

WHERE TO PLAY:
GAME-CHANGING
TECHNOLOGIES
FOR **HEALTHCARE**
& **PHARMACEUTICAL**



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Introduction

The key drivers of change influencing healthcare & pharmaceutical, much like in other industries, are not necessarily new. But they have manifested in new ways and seen rapid acceleration over the past two years.

COVID-19 has had the effect of intensifying demands and advancing the development of solutions. It's this intersection of necessity and opportunity that holds the greatest potential for progress and innovation. Take, for instance, the 38X increase in telehealth use from the pre-pandemic baseline. Or the unprecedented speed at which the coronavirus vaccine was developed—within a year—along with the establishment of mRNA vaccines—a possible revolution for vaccinology.

Where healthcare & pharmaceutical differs from other industries during this time is in its position, literally at the frontline of global health. Here, the stakes are much higher; reducing time to market and scaling innovation

impact more than just competitive advantage. In this industry, speed—rapid diagnosis, shortened drug discovery—can save lives. While more widespread, accessible products and services can promote equity in healthcare and, ultimately, a better quality of life for a greater number of people.

Indeed, the pace and magnitude of change are increasing for healthcare & pharmaceutical organizations. Digitalization has gone from an opportunity to an imperative. Infusing digital solutions throughout value chains is the catalyst for moving from fragmented, opaque, and one-size-fits-all treatment to integrative healthcare ecosystems.

These ecosystems are designed to deliver the right treatment in the right environment in a timeous and empathetic manner. They rely on (a) a network of diverse service providers across health, pharma, and tech, (b) a system that integrates holistic data, taking into account the social and behavioral determinants of health, and (c) the right technology to analyze this data, match patients' needs and treatment, and share critical data and insights across organizations.

This report aims to provide decision-makers in healthcare & pharmaceutical with a view of the technologies that hold the greatest potential for meaningful innovation. These game-changing technologies range from emerging to evolving and present several innovative use cases for enhancing resilience, relevance, and impact in the industry. The information contained within this report is interlinked with the ITONICS Innovation Platform to help you visualize the connections between various drivers of change and identify the technologies that align with and enable your strategic innovation goals.

An Introduction to Technology Scouting

End2end innovation management begins by asking the fundamental question, **Where to Play**. Answering this question relies on several congruent activities and internal capabilities that primarily fall within the discipline of Foresight and Strategy, as advocated by our distinct **ITONICS COFIM** model. Organizations equipped with strong foresight capabilities can align their strategy with future scenarios and build resilience in an increasingly uncertain and competitive landscape.

Essential in **Foresight and Strategy** is an organization's capacity to scan its business environment comprehensively and continuously—environmental scanning. This is the capability to scan the horizon for weak signals that might indicate larger shifts and influence or disrupt the environment. It begins with the collection of vast amounts of data from which patterns are revealed through sensemaking analysis.

Environmental scanning focuses on control objectives that enhance innovation intelligence, thereby enabling the identification of new opportunities for growth, informing strategic priorities, and shaping future goals. These include capability supervision, competitor watch, trend scouting, and technology scouting.



As the focus of this industry report, **technology scouting** is the process of observing technological shifts and developments by collecting pertinent data, contextualizing change to uncover discernable patterns as weak signals, and identifying emerging technologies that hold both impact and relevance.

Actively screening for shifts in technology adoption, R&D, and patents serves as an early-warning system to help organizations anticipate and respond to changes while also minimizing risk.

Applying an industry lens to the process of technology scouting helps organizations direct their focus and resources more optimally.

And by gaining an understanding of the technological developments and adoption trends that may present future opportunities in their industry, they can equip themselves with the innovation intelligence needed to take decisive, strategic action and ultimately gain a competitive advantage.



The Role of Technologies in Innovation

Emerging, evolving, and disruptive technologies serve as solution drivers, helping innovators connect the dots between their current and future states. These are the tools capable of meeting—and sometimes, creating—new needs, desires, and demands.

Technologies enable new business models, products, and services. They have the potential to meaningfully expand an organization's existing portfolio and transform an entire industry.

The Interplay between Technologies and Trends

Technologies and trends are complementary elements that interact with and influence one another. Trends are expressions of new consumer attitudes, expectations, or behaviors—an indication of market pull; whereas technologies are designed either in response to these shifts or as precursors to nascent demands—representing a market push.

Together this push and pull exert force on the market, driving change forward. It is organizations' ability to pre-empt or respond to this change through innovation that determines their success.

Determining Industry Relevance

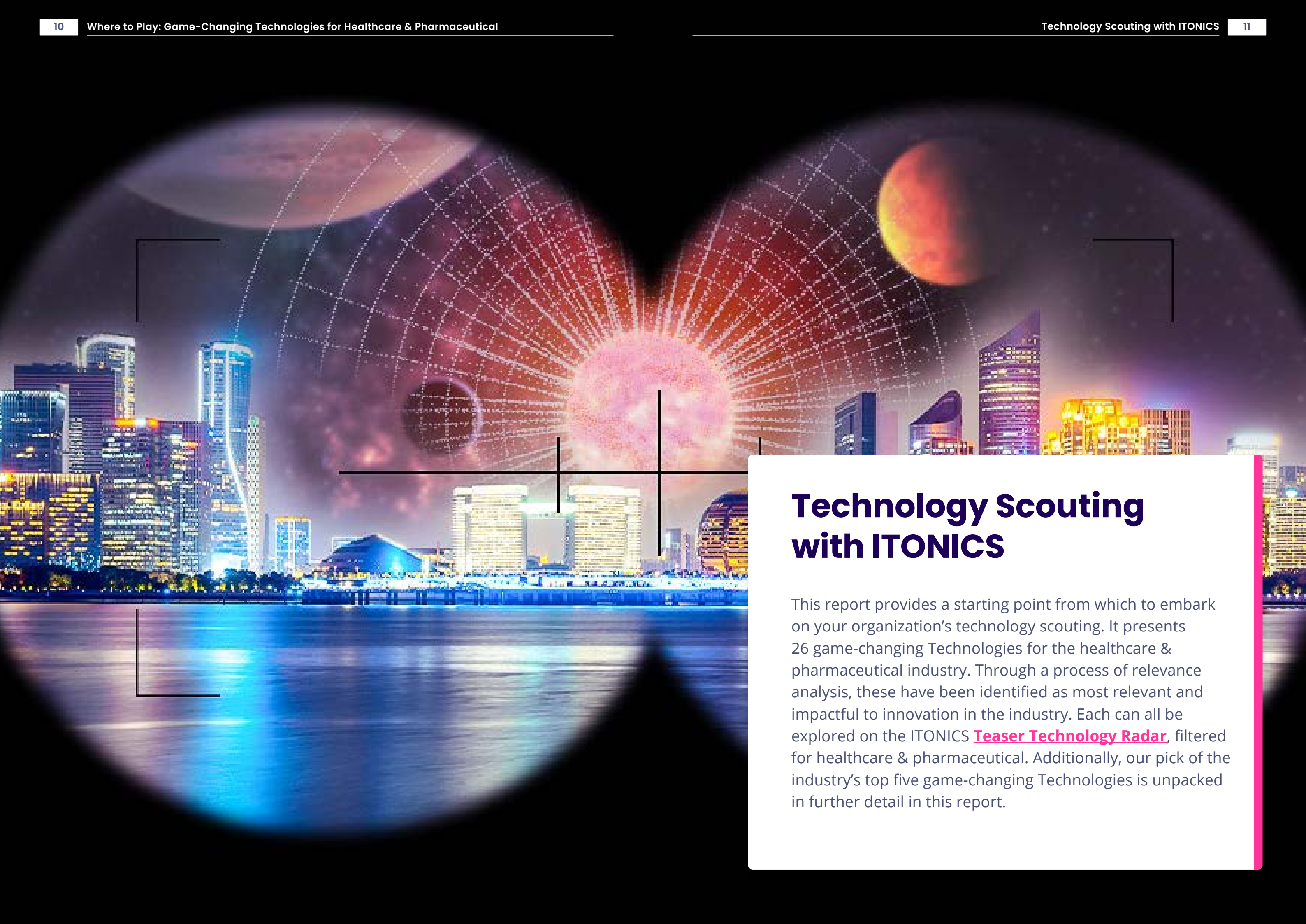
Environmental scanning is a divergent exercise; too narrow an approach and important opportunities can easily be missed. And while all elements in the ITONICS portfolio hold relevance—the degree of relevance differs depending on the industry in which your organization operates.

