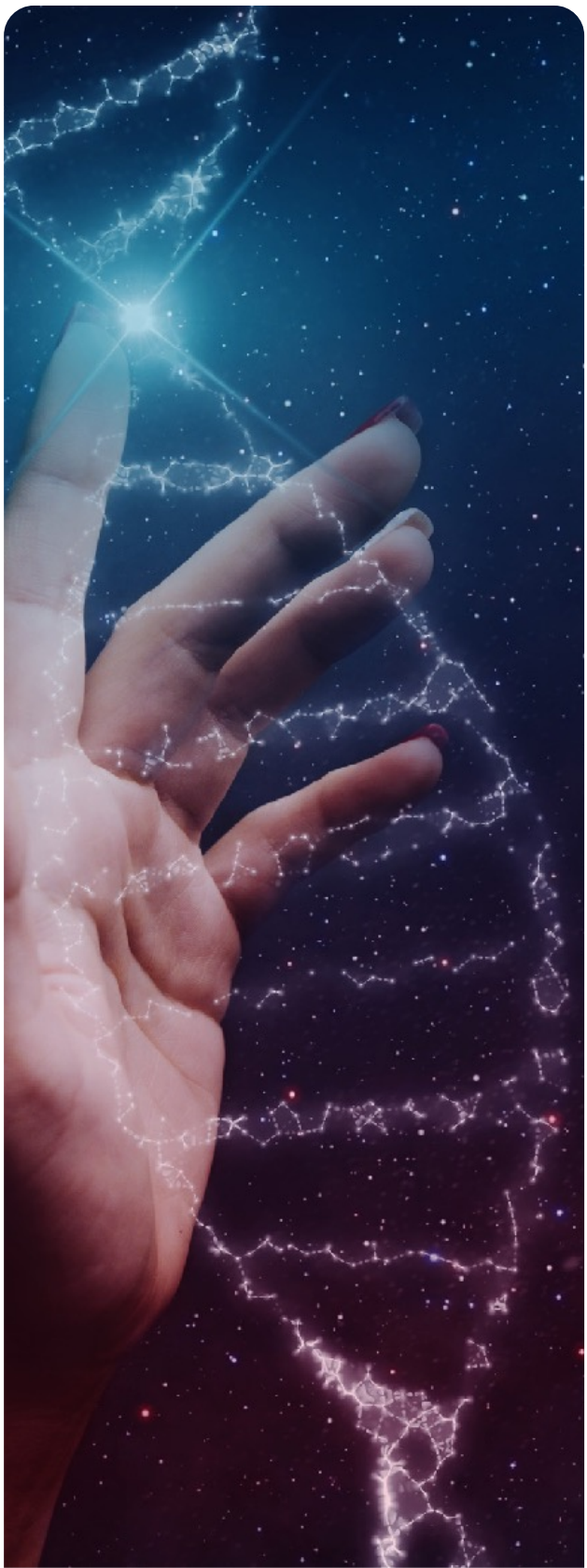
This technology signal can be aligned with the National RDI Mission:

"Increase healthy life expectancy by 5 years by 2040".

Multi-Dimensional Evaluation



05
CRISPR Gene Editing



CRISPR stands for "clustered interspaced short palindromic repeats". It is a microbial immune system that allows bacteria and archaea to recognize and destroy viral invaders. This system has been adapted for gene editing, enabling precise changes to DNA.

CRISPR works by incorporating DNA from invading viruses into the bacteria's genome, creating a "memory." When the virus attacks again, CRISPR uses this memory to recognize and destroy the virus by creating a guide RNA that binds to the invader's DNA and cuts it. In other words, CRISPR/Cas9 edits genes by precisely cutting DNA and then harnessing natural DNA repair processes to modify the gene in the desired manner. The system has two components: The Cas9 enzyme and a guide RNA (gRNA).

For more information, click here

Gene therapy involves using CRISPR to repair or regulate defective genes, potentially treating diseases. It can fix single mutations like those in sickle cell anemia. Cell therapy, on the other hand, involves engineering immune cells, like T cells, to fight diseases such as leukemia. CRISPR can enhance the efficiency and control of these therapies, making them more precise.

For more information, click here

CRISPR is easier to program than earlier gene-editing technologies, as it primarily uses RNA to find its target, allowing for faster and more precise editing. CRISPR holds immense potential for clinical applications, especially for genetic diseases that cannot be treated by traditional methods. Its precision makes it an appealing tool in the biomedical sciences, with the potential to cure diseases at their genetic roots. CRISPR-based therapies like CASGEVY, approved for treating sickle cell anemia, showcase its ability to provide long-term solutions for genetic disorders.

