Accenture Biopharmaceutical
Technology Vision 2022

Meet Me in the Metaverse

The continuum of experience and technology, transforming biopharma

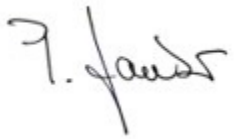
Foreword

Biopharma has changed forever.

In the last decade, biopharma has experienced extensive innovation-driven transformation. The pace of change was particularly accelerated by the COVID-19 pandemic, spanning the entire ecosystem from drug discovery to development to patient journeys. With the introduction of metaverse technologies, biopharma can continue to create robust, meaningful experiences for all stakeholders.

Imagine a world where a patient journey starts at disease prevention or risk prediction, not at diagnosis. A world where product testing can be done on digital twins, rather than living beings.

We see the metaverse as a clear and present priority, and biopharma leaders must prepare. Biopharma companies will need to consider how to adjust their businesses to the continuum of rapidly emerging capabilities, use cases, technologies and experiences. Given its importance to the welfare of all humanity, we must seize the Metaverse Continuum opportunity to ensure that it is developed with responsibility at the core. From ownership of data to inclusion and diversity, to sustainability and through to security and personal safety, the work starts now.



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Biopharma's new prescription: transform how business is done

A DEFINING MOMENT FOR ALL LEADERS

The biopharma industry is on the threshold of a new decade of digital transformation. The **Metaverse Continuum** will transform how businesses interact with customers and how work is done. Our survey of 100 biopharma executives confirms this with 85 percent saying the metaverse will positively affect their organizations—well above the 72 percent average for other industries.

It will profoundly affect what medicines and services companies offer, how they make and distribute them and how they fundamentally operate their organizations. Patients and biopharma employees can expect vastly more personalized experiences, with the lines between virtual and real-world experiences blurred into a unified metaverse reality.

The Metaverse Continuum– touching all of business (and life)

The "Metaverse Continuum" incorporates all digitally enhanced realities—both social and business-related. It touches all patients, healthcare professionals and enterprises – from reality to virtual and back. Like two hemispheres of a brain, the Metaverse Continuum uses a million connections to bring virtual and reality together.

Eventually this spectrum of ideas will coalesce into a more broadly unified experience, but the range of business areas that it will impact will only grow. Just as the internet evolved beyond simple websites to underpin most of today's businesses, it would be wrong to think the experience of the metaverse will be constrained to digital space.

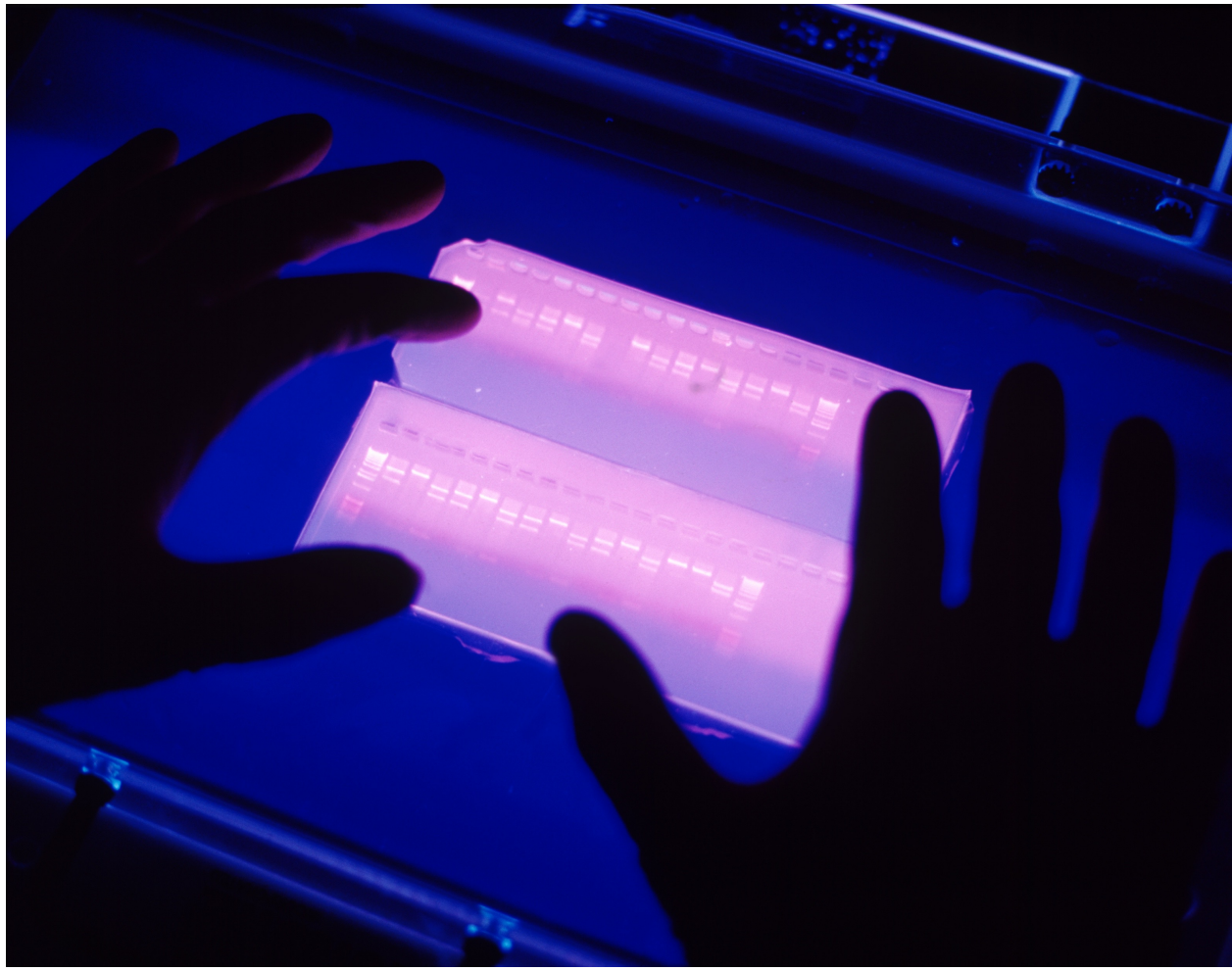
That is why we've introduced the Metaverse Continuum. Accenture looks at the metaverse as an evolving and expanding continuum on multiple dimensions because it:

- Comprises multiple technologies including extended reality, blockchain, artificial intelligence, digital twins, non-fungible tokens and smart objects – including cars and factories, and edge computing.
- Encompasses the 'virt-real' – the range of experiences, from purely virtual to a blend of virtual and physical.
- Describes the spectrum of emerging consumer experiences and the enterprise applications and models that will be reimagined and transformed.

Where new worlds are taking shape

Leaders need to pause and reimagine how they will approach their business for the next decade – which worlds they will define and design and what roles they will play in each world: What could your role be in creating a secure and trusted patient experience, and shaping the future of interaction with patients and providers? Could you become a leader in bringing your corporate values of trust, security, privacy and safety to the metaverse?

While we are in the early days of the metaverse, it will advance very quickly. If companies don't act now, they'll find themselves operating in worlds designed by, and for, someone else. In this Technology Vision, we explore how today's technology innovations are the building blocks of our future. The trends investigate the entire continuum, from the virtual to the physical, across patients and machines alike. They identify where ambitious companies can find rich opportunities by uprooting themselves from today and planting themselves firmly in the future.



Our Four Technology Trends for 2022

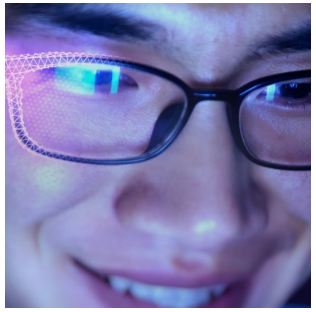
Accenture has identified four key technology trends for 2022, and in this report, we provide a customized view of how they apply to biopharmaceutical companies.

WebMe

Illustrates how the internet is being reimagined with the metaverse as an experience layer and Web3 as a new distributed data layer. In the metaverse, rather than viewing digital content, people will be present with it. With Web3, data will move with the person and not the platform.

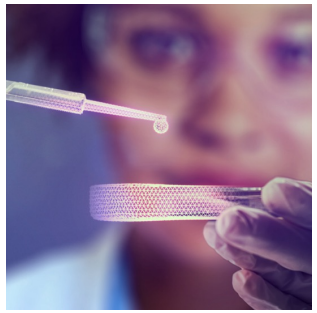
Programmable World

Tracks how technology is being threaded through our physical environments in three layers: connected, experiential and material. 5G, ambient computing, augmented reality, 3D printing and smart materials are converging in sophisticated ways, turning the physical world into an environment that is as smart, customizable and as programmable as the digital one.



The Unreal

Explores the 'unreal' qualities that are becoming intrinsic to artificial intelligence, and even data, making the synthetic seem passably authentic. Synthetic data and synthetic content can be both helpful and harmful, so we must look through a continuous lens of verifying authenticity.



Computing the Impossible

Outlines the outer limit of what is computationally possible as a new class of computing machines emerge with a new curve of compute capability to tackle grand challenges that once seemed insurmountable.

Trend 01

WebMe

Putting the Me in Metaverse

WHAT IT MEANS FOR BIOPHARMA

Metaverse and Web3 innovations are transforming the fundamental underpinning and operation of the virtual world. Instead of the internet as a disparate collection of sites and apps, metaverse efforts envision a persistent 3D environment, imbued with a sense of place, where moving from work to a social HCP collaboration platform is as simple as walking from the office to the cafeteria on the first floor. Web3 further shapes this evolution by introducing a data framework that generates veracity, trust, and even scarcity – things we've long had conventions for in the physical world but have in many ways evaded us in the virtual ones.

The Metaverse Continuum and Web3 innovations have huge potentials to transform the biopharma industry from the bottom up. Importantly, Web3 also fundamentally changes the relationship between people and platforms, as well as how businesses engage with their customers, stakeholders, patients and business partners across digital spaces. Blockchain and non-fungible tokens (NFTs) can revolutionize our industry, solving traditional supply chain and manufacturing problems and creating new marketing opportunities. Monetizing health data through NFTs can incentivize patients to sell their information. Biopharma companies could buy information tailored to their needs and save money that would otherwise be spent on 'dummy data'. NFTs provide safe, transparent data exchange and could improve public trust in the biopharma industry. It will be important to define a patient-centric digital trust strategy centric that gives people control of their health data and experience as you start your journey into the Metaverse.

The metaverse could also change the reality of clinical trial participation. Anyone could be part of ongoing global clinical trials at any point. Wearables, implantables and other sensors could make large-scale decentralized trials a reality, with real-time trial data seamlessly accessible to the right people in the right format, across the globe.

95%

of biopharma executives agree that future digital platforms need to offer **unified experiences**, enabling interoperability of customers' data across different platforms and spaces.