To help provide this industry lens, ITONICS analysts have performed relevance analysis to identify the Technologies and other elements that are most relevant and likely to be game changers in each respective industry.

Our team of analysts monitored the frequency with which each Technology appeared in a given industry. Instances of real-world applications, R&D, patents, and startup activities were tagged with relevant industries through a process combining manual and automated data classification.

This initial mapping of the ITONICS portfolio served as hypotheses of industry relevance. These hypotheses were further validated and enriched through additional quantitative and qualitative industry research to arrive at nine industry packages.

Each industry package, available on the ITONICS Innovation Platform, displays the Technologies, Trends, and Inspirations that represent the most relevant—that is, impactful, disruptive, and transformative—areas in which to play.



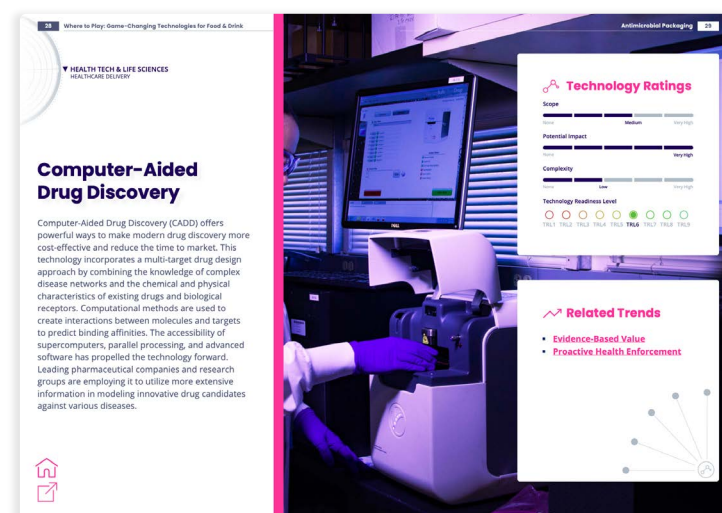
Technology Scouting with ITONICS

This report provides a starting point from which to embark on your organization's technology scouting. It presents 26 game-changing Technologies for the healthcare & pharmaceutical industry. Through a process of relevance analysis, these have been identified as most relevant and impactful to innovation in the industry. Each can all be explored on the ITONICS [Teaser Technology Radar](#), filtered for healthcare & pharmaceutical. Additionally, our pick of the industry's top five game-changing Technologies is unpacked in further detail in this report.

How to Read the Technologies

The **Synopsis** gives a brief overview of the Technology, explaining why it is important, what is required to enable it, how it has evolved, and any current limitations and opportunities.

The **Segmentation** of the Technology is indicated corresponding to the relevant categories that appear on the ITONICS Radar: Chemicals & Materials, Energy & Resources, Engineering, Healthcare & Life Sciences, ICT, and Mobility. Listed below, the **Sub-segmentation** provides a more narrow scope as to the area of technological development.



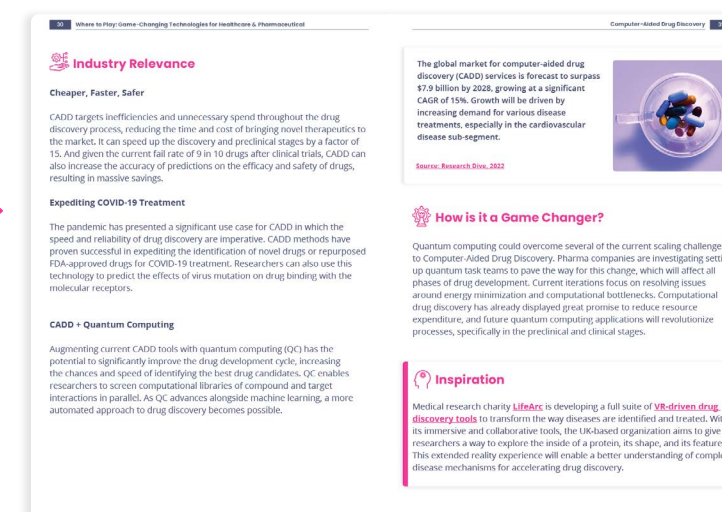
In the navigation bar, the  icon will bring you back to the Table of Contents page. The  button will open up the individual element in the ITONICS **Teaser Technology Radar**. Here you can deep dive into the Implications for Innovation associated with the Technology and view the interconnected elements that influence and impact it, including related Trends, Inspirations, and other Technologies.

 The **Technology Ratings** look at the parameters of Scope, Potential Impact, Complexity, and Technology Readiness Level (TRL).

 **Related Trends** show the elements that are influenced by and have an influence on the Technology, its development, and adoption. This network provides greater context as to the interplay between elements and points to possible opportunities.

 **Industry Relevance** unpacks the industry-specific applications and potential use-cases that are most prominent with regard to the Technology. Each point looks at the strategic advantage gained through adoption of the Technology and the considerations for its future development.

 **How is this a Game Changer?** elaborates on how the Technology may contribute to or influence possible future scenarios. The relationship between the Technology and nascent demands is explored through a future-oriented lens.

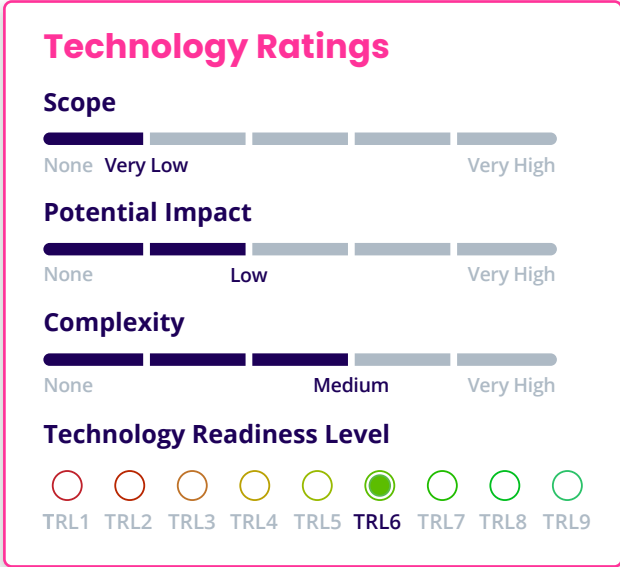


 **Inspirations** provide evidence of how organizations are applying the Technology in the real world. They serve as springboards for ideation, helping innovators look beyond their category, connect information in new ways, and nurture fresh thinking.

ITONICS Ratings

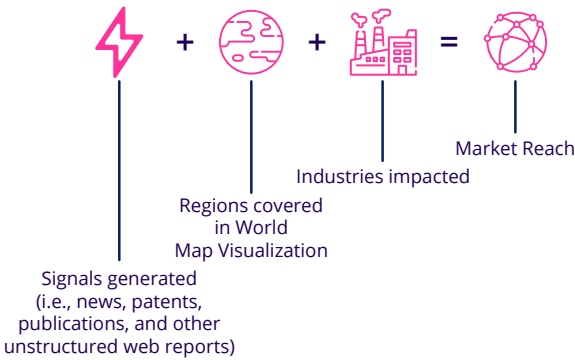
The evaluation of trends or technologies is one of the most important activities in innovation management. The goal is to predict future changes in your industry and whether they are relevant to your organization.

ITONICS Trends and Technologies are presented with ratings that help foresight teams focus their attention and identify relevance based on their unique set of strategic objectives.



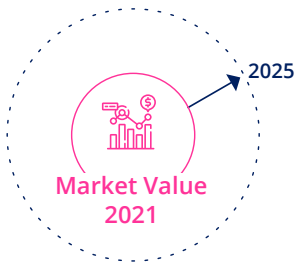
Scope: How far-reaching is the potential influence of this element on this market?