Beyond healthcare, CRISPR has applications in diagnostics, allowing for the detection of pathogens, and in manufacturing, where it could improve the efficiency of producing some goods. It also has uses in sustainability, offering solutions for reducing carbon emissions and waste. Ecological engineering is another area, with efforts to modify mosquito populations or even resurrect extinct species like the woolly mammoth. However, the long-term safety of these ecological applications remains a subject of ongoing research.

The commentary published in the American Journal of Medicine:"CRISPR-Cas Gene Editing to the Genetic Rescue" by authors from Harvard and Brown Universities, outlined the transformative potential of CRISPR-Cas systems, particularly CRISPR-Cas9 and its variants, in clinical medicine. The CRISPR-Cas9 complex operates by targeting specific DNA sequences to delete, add, or modify genes, and it is now being used to address various genetic diseases. The article explains the four key components of the CRISPR-Cas9 system: the CRISPR DNA array, Cas9 nuclease, single guide RNA (sgRNA), and the protospacer adjacent motif (PAM), which together allow precise gene editing.

For more information, click here

Tech Signal

CRISPR-Cas Gene Editing for Sickle Cell Disease and Genetic Therapies

One of the significant advancements discussed is the use of CRISPR-Cas12a, which, unlike Cas9, can be applied for therapeutic delivery and diagnostic purposes. CRISPR-Cas12a is activated when it interacts with target DNA, allowing for the delivery of drugs, enzymes, or cells to specific tissues. This system also has diagnostic applications, such as detecting methicillin resistance in Staphylococcus aureus infections.

In terms of human disease treatment, CRISPR-Cas9 has shown success in conditions like transthyretin amyloidosis (ATTR), where the accumulation of misfolded proteins causes damage to the heart and nerves. A clinical trial using CRISPR to disrupt the gene responsible for ATTR in hepatocytes reduced protein levels significantly, demonstrating the long-term potential of this therapy. Additionally, the commentary highlights the use of CRISPR-Cas9 to elevate fetal hemoglobin (F-Hgb) levels in sickle cell disease by targeting and disrupting transcriptional repressors, effectively reducing the complications of the disease. Another example includes gene editing for hereditary angioedema by disrupting the prekallikrein gene to lower plasma kallikrein levels and reduce angioedema attacks. It is found that CRISPR-Cas systems have already proven beneficial in editing genes, diagnosing diseases, and delivering treatments to specific tissues, and the future of these technologies holds even more promise for clinical applications.

For more information, click here

In the same journal, American Journal of Medicine, the commentary titled: "CRISPR Therapy of Sickle Cell Disease: The Dawning of the Gene Editing Era" discussed the landmark approval of CRISPR-Cas9 gene therapies, CASGEVY and LYFGENIA, by the U.S. FDA in December 2023 for treating sickle cell disease (SCD) in patients aged 12 and above with recurrent vaso-occlusive crises.

For more information, click here

This follows similar approval by the UK's Medicines and Healthcare products Regulatory Agency (MHRA). Sickle cell disease, a life-threatening genetic disorder affecting around 100,000 people in the U.S., has limited therapeutic options and leads to severe complications like pain and organ damage due to blocked blood flow. Until now, treatment has largely focused on symptom management and blood transfusions.

CRISPR-Cas9 offers a new approach by editing patients' blood stem cells, converting the mutated beta-globin subunits (responsible for the abnormal hemoglobin S) into fetal hemoglobin (HbF), which prevents red blood cell sickling. The edited cells are infused back into the patient following myeloablative conditioning to eliminate affected cells from the bone marrow. Clinical trials have shown impressive results, with 93.5% of patients free of severe vaso-occlusive crises for at least 12 months. CASGEVY's approval marks the first clinical application of CRISPR-Cas9 technology, opening the door for gene editing to be used in a range of genetic disorders. The commentary concludes by highlighting the transformative potential of CRISPR-Cas9 in genetic medicine, but emphasizes the need for broader access and continued research to maximize its clinical impact.

For more information, click here

Market Size

The genome editing market size was USD 8.45 billion in 2023, calculated at USD 9.88 billion in 2024, and is expected to reach around USD 40.48 billion by 2033, expanding at a CAGR of 16.96% from 2024 to 2033.

