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Life Sciences: Navigating the Digital Future

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The Digital Future of Life Sciences

Life sciences is in the midst of a transformative era where digital innovation, data-driven decision-making, and patient-centric technologies are no longer optional – they are the foundation for sustainable success. The sector faces unprecedented challenges: rising regulatory complexity, accelerating technological change, and growing expectations for personalised, sustainable healthcare. At the same time, there are opportunities abound for those who embrace agility, collaboration, and continuous innovation.

'Life Sciences: Navigating the Digital Future' brings together leading voices from industry, academia and technology to explore what digital innovation means in practice. This collaborative perspective moves beyond theory, showcasing how advanced technologies, such as AI, data-driven platforms and patient-centred solutions are transforming R&D, regulatory compliance, and healthcare delivery. Through expert insights and real-world examples, the report provides actionable strategies for navigating the digital shift and shaping a future-ready life sciences ecosystem.

The next decade will reward those who act boldly, experiment early, and scale what works with discipline. For life sciences, the question is no longer whether to transform, but how quickly and how effectively they can do so.

Welcome to **"Life Sciences: Navigating the Digital Future."** – your guide to shaping the future of healthcare and innovation in the digital era.

Chris Mean
CEO (UK & US)
Columbus®

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The Road to 2026 and Beyond

Before

- Siloed systems
- Episodic compliance
- Digital as tools

Today

- Rising regulatory pressure
- Patient expectations accelerating
- Data growing faster than insight

What's Ahead

- Embedded compliance
- Patients as active participants
- Digital human partnership
- Agility by design

This roadmap sets the lens through which the following chapters are explored, examining regulatory, patient, and digital change on the path to 2026 and beyond.

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Meet the Experts

Thank you to the industry experts who have contributed to this report.

Tarn Brown
Life Sciences Industry Lead
Columbus Global

Shaping value led digital transformation for life sciences organisations, designing compliant, phased roadmaps that align people, capability, and data integrity with measurable outcomes.

Massimo Crudeli
Director of Client Solutions
Staedean

Trusted advisor in life sciences ERP and supply chain transformation, specialising in compliant, global system implementations across pharma and medical devices.

Chris Reid
Head of Digital Quality CoE
ProductLife Group

Global authority on digital quality and IT compliance, supporting life sciences organisations to adopt innovative technologies while maintaining GxP and data integrity.

Gareth Willis
CEO and Co-founder
Exosla Therapeutics

Leading Exosla Therapeutics in developing scalable extracellular vesicle based immunotherapies, bridging translational science and next generation biologics manufacturing.

Stephanie Schorge
Head of Research Department
UCL

Advancing translational neuroscience research at UCL, driving academic–industry collaboration to advance neurological therapies from discovery to clinical impact.

Professor Alejandro Frangi
Bicentenary Turing Chair in Computational Medicine
The University of Manchester

World leading authority in computational medicine, advancing AI driven in silico trials and digital twins to transform how medical products are developed and regulated.

Magnus Oxenwaldt
VP Group AI
Columbus Global

Driving AI strategy at Columbus Global and accelerating time-to-value for clients through AI-enhanced solutions.

Divya Vijay Pratheek
Vice President of Product and Marketing
Ribbon Bio

Biotechnology product leader shaping the future of synthetic DNA manufacturing, combining deep life sciences expertise with a focus on scalable, high precision production platforms.

Daniel Garner
Director of IT
Dental Directory Group

Leading digital and operational modernisation across one of the UK's largest healthcare distribution networks, aligning technology, security, and supply chain systems to support regulated growth.

Oliver Johnson
Editor
MedTech Insights

MedTech journalist and editor covering innovation across medical devices, manufacturing, and the commercial forces shaping the global MedTech sector.

Steve Rozow
Co-Founder
Mach Medical

Medical device manufacturing pioneer focused on reinventing the orthopedic supply chain through high velocity, patient specific production models.

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The Current Landscape

The life sciences sector in 2026 is defined by a rapidly evolving environment, in which digital technologies are reshaping how organisations discover, develop and deliver new therapies. Market pressures, from pricing constraints to shifting patient expectations, are accelerating the need for smarter, more connected operations. Meanwhile, scientific breakthroughs, advances in automation, and the rise of AI-enabled insights are unlocking new possibilities for speed, precision, and scalability across the value chain.