ITONICS Insights tool uses keywords to retrieve data across three dimensions and derive an aggregated mean value to indicate the market reach of each Technology.



Potential Impact: How high is the potential impact of this element on the market?

Market growth data for each Technology is collected from a minimum of 5 verifiable sources, aggregated and extrapolated to 2025.



Scale: Projected market value in 2025 (USD billion):

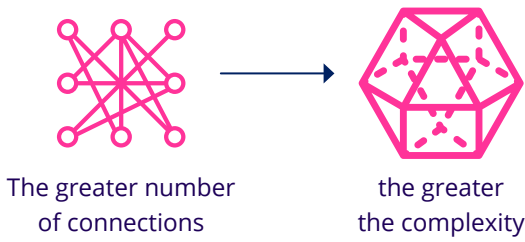
- Very Low: >10 bil.
- Low: 10-50 bil.
- Medium: 50-500 bil.
- High: 500-1,000 bil.
- Very High: >1,000 bil.

Our team of analysts uses advanced query and **ITONICS Insights** to garner the relevant information alongside our research and statistically derive the ratings from quantifiable historical and present data.

Each Technology is rated on Scope, Potential Impact, Complexity, and Technology Readiness Level (TRL) to provide targeted and tailored analysis at your fingertips.

Complexity: How high is the complexity of this element?

A complexity score is derived based on the number of connections each Technology forms with other elements.



Technology Readiness Level (TRL): How mature is this element in the market?

Each Technology is mapped by its Technology Readiness Level (TRL) to determine its relative maturity.

PHASE	TRL	DEFINITION
RESEARCH	1	Basic principles observed
	2	Concept formulated
	3	Experimental proof of concept
DEVELOPMENT	4	Validated in lab
	5	Validated in relevant environment
	6	Demonstrated in relevant environment
DEPLOYMENT	7	System prototype demonstrated in operational environment
	8	System complete and qualified
	9	Actual system proven in operational environment

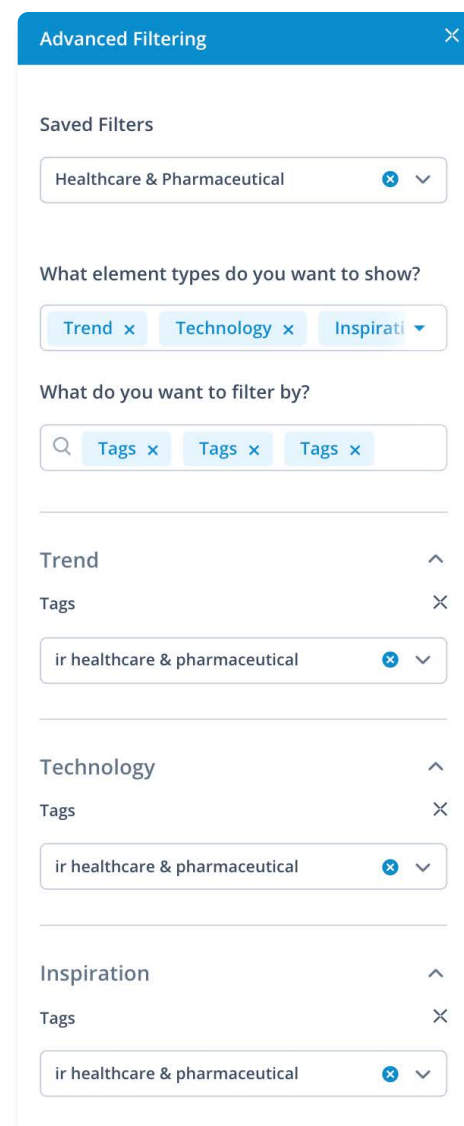
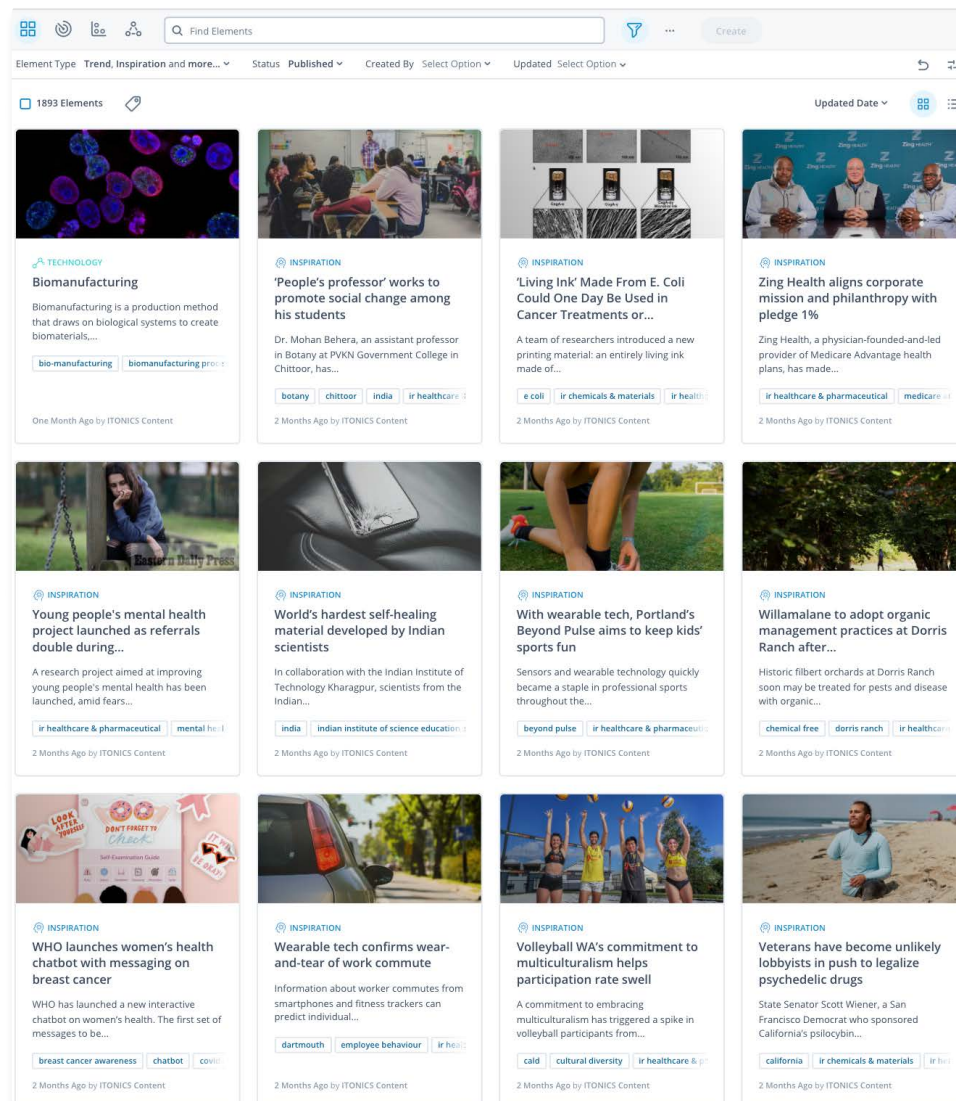
Exploring the ITONICS Radar

Having the right tools to manage innovations, technologies, projects, and opportunities is vital to act on your organization's innovation strategy in an increasingly uncertain and dynamic world. After all, what you can't manage, you cannot change.

Get started by exploring the ITONICS [Teaser Technology Radar](#) and [Teaser Trend Radar](#), displaying the elements that are most relevant

to your industry. Here you will find a read-only overview of each Technology and Trend.

Beyond what's available in the Teaser, the full content on the ITONICS Innovation Platform provides deeper insight into each Technology. It allows users to interact with and configure different elements to derive greater meaning and prompt informed decision-making.



The ITONICS Innovation Platform provides access to:

- The full portfolio of **175+ Trends and Technologies**, each with detailed explanations of how they have developed, where they are currently having an impact, and how they could evolve into the future.
- 7,000+ Inspirations**, continually updated to illustrate how Trends and Technologies are being activated and brought to life by innovators, businesses, and consumers.

- The ability to set **Internal Ratings** such as Business Relevance, Strategic Fit, Internal Know-How, and Need for Action. Undertaken as a collaborative evaluation exercise within your organization, these ratings help build the consensus and commitment needed in the innovation journey.