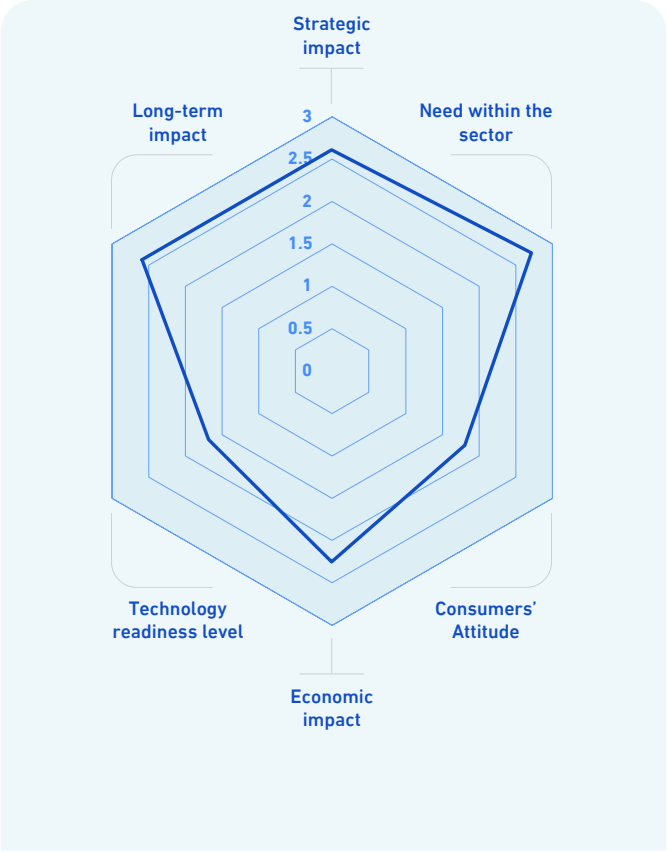
For more information, click here

Alignment with the National RDI Missions

This technology signal can be aligned with the National RDI Mission:

"Genetic therapies for at least 2 out of KSA's top 10 rare diseases are in development by 2035".

Multi-Dimensional Evaluation



06
Robotic Surgery

Surgical robotic systems are transforming modern medicine by enhancing visualization, precision, and ergonomics for surgeons. These advanced platforms go beyond traditional robotics, enabling minimally invasive procedures that offer significant advantages for both medical professionals and patients. Although still relatively new, robotic technology has rapidly gained traction, particularly in orthopedics, where major companies have adopted robotic systems to stay competitive in the market.

Indications treated and specialties include, and not limited to: general surgery; urology; gynecology; orthopedics; cardiothoracic; head and neck; and others.

Robot-assisted surgery has experienced significant growth in recent years, rapidly gaining global adoption due to its numerous advantages:

- Robotic systems offer surgeons enhanced precision and control during procedures.
- Operating from a console helps reduce fatigue and strain during lengthy surgeries.
- These systems provide superior visualization of the surgical area with magnified 3D imaging.
- Robotic-assisted surgeries often lead to quicker recovery times, less pain, and fewer complications, contributing to higher patient satisfaction.
- By enabling more accurate implant placement and better tissue and bone preservation, robotic systems have the potential to improve long-term patient outcomes.
- Robotic systems have the capability to facilitate procedures, techniques, and approaches that are difficult to perform using traditional methods.

It is worth noting that King Faisal Specialist Hospital and Research Centre has successfully performed the world's first robotic heart transplant for a patient under the age of sixteen who suffered from stage IV heart failure, overcoming the medical challenges and complications associated with this type of operation, in a qualitative precedent that enhances the Kingdom of Saudi Arabia's position and leadership in the field of healthcare.

For more information, click here

Tech Signal

Revolutionary Surgical Robotics: A Breakthrough in Medical Technology

The development focus in robot-assisted surgery is increasingly shifting towards miniaturization. While current robotic systems are often large and cumbersome, the industry is moving towards creating smaller, more compact models. These advancements promise greater flexibility and accessibility, making surgeries even less invasive and broadening the range of procedures that can be performed robotically.

Another key area of development is the expansion of robotic surgery applications for new medical indications. For example, Zimmer Biomet introduced a total shoulder application for its ROSA orthopedic robot in February 2024. Similarly, several startups are developing robotic solutions for extremities like the foot and ankle, as well as for soft tissue repair.

Manufacturers are also in the early stages of integrating Artificial Intelligence (AI) and Machine Learning (ML) to enhance surgical planning. The future envisions these technologies transforming every phase of surgery from preoperative to postoperative through the use of sensors, intuitive interfaces, and advanced algorithms.

Augmented Reality (AR) is being explored as a way to overcome the limitations of two-dimensional screens in operating rooms. This could potentially drive widespread adoption of robotic systems in surgery.