This transformation is not just about adopting new tools; it is about redefining how life science organisations operate – from strengthening data foundations and modernising legacy systems to enabling faster, more informed decision-making across the value chain. Data and AI are becoming strategic assets, driving predictive insights, faster drug discovery, and precision medicine. Patient-centric technologies are reshaping engagement models, while sustainability is shifting from a compliance checkbox to a business necessity.

Looking ahead, the sector is moving decisively towards a digitally enabled and intelligence-driven future. Cloud-based R&D, virtual and decentralised trials, and digital twins are transforming development models and accelerating time-to-market for breakthrough therapies. Advances in smart manufacturing, automation and greener production technologies are reshaping operations, fuelled by continued government and industry investment. Yet persistent challenges, including fragmented data landscapes, increasing cybersecurity risks and growing global cost pressures, require coordinated and strategic responses.

The organisations that succeed will be those that act now: building the capabilities, partnerships and operating models needed to compete confidently in a rapidly evolving scientific and technological landscape.

As this landscape evolves, organisations need partners who understand not only the technologies involved but the operational realities behind them. Columbus brings a vantage point shaped by working across some of the most highly regulated and innovation-driven industries. This cross-sector insight gives us a clear understanding of the patterns behind successful transformation – how data foundations mature, how operating models evolve, and how digital capabilities scale sustainably.

Our work focuses on making transformation tangible by simplifying complex landscapes, aligning technology with real business outcomes and enabling organisations to move with confidence in environments where precision, compliance and speed all matter.

Chapter 1

Regulatory and Compliance Challenges

1

Tarn Brown
Life Sciences Industry Lead,
Columbus Global

Keeping Pace: Turning Compliance Challenges into Organisational Alignment

"Regulation is far more than a box-ticking exercise"

Life sciences regulations are evolving at speed. With new technologies, driven by scientific breakthrough and the growing demand for secure, transparent data, organisations face an ongoing challenge: how to keep pace with compliance requirements?

For Tarn Brown, Life Sciences Industry Lead at Columbus, compliance shouldn't be viewed as a burden, but an opportunity to achieve organisational alignment.

Evolving from Episodic to Embedded Compliance

As regulatory expectations intensify, many life sciences organisations remain constrained by episodic, manual compliance models that struggle to keep pace with innovation.

Episodic Compliance:
Fragmented systems, manual documentation, point in time audits, compliance as overhead

Managed Compliance:
Defined governance, cross-functional effort, inconsistent assurance

Embedded Compliance:
Continuous assurance, data-driven oversight, security and compliance by design

Consistent Data Practices Streamline Compliance

The compliance burden is amplified by siloed systems and inconsistent data practices. Without a unified approach, compliance becomes reactive rather than strategic – leaving businesses vulnerable to delays, penalties, and reputational damage.

Massimo Crudeli, Director of Client Solutions at Staedean, adds: **"Many companies struggle with integrating modern platforms into legacy environments without disrupting validated processes. Data integrity and compliance become exponentially harder as systems and geographies expand, especially under evolving regulatory expectations such as GDPR, FDA, SOX and HIPAA."**

Unlocking the potential of regulatory data is key to streamlining compliance. Leading organisations are embedding digital solutions into their day-to-day compliance activities to build a culture of compliance, such as:

1. Cloud-based platforms for real-time data access and GxP compliance
2. Risk-based validation strategies aligned to global standards
3. AI-driven monitoring for continuous quality assurance

"Data integration across R&D, manufacturing, and supply chain is the backbone of digital transformation," Crudeli says. The result: real-time insights that allow companies to predict demand, optimise resources, and maintain regulatory alignment.

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Compliance as a Strategic Imperative

Lasting compliance requires clear governance and data ownership across the organisation, role-based access controls, and cross-functional collaborations between IT, quality, and business teams. Crudeli says: **"Scaling digital initiatives is a major cultural challenge: driving change across diverse teams, from R&D to manufacturing, requires strong governance and clear communication to overcome resistance. Organisational alignment is key."**

When compliance becomes part of the organisational DNA, businesses not only meet regulatory demands but also gain a competitive edge in a highly regulated environment.

Massimo Crudeli
Director of Client Solutions,
Staedean

Embedding Security by Design

As innovation accelerates, security risks rise. Analysis of ransomware attacks in 2025 identified 293 attacks on hospitals, clinics and healthcare tech providers, and another 130 attacks on healthcare business service providers. With attacks resulting in reputational damage, legal consequences, and at worst, risking patient safety, cybersecurity can no longer be an afterthought.

The priority is clear: innovation must be secure by design, with robust access controls, encryption, and governance frameworks embedded from the start.