98%

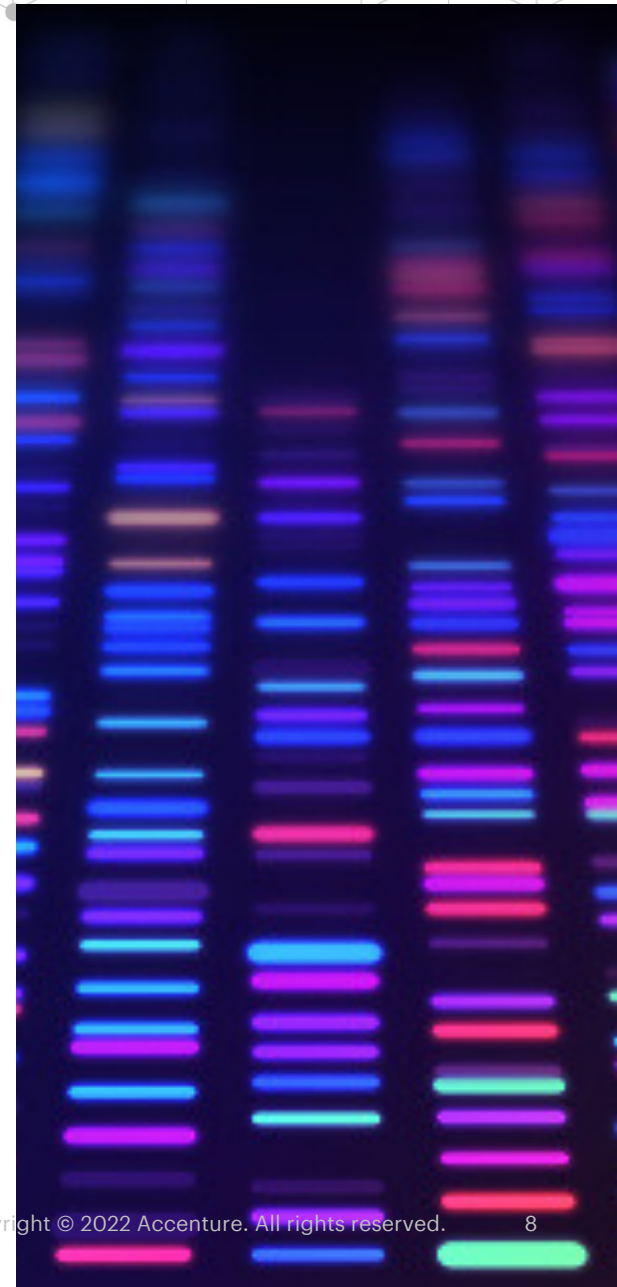
Said that the **realization of Web3** over the next decade will fundamentally change how businesses engage with users online.

The metaverse will drive collaboration across healthcare professionals (HCPs) in a 'world' where HCPs can 'gather' to study and learn from one-another's patient cases across institutions and across the globe. This 'meta–tumor board' would allow professionals to share images, blood tests, patient medical records and even 'hear' from the avatars of patients on their individual care journeys—to prevent and cure at speeds never possible before.

However, a word of warning is necessary. Just as early innovation in this space can carry outsized value, it can carry outsized risk as well. Leaders are not just pioneering a new digital future, but a new future for human and enterprise interaction, and many of the rules remain undefined. It is critical that enterprises take steps to proactively shape the 'Responsible Metaverse'.

Though today's solutions may sometimes seem too futuristic, niche, or disjointed, they are broader signals indicating the next digital revolution is beginning to appear on the horizon. The biopharma industry challenges with interoperability and data access across the different constituents of the ecosystem, can be addressed with Web3 in new ways, with newer channels of access, direct engagement with patients, with the patient's comfort of knowing that they are the ones in control of the information shared in that relationship. Similarly, biopharma companies looking to share access between systems, or transact between different metaverses, will need a trusted layer to navigate across those ecosystems.

Keep in mind: A holistic talent strategy, that includes development and retention, is a critical component to reap the full potential from the metaverse. Biopharma companies should explore upskilling existing employees through vendor-based training and build familiarity and skills with the metaverse and Web3 platforms they intend to use.



WEBME IN ACTION

Medable and Science37 [1] form the backbone of a new generation of digital trial capabilities in the market. They expand on passive data capture through monitoring and diagnostic devices. In the future, a new generation of digital devices will integrate into the metaverse. The next wave could include smart technology like Alexa or PlayStation®, everyday objects like home appliances that provide salient data on healthy human behaviors and medically regulated devices such as **Donisi**. In this context, the metaverse will add vast amounts of new data to monitor health (and mood), which could also be linked to new digital biomarkers as technology allows for increasingly complex ongoing monitoring.

Acoer, a leading developer of real-time blockchain-enabled software, launched a decentralized software engine called RightsHash. The engine allows individual consent to participate in a clinical trial to be managed and tracked using NFTs.[2]

Trend 02

Programmable World

Our Planet, Personalized

WHAT IT MEANS FOR BIOPHARMA

Disruptive technologies like extended reality (XR) and 5G will challenge existing business models in biopharma by providing targeted, accurate solutions that go beyond two-dimensional technologies. When digital capabilities are woven into the very fabric of the world, the physical world becomes as smart, customizable and programmable as we expect the digital one to be. To meet our new expectations, biopharma companies will need a deep understanding of three layers that comprise the programmable world: **the connected, the experiential** and **the material.**

> 89%
>
> *of biopharma executives believe that programming the physical environment will emerge as a competitive differentiation in their industry.*

The first layer of programmable world technology is the focus on creating a connected foundation. 41% of the biopharma executives we surveyed say the number of IoT/edge devices deployed in their organization has significantly or exponentially increased in the past three years.

The next layer of the programmable world is experiential. It has the ability to sense and change its own characteristics; digital twins and augmented reality are core constituents of this layer.

Biopharma companies have yet to extract the full potential of digital twin technology, even in the manufacturing space. XR and digital twins for enhanced consumer and marketing engagement are already being piloted, especially in the learning and knowledge sharing area. Digital twins hold great promise in therapeutic areas requiring high-quality, multi-dimensioned clinical trial and real-world. Augmented reality (AR) is another potential game changer applied across the value chain (including clinical trials, manufacturing, sales and marketing, patient education, etc.). In fact, 80 percent of biopharma executives say that AR will disrupt the industry in the next three years.