- Interactive **Network Graph** visualizations that display first- and second-level relations for a selected element. New relations that hold strategic relevance to your organization can also be added to any network graph.

Various **Tags** attributed to each element to help users focus their searches. A **Tag Filter** function allows advanced searching by tags and gives suggestions for related tags. To view the Trends, Technologies, and Inspirations that are most relevant to food & drink, use **Advanced Filtering** and select the **Saved Filter: Healthcare & Pharmaceutical**.

For full access to this content and functionality, register an account on ITONICS Cloud for free today.

REGISTER

Forces Shaping the Future of Healthcare & Pharmaceutical

Context of Change

Defining the objectives and scope of environmental scanning activities like technology scouting requires a clear understanding of the context of change in your industry. Context provides a foundation for identifying and assessing the driving forces shaping the future. It points to evidence of where we see change happening in social, technological, economic, environmental, and political spheres and where the change will expand to next. It is the landscape upon which trends and technologies play out; the ability to navigate this landscape is the ability to adequately prepare for possible futures.

Forces Shaping the Future

Around the globe, several driving forces are impacting the healthcare & pharmaceutical industry. The pandemic continues to dominate health systems and direct the outlook of many organizations. It has accelerated and amplified many trends—from telemedicine and remote patient monitoring to the use of advanced analytics and artificial intelligence in clinical decision-making. And although the path to systemic change is long, there is a growing acknowledgment of the myriad and interrelated social determinants of health. These are positive, if not necessary, shifts as the industry confronts rising chronic diseases, aging populations, and health inequities.

Here we'll discuss some of the forces shaping the future of the healthcare & pharmaceutical industry.

THE COVID-19 CRISIS

will continue to stress healthcare systems.

The healthcare & pharmaceutical industry has seen massive changes during the pandemic, some progressive—like the precedent-setting vaccine development and increased virtual care—and many others adverse. Hospitals, healthcare workers, and both the physical and mental health of the general population are all taking strain. In the US alone, nearly half a million healthcare workers have left their jobs since early 2020 ([The Wall Street Journal, 2022](#)), creating staffing shortages that further exacerbate the problem. The pandemic is also linked to a sharp increase in behavioral and mental health issues in kids and young adults. Meanwhile, medical mistrust is high, particularly regarding the COVID-19 vaccine.

PROACTIVE PATIENTS

will seek greater autonomy and choice.

People are increasingly advocating for healthcare on their own terms. Along with the pandemic, this trend has fuelled the adoption and advancement of telehealth. Leveraging mobile video conferencing, IoT, and advanced analytics, telehealth is a cost-effective alternative or supplement to traditional care. The pervasiveness of “quantified self” and connected self-tracking devices will further accelerate the field of remote patient monitoring, diagnostics, and treatment. Online pharmacies are also gaining popularity, offering greater value, choice, and on-demand delivery options. As a result of these shifts, big tech disruptors and startups are vying for market share while incumbents scramble to meet new patient expectations.

III DIGITAL HEALTH SOLUTIONS

will give rise to diverse digital health ecosystems.

Advancements in predictive analytics and artificial intelligence enable medical professionals and scientists to make decisions with greater speed and acuity. AI platforms connect data and insights across an often-fragmented landscape, facilitating optimized workflows like precision treatment, diagnostic medical imaging, and drug discovery. While the industry has been progressively adopting digital solutions for the last several years, the pandemic pushed digital transformation from an opportunity to an imperative. Now, digital health ecosystems are emerging that integrate networks of health service and technology providers. These new ecosystems are rich with opportunities, and cross-industry players, including big tech, banks, telco companies, and retail conglomerates, are all looking to compete.

IV HOLISTIC APPROACHES

will become increasingly integrated into healthcare.

The shift from mainstream, Western medicine towards holistic health has been underway for many years. Only more recently, however, have health service providers started integrating this thinking into their practices. A new, more holistic picture of health is emerging, comprising physical, mental, social, and environmental determinants. During the pandemic, in particular, mental and behavioral health has come into stark focus. In response, there has been greater acknowledgment of the interconnectedness of emotional needs and factors such as sleep, nutrition, exercise, and work-life balance. This has dovetailed with the rise in alternative channels and forms of treatment, including telemedicine, meditation apps, CBD products, and psychedelics.

V GLOBAL HEALTH

will demand transformation of public health systems.

Many global health indicators are improving—life expectancy is rising, child and maternal mortality are down, and medical science is advancing rapidly. But even in developed nations and with increased prosperity, not all trends are positive. Chronic diseases like obesity, diabetes, and cardiovascular disease have been rising over the past 30 years ([The Lancet, 2020](#)). These comorbidities, in turn, have left afflicted adults more vulnerable to COVID-19 and exposed public health failures in tackling many of these preventable and treatable critical risk factors. Add to this an aging global population, and the increasing demand for public health services will call for greater funding, strong political commitment, and better data and technology.

VI HEALTH EQUITY

will require organizational and systemic change.

The pandemic deepened long-standing inequalities in access to healthcare based on social determinants such as race, gender, economic stability, and health literacy. Issues of health equity have come to the fore along with the underlying drivers, including structural flaws in the health system and systemic and unintentional bias. These biases can wind up encoded in data models and analytics tools when left undetected, thereby perpetuating existing health inequities. Healthcare & pharmaceutical organizations must strive to advance health equity, beginning with internal change and promoting diversity and inclusion within their own workforce. Designing for equity and acting as advocates for systemic change in the communities they serve are also key actions required by industry leaders.



Use this context to help better understand the strategic importance and innovation opportunities associated with the game-changing technologies identified for the healthcare & pharmaceutical industry.

Game-Changing Technologies for Healthcare & Pharmaceutical

Technology Navigation

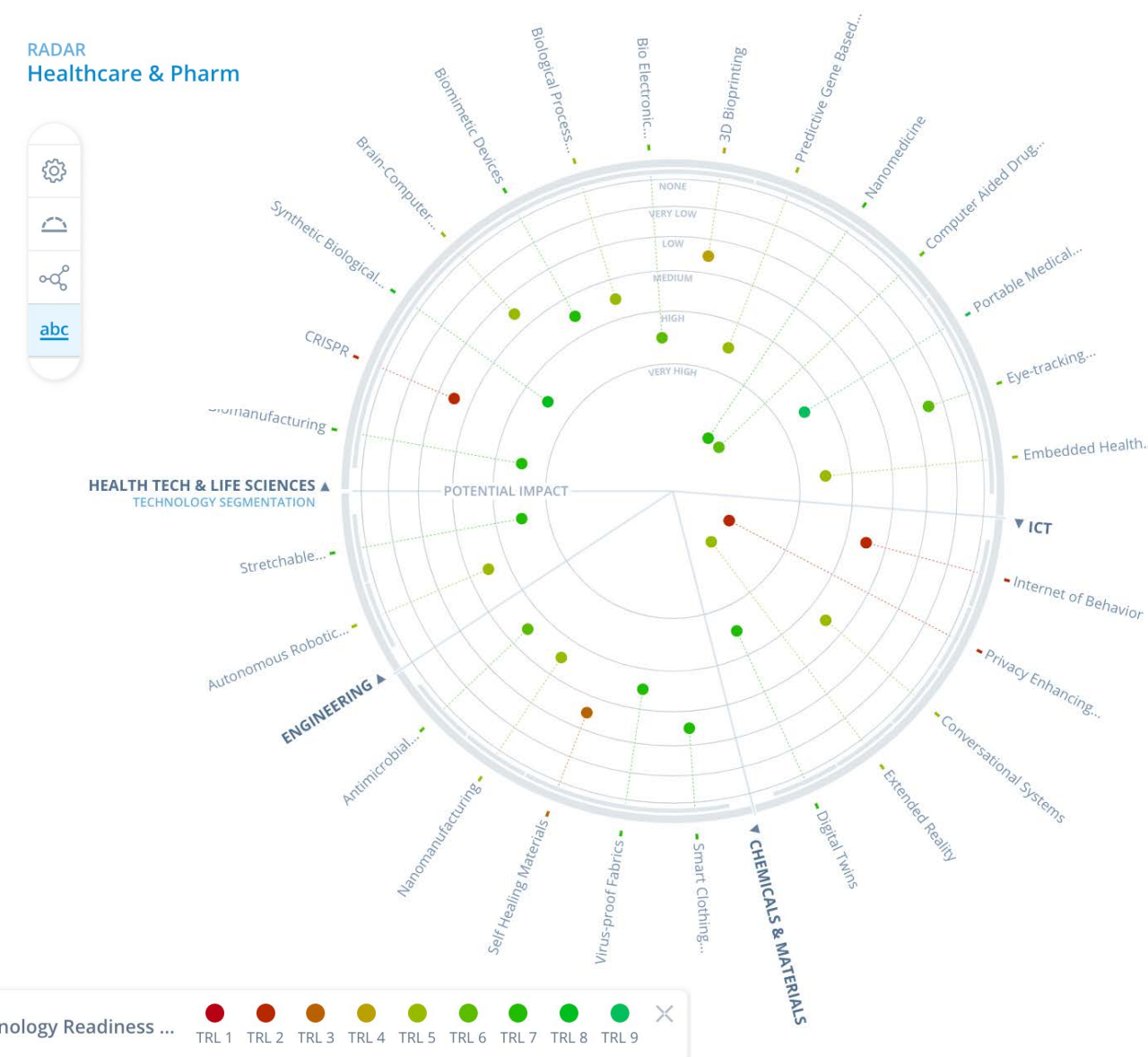
Through a process of qualitative and quantitative industry research, our team of analysts conducted relevance analysis in order to identify the Technologies within our portfolio that are **most relevant and influential in the healthcare & pharmaceutical industry**.