As robot-assisted surgery becomes more common, there will likely be a push to reduce costs, increasing the accessibility of this technology to more healthcare facilities and patients. Remote surgery, made possible through robotics, could revolutionize the field by making expert surgical care available in remote or underserved areas, significantly improving patient outcomes. An example of this is the recent deployment of Virtual Incision's spaceMIRA robot to the International Space Station, where it was remotely operated by surgeons to perform several procedures. This demonstration of remote-controlled robotic technology has significant implications for its use on Earth, particularly in challenging or inaccessible locations.

While this summary focuses on orthopedic and laparoscopic surgical robotics, other robotic systems are also being developed for specific therapeutic areas, such as interventional oncology. Recent launches include systems designed for minimally invasive biopsies and tumor ablations, such as Quantum Surgical's Epione, Perfint Healthcare's MAXIO, and Interventional Systems' Micromate. Additionally, robotic systems like XACT Robotics' XACT ACE are capable of automated needle insertion.

For more information, click here

Market Size

Surgical Robots market size was valued at USD 7.1 billion in 2023 and is anticipated to witness growth at a CAGR of 16.1% between 2024 and 2032, to reach around USD 26.4 billion in 2032.

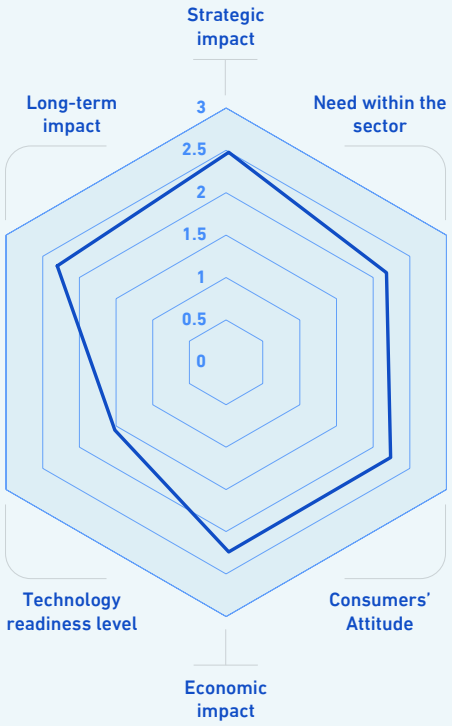
For more information, click here

Alignment with the National RDI Missions

This technology signal can be aligned with the National RDI Mission:

"40% of population has had an intervention with a digital therapeutic developed by Saudi-based scientists by 2035".

Multi-Dimensional Evaluation



07
Circular RNA

Circular RNA (circRNA) is an emerging technology that experts see as highly promising for the future of vaccines and gene therapies. Though still in early development, circRNA could potentially replace mRNA in some therapeutic applications due to its enhanced durability, lower immunogenicity, and cost-effective production.

CircRNA is a type of single-stranded, non-coding RNA that forms a continuous loop, differing from linear RNA by lacking the typical 3' and 5' ends. Discovered in humans in 1991, circRNA was initially overlooked as an error in RNA splicing! However, it is now recognized for its significant role in gene regulation, with thousands of circRNAs identified in various organisms. Their expression has been linked to developmental stages, physiological conditions, and diseases like cancer.

CircRNA is considered promising because it may outperform mRNA, which has transformed vaccine technology recently. While mRNA vaccines are costly to produce, require cold storage, and are challenging to transport, circRNA could offer a more durable and cost- effective alternative. CircRNA's chemical structure, which is more stable than linear RNA, allows it to remain longer in cells, potentially leading to more effective vaccines that require lower doses and fewer adverse effects.

The commercial success of RNA vaccines against the COVID-19 pandemic has raised hopes that circRNA could be the foundation for the next generation of treatments. What happened during the pandemic years qualifies the rollout of these vaccines to be the largest and most profitable in history, and has already qualified them for the 2023 Nobel Prize in Medicine.

For more information, click here

Tech Signal

The Therapeutic Potential of Circular RNA Could Potentially Replace mRNA

Circular RNA (circRNA) could extend beyond vaccines into gene therapies. For example, Circio, a biotech company, is developing circRNA-based gene therapies for conditions like alpha-1 antitrypsin (AAT) deficiency. Unlike adeno-associated virus (AAV)-based gene therapies, circRNA may allow for more durable and concentrated protein expression, reducing dosing requirements and associated costs. However, circRNA gene therapies might require multiple infusions over a patient's lifetime.