The final layer of the programmable world is material and constitutes how things are made. It includes a new generation of digital manufacturing and smart materials, which will bring programmability into the physical aspects of our environments. Bioprinting (the process of creating cell patterns in a confined space using 3D printing technologies, thereby preserving cell function and viability within the printed construct) is already a reality, and a great example of this third programmable layer.

Bioprinting[3] of tissues and organs eliminates transplant rejection and test patient-specific immunologic responses. In terms of drug discovery, the arrival of players like **DeepMind**[4], whose AlphaFold technology can accurately predict 3D models of protein structures, has the potential to revolutionize the process. With the metaverse as a foundation, automation and cloud computing could enable virtual, global gatherings[5] in meta-labs to conduct experiments, share real-time insights and lab instruments, and conduct impact analysis across geographical locations and time zones.

The connected, experiential and material layers of the programmable world will enable new ways to augment, customize, automate, alter and otherwise 'program' our physical environments for HCP, patient and enterprise applications—and they will introduce an entirely new competitive landscape for the biopharma industry. Ten years from now, we can expect to see the programmable world offer new opportunities for HCPs and providers to blend their services for further differentiation and better service.

Keep in mind: Have product and services teams begin planning for the compound risk of new services and integrated experiences in a shared supply chain. Assess how this can change the risk exposure of those initiatives.

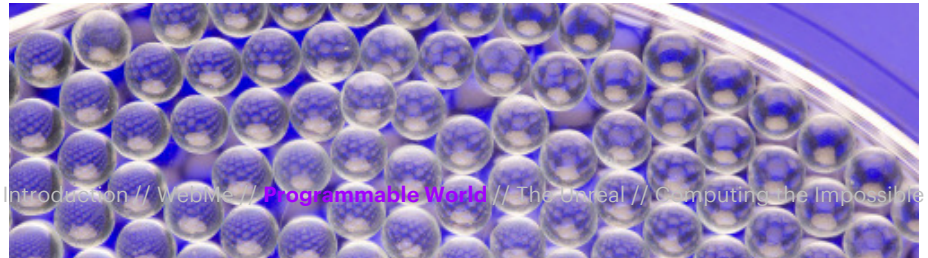
92%

of executives agree that leading organizations will push the boundaries of the virtual world to make it more real, increasing the need for persistence and seamless navigation between the digital and physical worlds.

PROGRAMMABLE WORLD IN ACTION

Sanofi's Framingham Lighthouse facility is a digitally enabled, continuous manufacturing facility to achieve high sustainability goals. Virtual twin technologies optimize remote manufacturing using real-time data capture and analysis.[6] The whole industrial process is digitalized and paperless, and it is 80-times more productive than a traditional factory. Within the facility, observed performance indicator improvements include 80 percent reduction in energy consumption and CO2 emissions per year; 91 percent reduction in water footprint; 94 percent reduction in use of chemicals and 321 tons of waste reduction per year.

Q Bio is building a digital twin platform that might negate the need for regular, in-person medical checkups. Its Q Bio Gemini digital twin[7] "automatically reflects an individual's most accurate physiological state in the form of a digital twin", highlighting the most important changes in a person's anatomy and biochemistry. Data on important changes and individual risks can be automatically flagged and shared with healthcare professionals (across the globe, if necessary) to enable preventative or acute care at important moments in time.



Experiential augmented and virtual reality can enable a new generation of drug manufacturing that go well beyond two dimensions. In the biologics and genomics space, in partnership with the **National Institute of Bioprocessing Research and Training** (NIBRT)[8] in Ireland, Accenture has developed a digital twin to optimize the growth of Chinese hamster ovary (CHO) cells in a bioreactor to produce Monoclonal Antibodies (mAbs). CHO cells are the powerhouses that fuel the production of many biologics drugs on the market today. Essentially, a factory inside a factory, each CHO cell contains the genetic code for the active ingredient of the drug being manufactured. The cells' own architecture provides the equipment to manufacture the drug, harvesting the required raw materials from its environment inside a bioreactor and converting them into to mAb. This process is more complicated in reality than described above and there are multiple points where the biology of the cell can result in the production of a protein which is similar to, but not the same as the mAb required for the drug, causing low yields during manufacturing.

By taking advantage of the biological processes described in genomic, transcriptomic, and proteomic experimental research papers, **Accenture and NIBRT** are able to create a dataless digital twin to optimize cell growth and mAb production without having to gather the historical data from drug development. The metabolic and biological processes which can result in the production of undesired proteins are well understood and have been described using mathematical equations in the scientific literature. Built entirely using these publicly available mathematical equations for the metabolic processes occurring inside the cell to convert nutrients to mAb, the digital twin is able to game out cell growth, antibody production and overall yield in response to changes in the nutrients provided to the cells during growth. The overall aim of this cell growth digital twin is to allow scientists to identify the best combinations of nutrients and environment recommended by the simulation and then to validate the recommendation with real-world lab-based experiments.