Game-Changing Technologies for Healthcare & Pharmaceutical

Explore the selection of Technologies at play in the healthcare & pharmaceutical industry. Click on the Technology below to view it in the ITONICS [Teaser Technology Radar](#):

- [3D Bioprinting*](#)
- [Antimicrobial Packaging](#)
- [Autonomous Robotic Surgery](#)
- [Bio Electronic Medicine](#)
- [Biological Process Identification & Modelling](#)
- [Biomanufacturing](#)
- [Biomimetic Devices](#)
- [Brain-Computer Interfaces](#)
- [Computer-Aided Drug Discovery*](#)
- [Conversational Systems](#)
- [CRISPR*](#)
- [Digital Twins](#)
- [Synthetic Biological Engineering](#)
- [Embedded Health Monitoring Sensors](#)
- [Extended Reality](#)
- [Eye-Tracking Technology](#)
- [Internet of Behavior](#)
- [Nanomanufacturing](#)
- [Nanomedicine*](#)
- [Portable Medical Devices*](#)
- [Predictive Gene-Based Healthcare](#)
- [Privacy Enhancing Technologies](#)
- [Self-Healing Materials](#)
- [Smart Clothing Technology](#)
- [Stretchable Electronics](#)
- [Virus-Proof Fabrics](#)

*These Technologies make up ITONICS' pick of the healthcare & pharmaceutical industry's top 5 game-changing Technologies. These are unpacked in further detail in this report.



ITONICS Top 5 Game-Changing Technologies for Healthcare & Pharmaceutical

Click below to read more about the industry potential of these Technologies and examples of how organizations are applying them as solutions:

1. [3D Bioprinting](#)
2. [Computer-Aided Drug Discovery](#)
3. [CRISPR](#)
4. [Nanomedicine](#)
5. [Portable Medical Devices](#)

▼ HEALTH TECH & LIFE SCIENCES

BIOTECHNOLOGY

3D Bioprinting

3D Bioprinting combines molecular genetics, cell biology, and engineering to produce living tissue through biomaterial deposits that are layered from bio-ink. Bio-ink consists of human cells and is often combined with additional materials to create 3D cell cultures. Bioprinters have been used primarily for medical research and, in some cases, for implantable therapeutics. The technology addresses the demand for human organs in transplant patients and developing living functional tissue for regenerative medicine. Although acceptance is growing among medical experts, this scaffold-based printing approach still faces many challenges. Printing speeds, biocompatibility, and quality controls remain obstacles to higher adoption.



Technology Ratings

Scope



Potential Impact



Complexity

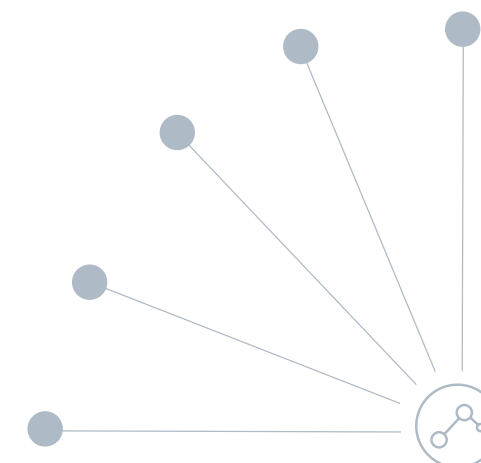


Technology Readiness Level



Related Trends

- [Aging Reinvented](#)
- [Bio Futures](#)
- [Human Optimization](#)





Industry Relevance

Ethical Pharmaceutical Testing

Researchers are developing bioprinted tissue, miniature cellular models, and organs-on-a-chip for use in testing pharmaceutical candidates. By mimicking the biology of human organs, bioprinted models can provide more accurate results on the efficacy of different drug therapies and dosages, removing the need for animal testing and other current, often costly, experimentation methods.

In Vivo Minimally Invasive Bioprinting

Intracorporeal tissue engineering is emerging as a minimally invasive laparoscopic option for many procedures. This involves bioprinting tissue scaffolds inside a living patient, bypassing the risks associated with surgically implanting fabricated tissue, such as infection and increased recovery time. The robotic direct-write 3D printing technique also employs a unique interlocking method to strengthen the attachment between the scaffolds and tissue.

Transplant Potential

Advancements in 3D bioprinting hold the potential for building and customizing complex tissue, including skin, cardiac, bone, and cartilage. This could help mitigate the organ transplant shortage, and using a recipient's host cells in the process decreases the risk of rejection. However, there are several obstacles to overcome, such as improvements in the ability to replicate minute details, regulation, and scalability.

"We will see fully functioning organs within the next decade or so. As of now, the industry is progressing at a steady pace due to the democratization of 3D bioprinting technology."

— Erik Gatenholm, CEO of CELLINK

[Source: The Medical Futurist, 2021](#)



How is it a Game Changer?

3D Bioprinting holds the potential for fabricating entire human organs as well as human body parts. While the technology has not yet matured to offer these solutions, demand will drive innovation. Injury recovery could be sped up and require fewer medical resources as concepts like spray-on cells for healing and regeneration gain traction. The nature of many surgical procedures will change due to this technology, and regulation and public opinion will have to align to ensure safe and ethical usage.



Inspiration

Researchers at the University of Virginia have developed a [new 3D bioprinting method](#) known as DASP (Digital Assembly of Spherical Viscoelastic Bio-Ink Particles). Drawing inspiration from the video game Minecraft, DASP creates cellular structures and tissues from biosynthetic "voxels" or small cubes. This offers greater structural versatility and more accurately mimics the body's natural conditions compared to current bioprinting techniques in which filaments are stacked layer by layer.

▼ HEALTH TECH & LIFE SCIENCES
HEALTHCARE DELIVERY

Computer-Aided Drug Discovery

Computer-Aided Drug Discovery (CADD) offers powerful ways to make modern drug discovery more cost-effective and reduce the time to market. This technology incorporates a multi-target drug design approach by combining the knowledge of complex disease networks and the chemical and physical characteristics of existing drugs and biological receptors. Computational methods are used to create interactions between molecules and targets to predict binding affinities. The accessibility of supercomputers, parallel processing, and advanced software has propelled the technology forward. Leading pharmaceutical companies and research groups are employing it to utilize more extensive information in modeling innovative drug candidates against various diseases.