Alongside Circio, other companies like Orna Therapeutics are actively developing circRNA technology. Orna partnered with Merck in 2022 and acquired ReNAgade Therapeutics to strengthen its position in the field. While all current work on circRNA remains in the preclinical stage, experts believe it holds substantial potential. As circRNA approaches clinical trials, the designs may need adjustments to account for its unique properties, such as longer-acting effects and optimized dosing strategies. Experts like Erik Wiklund predict that within 10 to 20 years, circRNA could dominate the RNA vaccine space, marking a significant shift in therapeutic approaches.

For more information, click here

Orbital Therapeutics is one of a dozen or more biotech companies currently developing treatments based on modified circRNA. Strand Therapeutics is also one of the companies that are incorporating circRNA into their drug programs.

Chimerna Therapeutics uses genetically modified bacteria to make circular RNA in a way it says is "very time- and cost-effective" compared with molecules grown entirely in the lab.

A team at biotech firm Rznomics has also reported an RNA recycling system that avoids leaving any unwanted self-splicing sequences in the RNA loop. Researchers from two Chinese companies, Circode Biomedicine and Suzhou CureMed Biopharma Technology, have separately published preprints demonstrating similar approaches.

Proponents of the technology expect circular RNA to establish itself as the preferred RNA-based platform for the pharmaceutical industry, and they see it eventually leading to a range of applications and products: from advanced vaccines and treatments for rare diseases to active cancer agents, among others.

For more information, click here

Market Size

The biotechnology market size was valued at USD 1.54 Trillion in 2023 and is projected to reach USD 5.68 Trillion by 2033, growing at a CAGR of 13.95% from 2024 to 2033.

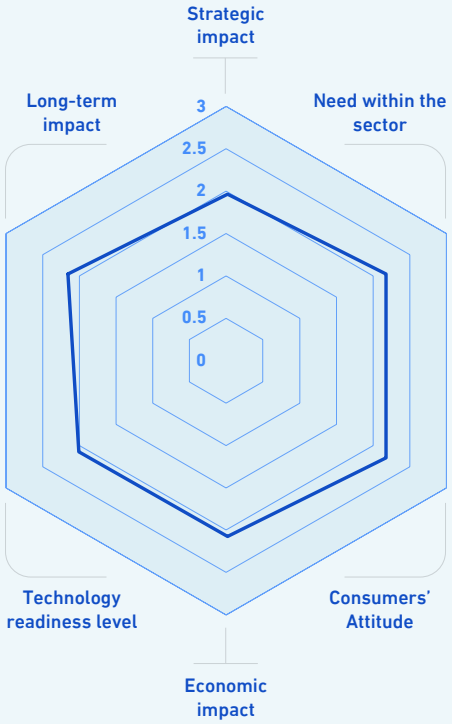
For more information, click here

Alignment with the National RDI Missions

This technology signal can be aligned with the National RDI Mission:

"Genetic therapies for at least 2 out of KSA's top 10 rare diseases are in development by 2035".

Multi-Dimensional Evaluation



08
Precision Psychiatry

Precision Psychiatry is an emerging field that integrates advances in neuroscience, neuroimaging, genetics, and artificial intelligence to tailor mental health treatments to individual patients. It moves away from the traditional "one-size-fits-all" approach to treating mental disorders such as depression and anxiety, focusing instead on personalized interventions based on biological and neurological profiles. One of the core principles of precision psychiatry is that mental health disorders manifest differently across individuals, both in symptoms and underlying brain function. This variability makes it essential to develop personalized treatment methods.

The groundbreaking study from Stanford University, for example, identified six distinct biological subtypes, or "biotypes," of depression using functional MRI (fMRI) scans and machine learning algorithms. This research suggests that each biotype is linked to specific brain circuits and patterns of activity that influence how individuals respond to different treatments, such as antidepressants or cognitive-behavioral therapy. For instance, certain patients with hyperactivity in cognitive brain regions showed a better response to pharmacological treatments like venlafaxine, while others with different brain activity profiles responded better to talk therapy. This approach reflects broader trends in neuroscience and mental health research, where understanding the biological and neural bases of mental disorders is seen as key to improving treatment outcomes.

Precision psychiatry aims to leverage tools such as neuroimaging, genetic markers, and machine learning to better predict which treatments will work for specific individuals, reducing the time spent on ineffective therapies and improving overall mental health care. The field holds promise not only for depression but also for a wide range of psychiatric conditions, offering a path toward more accurate diagnoses and more effective, individualized treatments.

For more information, click here

Tech Signal

Identification of six Biotypes of Depression

Researchers at Stanford Medicine have made a significant breakthrough in understanding and treating depression by identifying six distinct subtypes, or "biotypes," of the condition. This discovery, which leverages brain imaging and machine learning, could pave the way for more personalized and effective treatments for depression.