Trend 03

The Unreal

Making Synthetic, Authentic

WHAT IT MEANS FOR BIOPHARMA

We are entering a world with synthetic realness, where AI-generated data convincingly reflects the physical world. In this world of synthetic data, the biopharma industry stands to gain many benefits: faster, better trials, enhanced pharmacoepidemiology, more ambitious cross-border research, eased patient burden and reduction in cost. Synthetic data is very handy in the context of costly, time-intensive clinical trials in fields like oncology. Depending on the therapeutic area, treatment modality and disease complexity, the cost of bringing a new treatment to market is between $2.6B and $6.7B (including the cost of capital and cost of failure).[9] Using synthetic data for the control arm substantially reduces the demand for patient recruitment, saving time and resources. The number of patients needed for a clinical trial is a key factor driving the cost and duration of clinical development. The use of a synthetic control arm instead of a patient cohort receiving standard of care reduces the patient burden of participation in clinical trials.[10]

Biopharma companies are also realizing the significant value artificial intelligence (AI) can add to their core businesses - like patient support services and sales. Our survey shows that 92 percent of executives say their organizations depend on AI to function effectively. This is far higher than the 80 percent average response from other industries. In addition, 97 percent of executives agree that AI is becoming pervasive across their organization's business processes. At the same time, there is a growing concern about authenticity, deepfakes and disinformation attacks, and 100 percent of biopharma executives report concerns about it. Biopharma companies can use AI to detect fraudulent claims and assess member risk by visually mapping patients, providers, pharmacies and claims to groups of claims that indicate unusual behavior. This is growing in importance as state and local governments are increasingly seeking to hold drug companies accountable for drug abuses.[11]

Keep in mind: Differentiate your use of unreal world technologies from those of threat actors and build trust with patients and partners by having a clear and communicated purpose. Give people the ability to attest to the genuineness of your company and its outputs.

Using generative AI in an authentic way means taking heed of provenance, policy, people and purpose. By observing these four tenets, healthcare organizations can gain confidence not only in their decisions to trust others, but also in their use of generative AI such that others can trust them.

Provenance

One way to verify the provenance of digital content and identity – thereby demonstrating authenticity – is through use of distributed ledger technology (DLT). No matter what technologies you use, establishing provenance will be critical as your organization increasingly deals with potential deepfakes and disinformation – and enabling others to establish provenance as they interact with your business and content will be just as important, too.

Policy

Prepare to deal with the challenges that arise with the use of AI. Take stock of the policies your business must adhere to with respect to generative AI specifically. Much of this space is yet to be defined, so where there isn't guidance, you'll need to define your own policies based on your services, products, customers and most importantly, values.

People

Having these governance structures in place is imperative to handle the inherent risks baked into the unreal world in healthcare. Decide, for example, who is responsible for having these tough conversations and what committees are drafting internal policies? Who will be held accountable if privacy is compromised or patients or members feel duped? Finally, who will be the point person responsible if your organization falls prey to a deepfake or disinformation attack?

Purpose

Define the purpose behind the use of synthetic data and content. What are the key metrics that can demonstrate the advantage of synthetic over nonsynthetic content? For instance, if your organization uses a chatbot simply to cut costs (as opposed to improving availability), there's a good chance it's not living up to its intended purpose of serving people. However, if the purpose of using synthetic data in a model is to insert counter bias, thereby improving the output of the model, then it could be an authentic use of generative AI.

THE UNREAL IN ACTION

The National Institute of Health (NIH) in the U.S. is using a synthetic data engine to create and validate an anonymous copy of its COVID-19 patient database—which lists more than 2.7 million screened individuals and more than 413,000 COVID-19-positive cases. The synthetic data engine[12] is owned by **Syntegra**, an IT services startup and makes an exact copy of the original data—sans any original, identifiable information. That means it can be distributed for researchers around the world to better understand COVID-19 and speed up the development of vaccines and treatments.

Roche entered into a collaboration with **Bristol Myers Squibb**[13] to support the advancement of two assays for use in clinical trials with the development and deployment of two new digital pathology algorithms. Roche Digital Pathology is creating an AI-based image analysis algorithm to aid pathologists in interpreting the assays. Bristol Myers Squibb will use this algorithm to generate biomarker data from clinical trial samples. Data from both projects will be used to aid in cancer diagnosis and to advance personalized healthcare treatment options.

The **University of Florida Health** and **NVIDIA** have created SynGatorTron™, an AI tool that generates synthetic patient data that is used to train the next generation of medical AI systems to understand conversational language and medical terminology.[14] These types of tools will be key contributors to medical chatbots that communicate with patients just as simply as Siri does.

Trend 04

Computing the Impossible

New Machines, New Possibilities

WHAT IT MEANS FOR BIOPHARMA

Computational power has the potential to significantly accelerate, enhance the quality, and reduce the costs of data-rich R&D processes. 94 percent of biopharma executives say that their organization is pivoting in response to the unprecedented computational power that is becoming available. Three sets of new computing machines are emerging: high-performance computers (HPCs), bio-inspired and quantum.