Technology Ratings

Scope



Potential Impact



Complexity



Technology Readiness Level



Related Trends

- [Evidence-Based Value](#)
- [Proactive Health Enforcement](#)



Industry Relevance

Cheaper, Faster, Safer

CADD targets inefficiencies and unnecessary spend throughout the drug discovery process, reducing the time and cost of bringing novel therapeutics to the market. It can speed up the discovery and preclinical stages by a factor of 15. And given the current fail rate of 9 in 10 drugs after clinical trials, CADD can also increase the accuracy of predictions on the efficacy and safety of drugs, resulting in massive savings.

Expediting COVID-19 Treatment

The pandemic has presented a significant use case for CADD in which the speed and reliability of drug discovery are imperative. CADD methods have proven successful in expediting the identification of novel drugs or repurposed FDA-approved drugs for COVID-19 treatment. Researchers can also use this technology to predict the effects of virus mutation on drug binding with the molecular receptors.

CADD + Quantum Computing

Augmenting current CADD tools with quantum computing (QC) has the potential to significantly improve the drug development cycle, increasing the chances and speed of identifying the best drug candidates. QC enables researchers to screen computational libraries of compound and target interactions in parallel. As QC advances alongside machine learning, a more automated approach to drug discovery becomes possible.

The global market for computer-aided drug discovery (CADD) services is forecast to surpass \$7.9 billion by 2028, growing at a significant CAGR of 15%. Growth will be driven by increasing demand for various disease treatments, especially in the cardiovascular disease sub-segment.

[Source: Research Dive, 2022](#)



How is it a Game Changer?

Quantum computing could overcome several of the current scaling challenges to Computer-Aided Drug Discovery. Pharma companies are investigating setting up quantum task teams to pave the way for this change, which will affect all phases of drug development. Current iterations focus on resolving issues around energy minimization and computational bottlenecks. Computational drug discovery has already displayed great promise to reduce resource expenditure, and future quantum computing applications will revolutionize processes, specifically in the preclinical and clinical stages.

Inspiration

Medical research charity [LifeArc](#) is developing a full suite of [VR-driven drug discovery tools](#) to transform the way diseases are identified and treated. With its immersive and collaborative tools, the UK-based organization aims to give researchers a way to explore the inside of a protein, its shape, and its features. This extended reality experience will enable a better understanding of complex disease mechanisms for accelerating drug discovery.

HEALTH TECH & LIFE SCIENCES BIOTECHNOLOGY

CRISPR

Gene-editing technology enables the modification of an organism's DNA sequence through addition or deletion. The majority of research has centered on applications such as human disease prevention and disease resistance in plants. Recent advances in CRISPR technology are expanding the impact beyond medical and agricultural applications to include biofuels and food. Clinical trials are applying gene editing to develop pharmaceutical solutions, and the technology has paved the way for a variety of innovations. Various technical limitations currently exist alongside significant ethical concerns primarily related to the technology's future uses in humans.



Technology Ratings

Scope



Potential Impact



Complexity

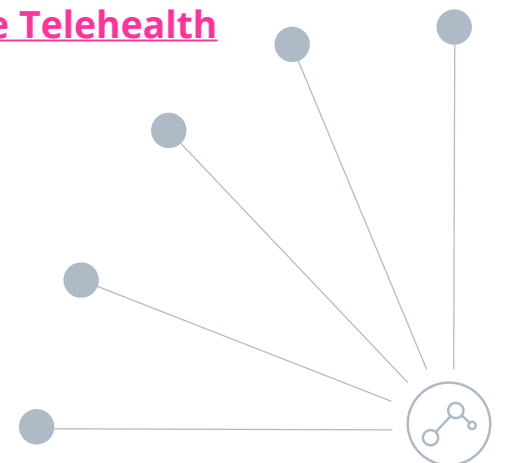


Technology Readiness Level



Related Trends

- [Aging Reinvented](#)
- [Bio Futures](#)
- [Human Optimization](#)
- [Responsible Telehealth](#)



Industry Relevance

Accessible Diagnostic Testing

CRISPR can improve access to diagnostic testing for consumers and in places where medical resources are low. A CRISPR diagnostic test can detect infectious and non-infectious diseases using an individual's saliva, blood, or urine. As the technology develops further and becomes cost-effective and commercially available, it will be possible to purchase these tests at a local drugstore and self-administer them at home, giving individuals greater control over their personal health.

Disease Treatments & Cures

CRISPR represents a versatile solution for treating and even curing many human diseases. While previous treatments only address the symptoms of genetic diseases, CRISPR could allow scientists to edit the genetic mutations that cause these diseases, and there are promising results from sickle cell and beta thalassemia clinical trials. CRISPR is also changing cancer treatment because of its ability to modify immune cells to recognize and attack cancerous cells more effectively.

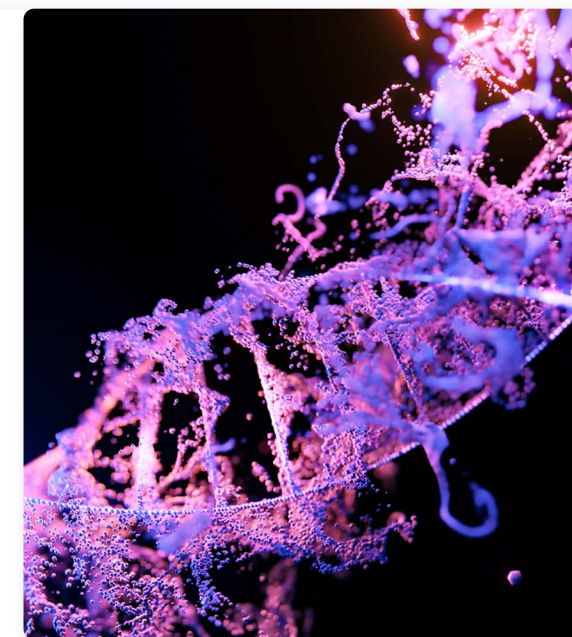
Eliminating Insect-Borne Diseases

Research is ongoing on the use of CRISPR gene drives to reduce or eliminate insect-borne diseases like malaria, dengue fever, and yellow fever. This involves transmitting genetic modifications through an insect population, rendering it incapable of further spreading harmful pathogens. This technique has great potential for managing mosquito-borne diseases but remains controversial due to ethical and environmental concerns.

“As an industry, we have to look for other ways to really achieve results in areas of high unmet medical need. These areas of proteonomics, cell therapies, gene therapies, gene editing allow us to attack diseases in a different way. Until five to 10 years ago, a lot of these things were not possible.”

— Marianne de Backer, Executive Vice President of Strategy at Bayer

Source: [Investors Business Daily, 2022](#)



How is it a Game Changer?

Gene-editing technology will continue to create innovative ways to answer specific human problems. It also has the potential to reverse species extinction by reviving species through cloning. This concept will likely be explored in the quest to improve human longevity and counter age-related diseases. However, these advances will invariably be accompanied by ethical concerns relating to applications that intersect with eugenics—such as the use of gene-editing technology to purge “undesirable” traits or create “ideal” specimens.



Inspiration

A team of bioengineers from Stanford University has developed an efficient, multi-purpose, **mini CRISPR system** referred to as CasMINI. This smaller version of the genome engineering tool is better suited for delivery into human cells and tissues for gene therapy and may also reduce immune reactivity complications in patients.

▼ HEALTH TECH & LIFE SCIENCES

HEALTHCARE DELIVERY

Nanomedicine

Nanomedicine refers to the application of nanotechnology in the field of medicine. It uses nanoscale materials like biocompatible nanoparticles and nanorobots to diagnose, deliver, monitor, treat, and repair biological systems. This technology can enable a more personalized, predictive, regenerative healthcare system. Although nanomedicine is still in its infancy, it is gaining traction in the treatment of cancer, Parkinson's disease, Alzheimer's, diabetes, orthopedic diseases, and several other diseases related to blood, lungs, and the cardiovascular system. However, the high cost of nanoparticle-assisted medicine compared to its conventional counterparts and strict regulatory issues could impede the growth of Nanomedicine.