The study, that was published in Nature Medicine, involved 801 participants diagnosed with depression or anxiety. Using functional MRI (fMRI) scans, researchers assessed brain activity both at rest and during tasks designed to test cognitive and emotional functioning. By focusing on specific brain regions known to be involved in depression and using a machine learning technique called cluster analysis, the team identified six unique patterns of brain activity, each corresponding to a different depression subtype.

Each biotype is characterized by distinct brain activity patterns and responses to treatment:

- Cognitive Overactivity: Patients with this biotype exhibited high activity in cognitive regions of the brain. They responded best to the antidepressant venlafaxine (Effexor), showing significant improvement compared to other biotypes.
- Emotion Processing: High activity in areas associated with processing emotions was observed in this biotype. These patients were more likely to experience anhedonia (inability to feel pleasure) and performed poorly on tasks requiring executive function.
- Problem-Solving: This subtype showed increased activity in regions linked to depression and problem- solving when the brain was at rest. These patients responded well to behavioral talk therapy, which involves learning new skills to manage daily problems.
- Attention Regulation: Patients with low activity in the brain's attention-regulating circuit were less likely to benefit from talk therapy. This suggests that pharmaceutical interventions to boost brain activity in this region might be necessary before other therapies can be effective.
- Mixed Symptoms: Some patients displayed brain activity patterns that did not neatly fit into the other categories but still showed distinct responses to specific treatments.
- Undefined Biotype: This group showed no significant differences in brain activity compared to non-depressed individuals. Researchers believe this indicates that the current study may not have captured all the relevant brain regions involved in depression.

According to the research team, this work aims to get treatment right the first time, minimizing the frustration and prolonged suffering that comes with ineffective treatments. The ultimate goal is to develop a personalized medicine approach for mental health based on objective brain function measures. The research team plans to expand their study to include more participants and explore additional brain regions that may be involved in depression. They also aim to test more types of treatments across all identified biotypes, including medications not traditionally used for depression.

For more information, click here

Market Size

The global precision psychiatry market size reached USD 1,060 million in 2023. IMARC Group expects the market to reach USD 4,028 million by 2032, exhibiting a (CAGR) of 15.5% during 20242032-.

For more information, click here

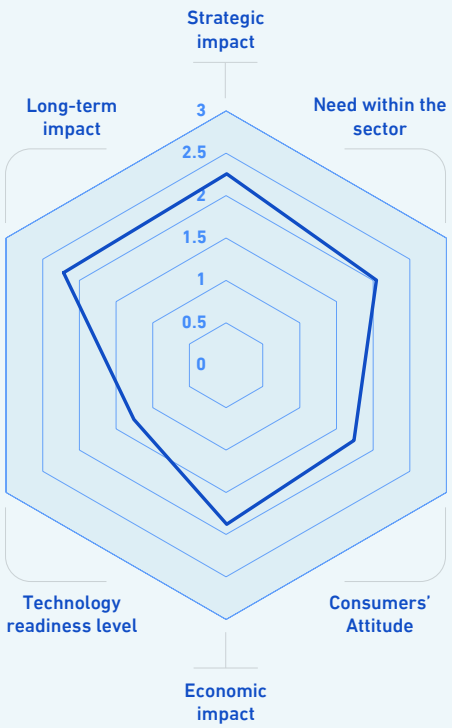
For more information, click here

Alignment with the National RDI Missions

This technology signal can be aligned with the National RDI Mission:

"Reduce prevalence of non-communicable diseases by 50% through prevention, better management, and treatment by 2035".

Multi-Dimensional Evaluation



09
Personalized Medicine

Francis Collins introduced the concept of "personalized medicine" in 2003, predicting that within 10 years, genetic tests would allow for tailored health maintenance and disease prevention. While there has been significant scientific progress, many personalized treatments remain inaccessible to the general public. Although the field has delivered remarkable advances, such as targeted cancer therapies and gene therapies, a gap persists between scientific potential and practical implementation. The challenge now is to address barriers to access, ensuring that the benefits of personalized medicine reach a broader population. This requires systemic changes in healthcare, focused on affordability, accessibility, and equitable distribution of cutting-edge therapies. The Personalized Medicine Coalition advocates for a health system that prioritizes cost-effective, prevention-focused strategies while reducing patient expenses, emphasizing the importance of implementation science to bridge clinical practice gaps. The ultimate success of personalized medicine will depend on its accessibility and affordability, not just its scientific achievements.

For more information, click here

The next technological breakthrough reveals a major advance in personalized medicine, specifically in understanding Down syndrome. As part of the ongoing Human Molecular Triad project at the Crnic Institute, the study identified distinct molecular and immune profiles among individuals with Down syndrome, providing valuable insights that could lead to personalized medical approaches to managing the condition.