The Future of Regulatory Alignment

Digital tools can transform regulatory alignment from a burden into a strategic advantage. By combining technology with a culture of continuous improvement, life sciences organisations can navigate complexity, accelerate innovations, and build trust – positioning themselves for sustained success in the digital era.

Intelligent Validation: From Checklist to Critical Thinking

"Compliance should enable innovation"

As regulation evolves in the digital era, the biggest shift is not technological – it's philosophical. Compliance is moving away from checklist-driven validation towards more intelligent, risk-based approaches.

As Chris Reid, Head of Digital Quality CoE at ProductLife Group, explains: **"Compliance strategies should enable innovation, not become a barrier to it. Validation now needs to be guided by critical thinking, a true understanding of risk, and practical approaches that leverage strong IT practices."**

The Challenge of AI in Compliance

Dynamic AI models introduce new complexities in compliance, particularly due to their probabilistic outcomes. **"Regulated companies need to demonstrate that such AI solutions are explainable and reliable,"** Reid says, noting that human-in-the-loop (HITL) approaches alone may not satisfy regulators. **"Our compliance approaches need to be leaner and truly based on risk,"** he adds.

To overcome these challenges, organisations must design AI systems with explainability, traceability, and validation in mind from the outset, rather than retrofitting compliance later. Technologies such as AI-assisted validation, automated monitoring, and continuous feedback loops are already enabling this shift.

Chris Reid
Head of Digital Quality CoE,
ProductLife Group

Data-driven Compliance

Over the next three to five years, compliance will become increasingly continuous and data-driven, shaped by:

- Continuous, AI-enabled validation: combining automated monitoring, AI-supported validation, and real-time performance data to ensure systems remain in a constant state of compliance
- Digital twins: simulating changes and assessing regulatory impact before deployment

For leaders, this signifies a fundamental shift from static documentation to dynamic, risk-based assurance – embedded directly into digital systems and processes. Organisations that make this transition will not only reduce regulatory risk but will accelerate innovation with greater confidence and control.

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Regulatory confidence must be designed into digital platforms and operating models, not audited in after the fact. Organisations that move from episodic to embedded compliance are better positioned to reduce risk and innovate with confidence.

Chapter 2

Patient-centred Technology

2

Gareth Willis
CEO and Co-founder,
Exosla Therapeutics

The North Star: Putting Patients at the Heart of Technology

"Don't fall in love with the algorithm; fall in love with the outcome"

As digital health evolves from standalone tools to connected, integrated ecosystems, the question is no longer what technology can do, but how it delivers meaningful outcomes for patients.

According to Gareth Willis, CEO and Co-founder of Exosla Therapeutics, the next wave of digital health tech must be defined by outcomes, not algorithms – ensuring that the patient remains the most important stakeholder.

From Passive to Active Participant

Precision medicine represents a fundamental shift in how patient needs are understood and addressed across the life sciences ecosystem. **"The industry is moving away from the one-size-fits-all model,"** Willis explains. **"Precision medicine is booming, and AI and machine learning are now capable of analysing vast genomic datasets to predict how specific patient subgroups will respond to a molecule."**

1 Patient as Recipient:
- Limited visibility
- One way communication
- Experience led

2 Patient as Engaged:
- Digital touchpoints
- Feedback loops
- Shared information

3 Patient as Active Participant:
- Transparency and trust
- Data participation
- Shared decision making

The Case for AI-driven Care

As AI-driven care evolves, one of the most significant opportunities lies in predictive, preventative healthcare. **"We could transition from a 'sick-care' system to a 'health-care' system, where AI identifies patterns in real-world data to flag early-stage chronic conditions years before they become symptomatic,"** Willis explains.

For healthcare systems and life sciences organisations, this represents a structural shift, from reactive treatment to proactive health management. The impact is substantial: reducing hospital admissions, lowering long-term costs, and easing pressure on overstretched healthcare systems.

Crucially, for patients, this shift centres around preserving individual health rather than treating illness. **"The North Star must remain the benefit to the patient."**

The Challenge of Scaling Digital Health

Despite its potential, scaling AI-driven care presents significant challenges, particularly around trust. For AI to be adopted in clinical settings, it must be explainable, transparent, and free from bias.

"We face a significant challenge in ensuring AI algorithms are not just accurate, but also transparent and free from the demographic biases that have historically plagued medical research," Willis says. Trust, therefore, must be designed into digital health solutions from the outset – including explainability, robust validation, and equitable data representation.