Technology Ratings

Scope



Potential Impact



Complexity

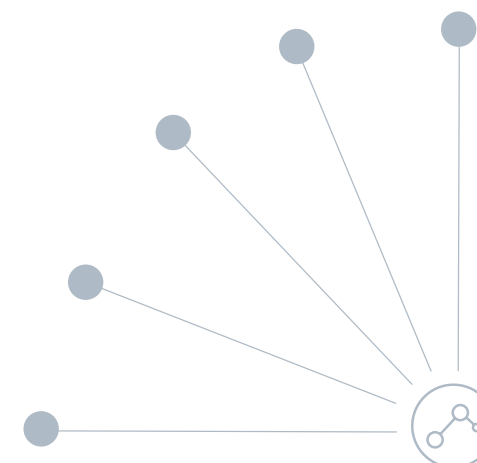


Technology Readiness Level



Related Trends

- [Proactive Health Enforcement](#)
- [Quantified Self](#)



Industry Relevance

Smart Pills

Smart pills, developed using nanotechnology, enable highly targeted sensing, imaging, and drug delivery. Advanced functions include dose-tracking, gas monitoring in the human gut, microneedles for delivering insulin and other drugs, and capsule endoscopy performed by tiny cameras. The growing preference for non-invasive procedures will drive the growth of smart pills. Currently, however, their cost remains prohibitive for many applications.

Miniature Surgeons

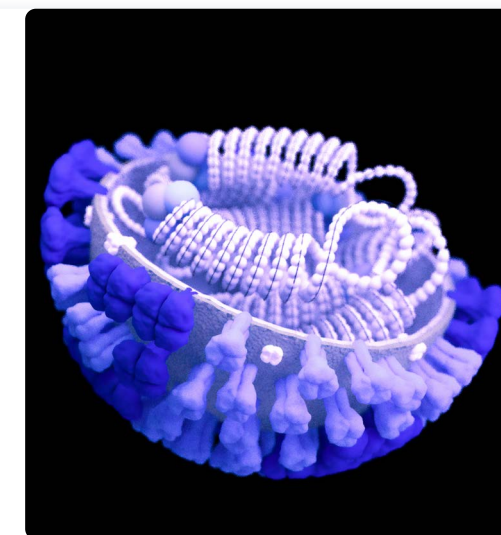
Research and development are ongoing on the application of nanobots in minimally-invasive, cellular-level surgery. These micro-scale surgeons can repair and replace intracellular structures in the body, perform biopsies, and clear arterial blockages. Scientists are also working on DNA-based nanobots that have the potential to target specific disease cells, replace DNA molecules, and correct certain genetic deficiencies.

Nano-enabled Wearables

Nanomaterial-based wearable sensors are gradually gaining prominence in healthcare. These devices can be embedded in smart textiles and other wearable devices to provide real-time diagnostic monitoring and issue alerts about changes in the body. Developers are investigating how to best integrate these nanotechnology monitoring solutions with other IoT devices to generate better insights. However, users will need reassurance of data privacy and ethics standards.

The global nanomedicine market is forecast to grow at a CAGR of 11.6% and reach over \$390 billion during the period of 2022 to 2027. Rising rates of cancer and cardiovascular disease, as well as significant government investment in nanomedicine research in the United States, will drive expansion in this field

Source: [Expert Market Research, 2022](#)



How is it a Game Changer?

Nanomedicine holds the potential to disrupt the field of healthcare, particularly in terms of treating rare and incurable diseases. This branch of nanotechnology and nanoscience could target diseases at the cellular level, creating new prospects for individualized healthcare. Medical science is moving towards incorporating nanoparticles into drugs to make dosages more precise and effective, thereby reducing possible side effects from inaccurate dosages.

Inspiration

Researchers at Penn State have produced a **nanoscale 'computer'** capable of controlling the function of a specific protein responsible for cell adhesion and movement—the initial steps in the development of metastatic cancer. Referred to as a cellular computer, this method marks a major milestone in the prevention and treatment of cancer and other diseases.

▼ HEALTH TECH & LIFE SCIENCES
MEDICAL DEVICES & DIAGNOSTICS

Portable Medical Devices

Portable Medical Devices are used for monitoring and managing medical conditions. Technology using 3D and 4D printing, miniaturization, and wireless connectivity enables remote healthcare that empowers patients and optimizes doctor-patient interactions. These easy-to-use devices increase patient engagement and improve treatment by incorporating AI and IoT. As the demand for remote healthcare grows in response to the pandemic, a rise in chronic disease, and the high cost of healthcare, these devices are shifting the point of care to the individual. A wide range of devices are already available, and many more are being developed. However, adoption among medical professionals remains relatively low.



Technology Ratings

Scope



Potential Impact



Complexity

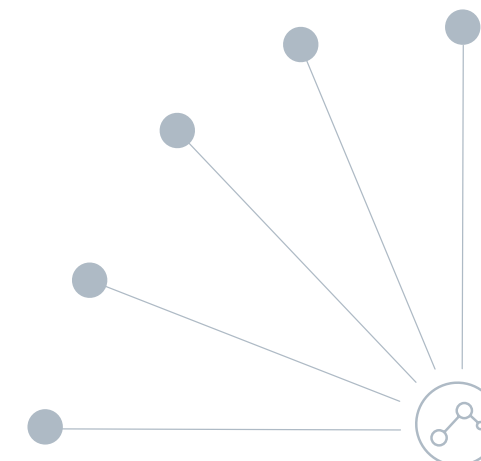


Technology Readiness Level



Related Trends

- [Proactive Health Enforcement](#)
- [Responsible Telehealth](#)



Industry Relevance

Rapid, Point-of-Need Diagnostics

With advances in biotechnology, image analysis, and microfluidics, scientists are developing portable medical devices to screen thousands of pathogens within minutes. This will revolutionize surveillance and contract tracing of infectious diseases. The portability and speed of these devices enable near real-time detection at the point of need. However, real-time monitoring is subject to wireless telecommunications infrastructure, which may not be feasible in more remote locations.

A Portable Bioluminescent Platform

Researchers are developing a portable bioluminescence imaging tool that can be used for in vivo monitoring of biological processes in humans and animals. This technology presents a minimally invasive way to monitor various metabolic functions and responses to treatment. Due to its mobility and cost-effectiveness, it also has high potential for use in biomedical research, translational medicine, and clinical diagnoses.

Software as a Medical Device

Software as a Medical Device (SaMD) refers to software that performs medical functions without being part of or supporting a hardware medical device. SaMD serves as a medical device in and of itself for the purposes of diagnostics, disease prevention, treatment, etc. It is, therefore, inherently mobile, and because there is no special hardware needed, SaMD benefits from faster feedback loops and product innovation.



Valued at \$37 billion in 2019, the global portable medical devices market size is forecast to surpass \$85 billion by 2027, growing at a CAGR of 11.35%. Advancements in technologies like IoT and big data analytics will contribute to this growth.

Source: Precedence Research, 2021



How is it a Game Changer?

Remote and underdeveloped regions will benefit immensely from portable medical devices. This technology could democratize healthcare, and several tech giants are already making inroads into digital health markets. Technology companies will have to partner with healthcare industry players to ensure functional and safe concept translations as development and testing are often far more rigorous within the health industry. AI, IoT, cloud systems, and 3D and 4D printing will continue to shape the future of digital healthcare as well as patient expectations.



Inspiration

Australian-based EMVision Medical is developing a **portable brain scanner** to perform rapid, bedside neuro-imaging to inform clinical decision-making and intervention. This groundbreaking, point-of-care solution will be available for use in ICUs, stroke and neurology wards, angiogram suites, and emergency departments in 2023.

Conclusion

Closing Remarks

The past few years have created the perfect breeding ground for innovation in the healthcare & pharmaceutical industry. Demand for enhanced, personalized, and holistic care—delivered in new and convenient formats and environments—is meeting a whole host of emerging and evolving technology solutions.

As in most other industries, digital transformation is a growing imperative throughout the healthcare & pharmaceutical value chain—from rapid diagnoses to patient care to public health monitoring. The industry is embracing data analytics-driven, virtual, and remote methods. The result is a gradual shift from fragmented, opaque, and one-size-fits-all health systems to integrative health ecosystems—offering a better quality of treatment for a greater number of people.