Tech Signal

Molecular Subtypes of Down Syndrome, Paving the Way for Personalized Medicine Approaches

A recent publication in Nature Communications by scientists from the Linda Crnic Institute for Down Syndrome (Crnic Institute) at the University of Colorado Anschutz Medical Campus reveals a major breakthrough in understanding Down syndrome. As part of the ongoing Human Trisome Project at the Crnic Institute, the study identifies distinct molecular and immune subtypes among individuals with Down syndrome, providing valuable insights that could lead to personalized medical approaches for managing the condition.

For more information, click here

The Crnic Institute research team examined gene expression patterns on chromosome 21, which is triplicated in Down syndrome, across hundreds of participants in the Human Trisome Project. They discovered unique gene overexpression patterns among these individuals. Using advanced machine learning techniques, the researchers correlated these variable gene expression patterns with three distinct molecular and immune subtypes in people with Down syndrome. This marks the first instance where molecular profiles derived from blood samples have been used to categorize the Down syndrome population into specific subsets.

According to the research team, there is significant variation in the developmental and clinical characteristics of people with Down syndrome, and it's believed that understanding this diversity is key to making discoveries that will enhance health outcomes and increase life expectancy in this deserving population.

Down syndrome, also known as trisomy 21, results from an extra copy of chromosome 21 and is associated with differences in neurodevelopment and a unique clinical risk profile. Individuals with Down syndrome have a significantly reduced risk for certain medical conditions, such as most solid tumors and hypertension, but face a much higher risk for others, including autoimmune disorders and Alzheimer's disease. However, the variability in how these traits present in individuals with Down syndrome has long been a challenge for medical and research communities.

These findings represent a pivotal advancement toward providing better medical care for individuals with Down syndrome. This shift enables to move from a broad treatment approach to one that is more precise and tailored, addressing the unique manifestations of co-occurring conditions in Down syndrome.

The identified molecular signatures related to immune function, cellular signaling, and metabolism offer both basic and clinical researchers a roadmap to develop targeted diagnostics and treatments for this population. This study also underscores the power of advanced computational techniques in analyzing large-scale datasets. With the datasets generated by the Human Trisome Project, it's possible now to envision a personalized medicine approach for Down syndrome, similar to advancements made in other medical fields.

This cutting-edge research not only enhances the understanding of Down syndrome but also highlights the potential for more precise diagnostics and treatments for complex medical conditions.

For more information, click here

Market Size

The global sales of the personalized medicine market in 2022 were held at USD 326.7 billion. With a CAGR of 7.8% from 2023 to 2033, the market in the country is expected to reach USD 690.9 billion.