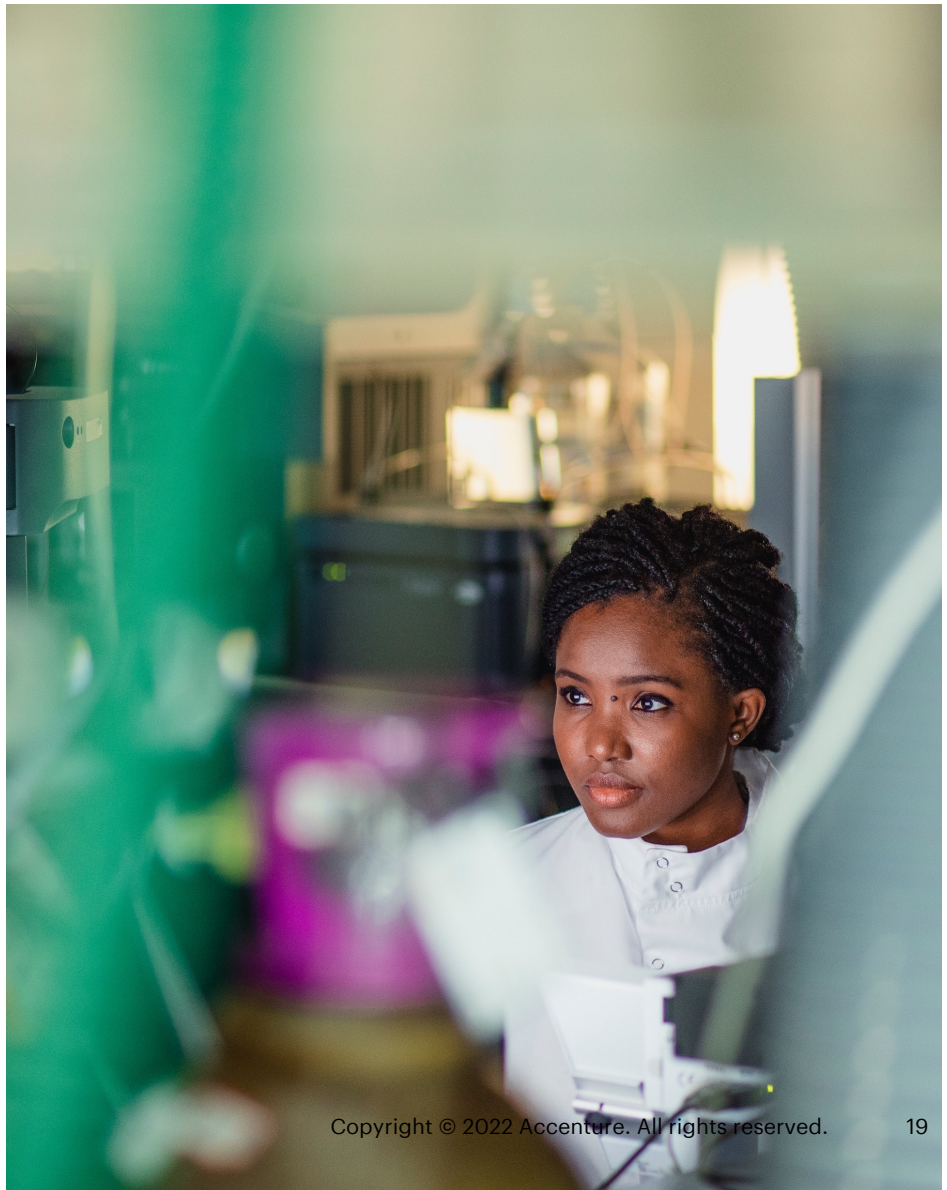
HPCs driving increasing computing power will enable AI's application to drug discovery, translating complex biological problems into computational ones. Various small AI-drug discovery companies and biopharma leaders leverage omics and AI to deepen the understanding of the disease mechanisms to identify new or better targets. In addition, they screen compounds to select drug candidates by using predictive methods. Accenture is investing in quantum in healthcare by way of The Good Chemistry Company platform, which combines cloud, AI and quantum computing in an integrated platform designed for developers.[15] The platform's engine enables faster, more accurate and scalable ways to simulate chemistry, which can accelerate pharmaceutical drug discovery.

Biopharma executives recognize that next generation of computing has the potential to address previously unsolvable problems:

99%
Quantum

98%
High-performance computers

97%
Bio-inspired computing



The promise of the AI-drug discovery methodologies is to accelerate timelines of drug discovery and develop drug candidates that are less likely to fail in clinical trials. At the same time, we are beginning to see the real fusion between biology and machines – where machines don't just mimic biological operations, but directly leverage biological processes. At the forefront of this space is data storage. In our survey, 61 percent executives say bio-inspired computing will have a breakthrough or transformational positive impact on their organizations in the future, far exceeding the 23 percent average response from other industries surveyed.

One such world is DNA of things, where DNA becomes a storage device for digital information with an order of magnitude shift in storage and processing capacity. When process logic moves to a cellular level, a new class of biological computers can be used to store digital assets.

This could become the dominant data technology—and it would likely be made by life sciences companies rather than technology giants.

Keep in mind: Identify opportunities to leverage new computational powers for your cyber defence capabilities.

COMPUTING THE IMPOSSIBLE IN ACTION IN BIOPHARMA

Bio-inspired computing is a new territory in healthcare, but many organizations are beginning to explore it. **George Washington University** is helping to open the door to bio-compute through the BioCompute Object Specification Project, which is an informal community that aims to streamline data and workflow exchange between the FDA, researchers, pharmaceutical companies and bioinformatics technology developers.[16] A recent research project illustrated that a BioCompute Object (BCO) can capture the data processing workflow and facilitate the submission of analyses to the U.S. Food and Drug Administration.

Western Digital, Microsoft, Twist Bioscience, and **Illumina** have partnered to launch the DNA Data Storage Alliance to create standardization and definitions in the field of DNA data storage–with the goal of developing cost- and energy-efficient commercial archival systems.[17]

Cambridge-1 is the UK's most powerful supercomputer, and it was designed and installed by NVIDIA with the entire healthcare ecosystem in mind. The project's founding partners—**AstraZeneca** and **GlaxoSmithKline**—are already using the machine to create a generative AI model for chemical structures and to accelerate the time to market for new medicines using predictive modeling respectively.[18]

A significant future role for AI is drug discovery. An artificial intelligence (AI) network developed by Google AI offshoot **DeepMind** has made a gigantic leap in solving one of biology's grandest challenges—determining a protein's 3D shape from its amino acid sequence. DeepMind's program, called AlphaFold, is an AI tool that predicts the structure of proteins. Deepmind recently announced the release of predicted structures for nearly all cataloged proteins known to science - over 200 million structures. The breakthrough could allow biologists from around the world to understand diseases better and develop new drugs.[19]

The reality of the Metaverse Continuum in biopharma

The continuum from reality to virtual may seem futuristic, but it's standing at the front door. The following three personas bring light to the way roles within a biopharma organization can improve and expand within the metaverse.