Improving access to accurate diagnostics is a key challenge for public health systems. In addition to its many other promising applications, **CRISPR** provides a diagnostic testing solution for areas where medical resources are low. The CRISPR test can be made available over the counter and self-administered. Likewise, **Portable Medical Devices**—when combined with biotechnology like CRISPR and other advances—are capable of real-time, point-of-need diagnostics.

Pharmaceutical companies are also infusing technology throughout their workflows, leveraging artificial intelligence (particularly deep learning) to support **Computer-Aided Drug Discovery**. These same companies are investing resources in researching quantum mechanics capable of accelerating drug discovery to previously unimaginable levels.

The healthcare & pharmaceutical industry has also made immense progress in precision medicine and understanding how an individual's genes, behaviors, and environment affect their health. This has coincided with developments in

Nanomedicine, including nano-scale wearables, precision drug dosages with nanoparticles, and the ability to target diseases at a cellular level.

Similarly, **3D Bioprinting** could revolutionize injury treatment and transplant surgery due to the customization of complex tissue using a recipient's host cells. Much like Nanomedicine, 3D Bioprinting has scalability challenges to overcome before it becomes widely available and cost-effective, but it too offers exciting prospects for individualized healthcare.

Within this context of change, we provide a set of questions for organizations in healthcare & pharmaceutical to consider in the hope of nurturing fresh thinking about the future they wish to be a part of and play an active role in helping to create.

- What if CRISPR is clinically proven and easily accessible in the fight against complex diseases such as cancer?
- What if healthcare becomes further decentralized, available via virtual consultation with medicines seamlessly delivered to a patient's home?
- What if unmanned health kiosks offer remote diagnosis and automated medication dispensers for common ailments to relieve pressure on health systems?
- What if quantum computing unlocks the full potential of computer-aided drug discovery?
- What if all health data is tracked on an individual and population level using wearables or embedded sensors?
- What if healthcare systems dedicate more funds to the prevention of ill health rather than treatment, taking the social determinants of health into account.

There are countless questions to be asked about what the future holds for food & drink. Finding possible answers to these questions requires a systematic approach and a structured innovation strategy.

The Way Forward

Create a future competitive advantage tomorrow by defining your strategic direction today.

Making better decisions for tomorrow relies on an organization's ability to collect, understand, and act on innovation intelligence—the multitude of building blocks that make up an organization's innovation process.

Scouting the trends, technologies, startups, and other forces of change that are shaping your industry is a crucial first step in this process. But turning this information into innovation intelligence, and subsequently into action, requires additional steps and capabilities that fall within Foresight and Strategy.

Taking Trends & Technologies to Opportunities



1. Discover ITONICS Trends



2. Build Internal Consensus



3. Develop Pictures of the Future

1. Discover ITONICS Trends

Supplement the insights gained in this industry-relevant technology report with an immersion into the trend landscape.

Get started by exploring the ITONICS [Teaser Trend Radar](#) displaying the elements that are most relevant to your industry.

For a full view of the trend landscape, our [Where to Play 2021+ Trend Report](#) contains the complete ITONICS Trend portfolio, presenting 90+ Trends with real-life inspirations and rich analysis.



DOWNLOAD NOW

2. Build Internal Consensus

In establishing **Where to Play**, it is essential to gain consensus and raise alignment within your organization. This can be achieved through a process of collaborative evaluation. Invite internal stakeholders and experts to participate in rating elements—trends, technologies, scenarios, opportunities, etc.—based on unique industry- and company-specific parameters.

When undertaken in the environmental scanning stage, an internal rating exercise helps empower teams with the consensus needed to ensure strategic relevance, strengthen buy-in, and act decisively.

ITONICS has provided the following internal rating criteria for organizations to consider for trends and technologies:

Technologies

- Technology Attractiveness: How high is the potential value of the technology?
- Internal Know-How: How much internal know-how does your business possess with regard to this element?
- Need for Action: How important is it that your organization take action with regard to this element?

Trends

- Business Relevance: How relevant is this element to your business?
- Strategic Fit: How well does this element fit into your organization's overall strategy?
- Need for Action: How important is it that your organization take action with regard to this element?

The ratings above are pre-set in the ITONICS Showroom. However, organizations can tailor rating criteria to align with their own set of needs and workflows.

3. Develop Pictures of the Future

It's not enough to identify the trends, technologies, disruptive startups, and other drivers of change that are relevant to your industry and organization. To develop an innovation strategy that remains effective beyond the time horizon of key drivers, organizations need to develop realistic and plausible pictures of the future in which these various drivers will unfold. This is done through a process of **scenario planning** and is the basis for discovering future opportunities upon which to act.

Scenario planning is a strategic tool commonly used by key decision-makers, innovation leads, and strategists to find focused foresight, grounded in dependable analysis. This equips them to anticipate exposures appropriately, evaluate innovation opportunities, and inform proactive responses.

What is a scenario?

In the context of business planning and strategy, a scenario is a postulated sequence or combination of events projected to take place that could hold relevance to an organization's future state.

Developing plausible, actionable scenarios requires a systematic approach and organizational participation. It builds on the internal rating exercise, which serves to identify those trends and technologies that hold the greatest strategic relevance and potential. From here, your organization must derive the underlying drivers that are influencing its business environment and extrapolate the different trajectories each driver could take.

Plotting these trajectories against one another and engaging your team's collective and creative input reveals multiple scenario narratives. While each narrative represents a possible future for which your organization may need to prepare, internal consistency and strategic objectives point to those scenarios that should be prioritized.

Your team should prioritize the scenarios they feel hold the most strategic relevance by asking the following two questions:

- Is this a future we hope to play an integral role in creating and shaping?
- Is this a future we hope to mitigate and avoid through thoughtful tactics?

The selected scenarios form a foundational springboard from which your organization can best derive and define clear opportunities—i.e., possible solutions or responses to the various scenario narratives. Use the **ITONICS Roadmap** to plot critical scenario events and develop a timeline of innovation activities required to explore the various opportunities ahead of the horizon in which they are set to occur.

In this way, scenario planning provides organizations with the information required to act on opportunities timeously—as well as the evidence needed to develop appropriate capabilities and assets, actively shape our world, and influence outcomes as they steer towards the future.

To further your innovation journey, all the Trends, Technologies, and Inspirations selected as most relevant to the healthcare & pharmaceutical industry can be found on the ITONICS Innovation Platform using the saved filter: [Healthcare & Pharmaceutical](#).

The ITONICS solution supports end2end innovation management, from environmental scanning and trend and technology management to building internal consensus and roadmapping.

REGISTER



About ITONICS

We build AI-powered SaaS to innovate, grow, and disrupt.

Our data-driven software platform helps organizations around the globe to identify emerging technologies, trends, and market potentials and translate them into powerful growth strategies.

Supported by artificial intelligence, companies can manage their entire innovation process in a modular software suite to efficiently achieve their business goals and remain future-proof.

Working with global teams to innovate new products, services, and business models, ITONICS professional services inspire, guide, and accompany organizations on their innovation journey. With more than 115 experts on four continents, we support innovation leaders such as adidas, AUDI, CISCO, Intel, Johnson & Johnson, and SAP.

As a strategic partner to key market players across all industries, we systematically advance the topics of innovation, strategy, and digitalization.



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What's Next

Turn Innovation Intelligence into Action

Your digital toolbox for game-changing innovation ▪ Industry-specific Trend and Emerging Technology Radars ▪ Strategic Roadmaps that guide you into the future ▪ Lean Portfolios to manage ideas, technologies, projects, and opportunities	Free access to inspiring insights & content updates ▪ Access to 6 million+ signals to uncover insights at large scale ▪ 90+ Trends, 85+ Emerging Technologies updated annually ▪ 7,000+ freshly curated inspirations maintained	Dependable thought leadership & advisory services ▪ Free innovation maturity assessment ▪ Exclusive access to COFIM Masterclass content ▪ Access to our international innovation community
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You can find us around the globe



ITONICS is a leading SaaS provider of systematic innovation management. The ITONICS Innovation OS combined with a systematic framework to steer innovation efforts helps companies to identify emerging technologies, trends, and market potential and to translate them into customized growth strategies.

With more than 150 experts worldwide, we support innovation leaders such as adidas, AUDI, BMW, CISCO, Intel, Johnson & Johnson, and KPMG.

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