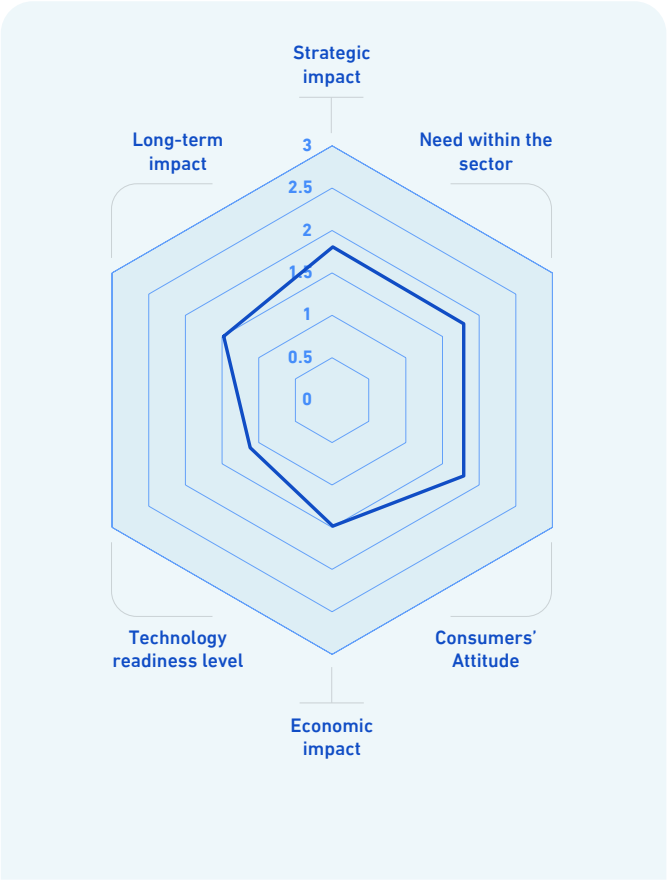
For more information, click here

Alignment with the National RDI Missions

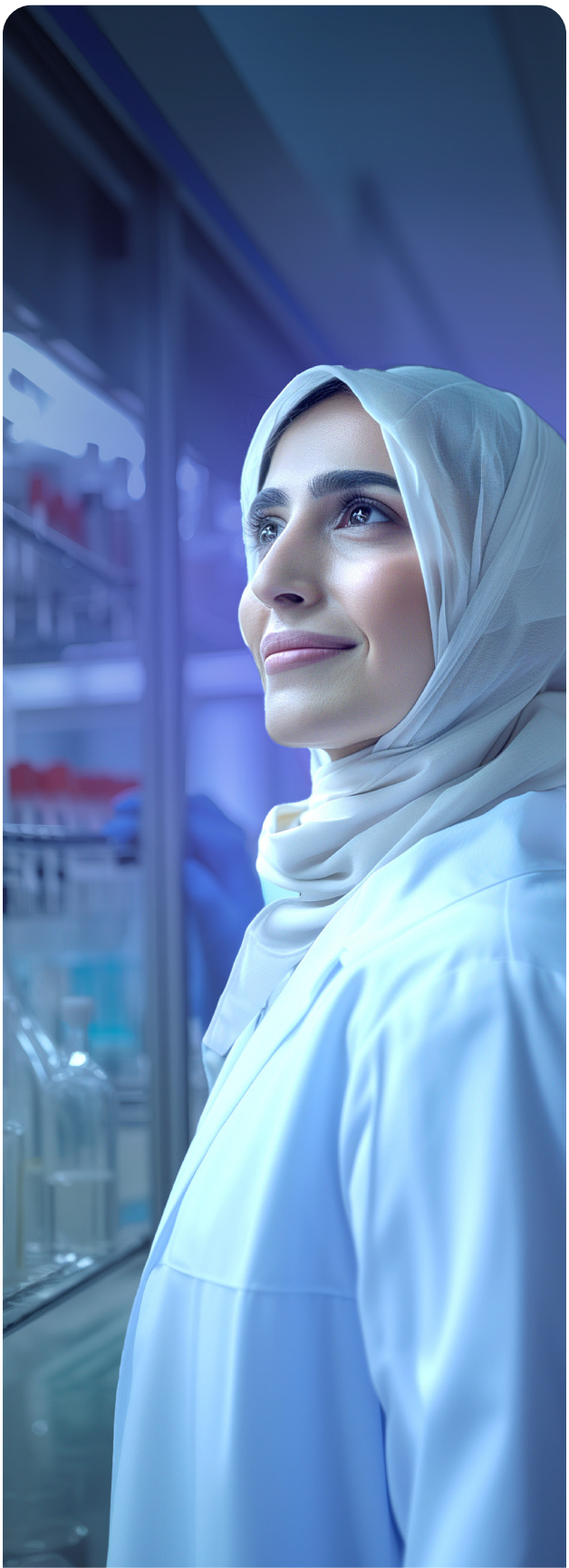
This technology signal can be aligned with the National RDI Mission:

"Increase healthy life expectancy by 5 years by 2040".

Multi-Dimensional Evaluation



04
CONCLUSION



This report highlights the innovative technological signals that have revolutionized the healthcare sector, underscoring the profound impact of advanced technologies on improving patient care and health outcomes. From drug discovery through artificial intelligence to gene editing with CRISPR, these innovations are fostering the development of precise and rapid therapeutic approaches that enhance the efficiency of healthcare systems. Breakthroughs such as protein synthesis and modeling, precision psychiatry, continuous glucose monitoring devices, and robotic surgical systems illustrate a future led by technology to improve diagnostic accuracy and accelerate therapeutic responses.

Technologies like circular RNA and early cancer detection pave the way for novel, personalized treatments that challenge traditional healthcare pathways. Additionally, personalized medicine and biotechnology offer ground breaking solutions for complex diseases, contributing to the enhancement of comprehensive healthcare delivery. Molecular biology remains central to our advanced understanding of diseases and the development of innovative therapeutic techniques.

These technological signals not only represent the future of healthcare but also embody hope for building an innovative and efficient health system that is ready to cope with and address growing global health challenges.

The emerging innovative technologies in health and wellness presented in this report can improve the quality of life and extend human longevity. By embracing these innovations, we can contribute to ensuring that these advancements are accessible to all, promoting equitable health outcomes globally.

هيئة تنمية البحث
والتطوير والابتكار
Research Development
and Innovation Authority