Meet Reyhana | The researcher

Reyhana is a biopharma oncology researcher at the University of Cape Town, South Africa. Traditionally she's undertaken drug research, development and testing using the facilities, equipment and available sample populations in her immediate surroundings. She would have found new therapeutic candidates based on the resources in her department, and her productivity would have been limited by the financial resources of her university or grant provider.

THE FUTURE

The Metaverse Continuum presents Reyhana with a world of possibilities. Suddenly the discovery phase is boosted with deep, broad standardized and consent-based data shared from all prior clinical research. It's combined with scientific literature and population health data to develop deep learning algorithms that identify new drug applications and candidates.

AI automatically identifies the most appropriate peers to collaborate with, and AR enables virtual precision oncology conferences with laser-like precision at short notice compared to the lead times required to travel to international conferences in the legacy world. Once 'there', Reyhana discusses possible therapies with a significant group of the world's leading precision oncology experts. The most promising candidate therapies identified are immediately explored using cloud-hosted simulations in virtual meta-labs. The simulations generate real-time insights and conduct impact analyses without the physical constraints of geographical location, time zones or instrument availability.

Reyhana creates digital twins of the therapy's potential target patients, and even entire health ecosystems, to evaluate the therapy's impact, potential drug interactions. She synthetically tests and identifies the best candidates to progress to physical world clinical trials. The metaverse approach holds fantastic promise in therapeutic areas requiring high-quality, multi-dimensioned clinical trial and real-world data.

It's also no problem to fast track the clinical trial. Once the candidate therapy has been developed, Reyhana bypasses the challenges of funding and getting ethical approval for traditional double-blind, placebo-controlled clinical trials—by using synthetic data. The synthetic data allows faster, 'bigger' and more diverse trials. Where human trial candidates are required, remote sensors (like wearables), telemedicine and home drug printing mean virtual/decentralized clinical trials dramatically reduce costs and improve patient experiences. A thrilling consequence of metaverse efficiency and insights is that research into rare diseases becomes far more possible, and previously unserved patient needs can be met. The enhanced pharmacoepidemiology, greater cross-border applicability, eased patient burden and reduced cost mean Reyhana will develop many more, and more effective, in her lifetime.

Meet Max | The supply chain worker

Max leads a major European biopharma company's supply chain operations team. The Metaverse Continuum presents him with a profound question—how to optimize and manage a supply chain that cuts through both virtual and physical worlds. The supply chain he manages has varying degrees of technology access and sophistication across its global footprint. How can he embrace and take advantage of the metaverse when his supply chain is digitally disparate? Max's entire world is changing, and he needs to prepare for it.

THE FUTURE

Max's metaverse-driven future is a step-change in terms of ethos and underlying technology. The power of virtual environments, synthetic data, in-silico digital twins and next generation computing technology is revolutionizing his supply chain.

Max and his C-suite could design their manufacturing and warehousing infrastructure (incorporating machines, robots and AI models) in the metaverse before building them in the real world, avoiding expensive iterations.

His factory employee training is migrating from the classroom to complex scenario training in the metaverse which mimics every component of the physical world—before using them on the factory floor. Digital twin technology enables Max to capture and analyze previously unconsidered scenarios. He plays out therapy lifecycles from development to manufacture, seamlessly and taking his operations, planning, management, and engineering teams on the journey. He walks them through complex processes in safe and controlled environments, without impact to actual patients. His team expands its data beyond what is easy or practical to capture in the real world using synthetic data and investigates root causes and rare events before they happen. In this way Max's team predicts imminent disruptions or even prevents them entirely.

Personalized medicine like cell and gene therapy and new treatment center onboarding is much easier given Max's remote support capabilities. He helps new personnel, augments limited teams and finds stand-ins when people are dealing with other priorities. Experts visit the point of care using the metaverse to build knowledge, skills and trust. As he develops new processes, equipment or supply chains for which no data exists, Max creates data-less digital twins leveraging the power of synthetic data and advanced algorithms to model what 'should be' against what 'could be' and compares it to real-world data as it becomes available. In this way, he speeds up time to optimization and diagnosis of root causes.

The metaverse even helps Max monitor reactions to a new environment and refine processes to improve both work/life balance and operational efficiencies (like reducing the stress of limited access to support, and of a challenging environment that takes a long time to enter and exit). These improvements allow him to upskill and reach his personal career objectives through continuous learning.

AI models study shop floor behavior, prevent mistakes and enhance human performance. Max's shop floor operators experience multiple plants in the metaverse to share expertise without the need for travel and accommodation. The same applies between departments, where R&D, commercial and manufacturing teams share knowledge during the product lifecycle and accelerate product launches by understanding different perspectives.

Meet Deepthi | The commercial sales and marketing lead

Deepthi is a Commercial Sales and Marketing Lead at a fast-growing biopharmaceutical company with a focus on market strategy and digital therapeutic offerings. She manages all aspects of the planning and development of resources and strategies to support and drive business. Key responsibilities include aligning with marketing strategies to develop strategic direction and plans in support of the multiple product launches and ongoing sales targets; building and maintaining a team to reach short-term and long-term goals; identifying and leading new business opportunities, and identifying technology/data operations to drive business growth and implement new customer acquisition; and foster relationships and collaborate with disease and patient advocacy groups.

There are several pain points that Deepthi sees as areas of opportunity and she is highly interested in emerging technologies such as VR/AR and mixed reality, which offer an evolution of the internet to move beyond 'browsing' toward 'participating and/or inhabiting' in a shared experience that spans the spectrum of our real world to a fully virtual world and in between. Deepthi believes that these innovative ways of working could create opportunities with improved experiences for patients and HCPs from clinical trials, marketing, market access launch and sales.

THE FUTURE

Experimenting with emerging technologies such as the metaverse allows Deepthi to grow business, drive market and life-cycle management strategies and partner with SMEs. These technological advancements allow her to disrupt the biopharma ecosystem where she can provide personalized experiences, capture real-time data seamlessly and enable HCPs and patients to make informed decisions at accelerated speeds. Deepthi aspires to expand and grow direct to patient marketing and brand influence, similar to retail. She is also using the metaverse to maximize field force effectiveness and invest in using real-world data and translating findings into evidence for improved health outcomes. By identifying key opinion leaders (KOLs) and monitoring social media ecosystems for new thought leaders, Deepthi helps provide real world evidence for patients, providers, caregivers, advocacy groups and stakeholders.

Apart from identifying KOLs, Deepthi could use the metaverse to identify and engage local influencers to create a more differentiated, diverse, inclusive and localized campaigns for HCPs, patients and caregivers. This can provide a unified view of HCP and patient data across the healthcare continuum. Silos are now broken down among groups such as market and salesforce for empowerment and collaboration. The digital space also solves the problem around limited access to clinicians with new ways meet HCPs in a more humanizing way via social channels. This gives patients the ability to see HCPs as people outside of sterile environments, conferences or via email.

The metaverse and emerging technologies have unlimited potential to help Deepthi revolutionize the industry by making collaboration more personal, meaningful and streamlined. This new digital vision can create more connected experiences with improved collaboration between sales and medical teams to enable a new reality for patients, providers, caregivers, advocacy groups and stakeholders.

In a boundaryless environment, disease and patient advocacy groups can feel more comfortable speaking freely, eliminating any biases they might have. Patient education can take a radical leap forward with HCPs being able to receive training to go above and beyond to meet the unmet needs of patients. The metaverse can better engage underserved populations, reduce barriers to entry, reduce costs and streamline clinical trials. Above all, innovative technologies offer a secure space for deep connections that can span the globe and positively impact widespread audiences unlike ever before.

Where should you begin?

Biopharma cannot linger—the Metaverse is here to stay.

In terms of **WebMe**, there are already some standard metaverse use cases that companies can leverage without high levels of risk. For instance, immersive technologies for training or productivity have been tested and experimented with for years. To guide their pilots, businesses should investigate how their enterprise platforms may be holding them, their stakeholders, or their users back. They should empower development teams to design and test new kinds of experiences that eliminate or circumvent these pain points. Finally. They must pay attention to the signals coming from partners and other comparable industry companies. Seek out opportunities for joint investments, like consortiums, with others facing similar challenges to increase collective access to emerging compute.

In the **Programmable World** enterprises need to prepare to adapt over time as new programmable world technologies mature. Investing in digital twin and IoT technologies will position enterprises with the experiential and data foundations they need to rapidly innovate and respond to new developments over time. As this space is still budding, it is critical leaders revise the way they consider return on investment, and what key performance indicators look like. Creating successful pockets of innovation throughout the enterprise will mean creating the space for safe experimentation and the ability to fail fast and iterate, while exploring new avenues for the future.

The Unreal will require exploration of synthetic data. Determine how its advantages could improve existing data strategies, and the algorithms and AI fueled by them like improving data set quality, reducing privacy risk, and correcting for bias present in historic data sets. Identify where unreal content like chatbots or AI-generated images, video, or content could help extend your brand and/or create preferred interactions with customers. Find the ways it can create new avenues of connection with your sales teams, HCPs, planers, other employees to improve the quality of their experiences, and drive new outcomes. Authenticity must become an enterprise-wide priority and a C-suite responsibility for generative AI. Know that regulations are formative in this new territory of the unreal world. Have each of your major enterprise functions identify the existing regulations they must adhere to and close the gaps with internal policies that align to company values. These should be reported up to the accountable C-suite leaders who should maintain a regular agenda item concerning the impact of AI to their business, and how to hold it to a higher standard.

When it comes to **Computing the Impossible**, start making bets on the future of computing. Establish a group to scan and benchmark any developments. Meeting quarterly or semi-annually to match the pace of change in your industry will help you predict which class of machines is likely to impact your enterprise the earliest, and in what way. The new problems that companies can – and will – start to solve are too big for anyone to tackle alone. Partnerships are no longer optional, and enterprises should already be starting to build relationships with next-generation computing providers, which are increasing in number and variety.

While much of this technology is still in the early adopter phase, there are signals that the future world will bring us closer to meeting the unmet needs of patients, employees and HCPs in previously unimagined ways. It will be about putting humanity at the core by designing better experiences for improved outcomes for our patients, improving the HCP experience and having better and more resilient supply chains. Biopharma companies need to build a truly competitive vision – both for what these future worlds will look like and what their enterprise will need to become to succeed in them.

There is a significant technology talent shortage already, and it only gets more severe as technologies and their associated skills become more advanced. Biopharma companies need to create a people strategy that prioritizes skills identification, acquisition and development.

Enterprises that don't start competing for talent soon are setting themselves up to fall behind.

Who better than the biopharma industry to appreciate that they must manage the risks carefully? Leaders are not just pioneering new digital future, but a new future for human and enterprise interaction, and many of the rules remain undefined. It is critical that biopharma companies take steps to proactively and responsibly shape the Metaverse Continuum.

Technology points us in the right direction, but the rest is up to you.

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About the Technology Vision

For more than 20 years, Accenture has developed the Technology Vision report as a systematic review across the enterprise landscape to identify emerging technology trends that will have the greatest impact on companies, government agencies, and other organizations in the coming years. This year the trends look further out into the future than ever before, while remaining relevant across industries and actionable for businesses today.

The biopharmaceutical industry sample comprised 100 executives in eight countries (China, France, Germany, India, Japan, Switzerland, the United Kingdom and the United States). Surveys were fielded in March 2022.

About Accenture

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