As adoption expands and data density increases, validation becomes ever more critical. Patients and clinicians remain wary of 'automated' medicine, and widespread adoption will depend on proving that AI-driven tools augments, rather than replaces, clinical judgement.

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The Value of AI: Asking Better Questions for Better Patient Outcomes

"Know why you're asking the questions"

AI is moving at a rapid pace in pharmacology and drug development: lab work is accelerating, research is more targeted-driven, and the potential for improving patient outcomes is unparalleled. But its value is not defined by speed alone.

For Stephanie Schorge, Head of Research Department at UCL, it's not algorithms that define the value of AI: it's people and patients. **"AI is really moving forward at speed, but having people ask the right questions is going to be really important – that's what leads to better patient outcomes,"** she explains.

Patients are the Experts of Their Health

Clinical practice is undergoing a shift: from working for patients to working with them. **"We're moving towards a space where the patients get the same data as the clinician,"** Schorge explains. **"Rather than telling the patient what's going on, the clinician instead helps the patient interpret what they're reading."**

Clinicians are increasingly seeking to understand patient priorities; insights that sometimes challenge scientific assumptions and alter the course of research. **"If you're going to help the patient, you try to understand what the need is and change your research to fit that. The patients are the experts,"** Schorge emphasises.

By framing the patient as the expert, we redefine the role of AI in healthcare: technology cannot create value on its own, and AI-generated insights only become meaningful when interpreted through the lens of a patient's lived experience and priorities. To become truly patient-centred, organisations must embed patient insight earlier in R&D, ensuring AI-driven decisions are grounded in real-world needs, not just scientific assumptions.

The Value of AI: Knowing What Questions to Ask

Through this patient-centric lens, the true value of AI lies in how we use it: **"The opportunity is the ability to do things; the challenge is knowing what you want to do,"** Schorge observes. AI can generate scientific answers at extraordinary speed and scale, but it cannot determine which questions truly matter – the crux of serving patient-centred goals.

For leaders, this shifts the focus from adopting AI tools to defining clear problem statements, ensuring that technology is aligned to meaningful patient outcomes.

Once a biological objective is clearly defined, AI becomes a powerful accelerator. It can rapidly propose multiple molecular strategies, simulate interactions, and optimise candidates in a fraction of the time traditional methods require. In receptor engineering, for example, AI enables the design of molecules with specific, intended effects rather than relying on slow trial-and-error discovery. In epilepsy – Schorge's field of research – this opens the door to more targeted modulation of neuronal pathways.

But defining the target remains a human responsibility, and the quality of the outcome depends entirely on the quality of the question.

Stephanie Schorge
Head of Research Department, UCL

Capturing the Complexity of Human Physiology

Even when we define the right target, success at a molecular level doesn't guarantee safety or effectiveness across the whole body. A therapy that performs well in vitro may behave differently in patients, where significant off-target effects remain a real risk.

While AI-enabled assays and organ-on-a-chip technologies are already reducing animal use in research, these solutions still don't capture the full complexity of human physiology. **"What we need now is a roadmap towards getting AI to model the whole complexity of the human body,"** Schorge says.

The next frontier is not just optimisation at a molecular level, but modelling biology at a systems level – allowing researchers to anticipate full-system consequences, and design therapies that are safe, effective, and meaningful in the real-world patients.

Bridging the Expertise Gap

The rapid advances of technology, while promising, create an expertise gap that could halt progress in life sciences. **"We need the people who are good at AI to talk to the people who are good at patient outcomes,"** Schorge says.

Cross-collaboration is key to combining clinical expertise with AI potential, but seamless communication remains a challenge for the industry, particularly as AI continues to evolve at an exponential pace. To bridge this skills-communication gap, Schorge asks: **"Is there a role for someone who is neither clinician nor AI expert whose job is to liaise between them – helping people talk to each other who are from very different worlds?"**

This requires new operating models that bring together clinical, scientific, and data expertise to ensure AI is applied effectively.

Future Outlook

AI may feel like a revolutionary shift, but the transformation is more nuanced. **"We've gone from an economy where finding information was hard, to one where we are drowning in data,"** Schorge explains. We are increasingly reliant on tools that filter and interpret information, and while AI is exceptionally powerful at surfacing patterns and synthesising insight, it cannot define the problem for us.

The differentiator for life sciences leaders is clear: competitive advantage will not come from AI alone, but from clarity of purpose – knowing which questions to ask, which problems to prioritise, and how to align technology with real patient need.

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Patient centred technology must move beyond experience to enable participation. Organisations that design for trust, transparency, and shared decision making will deliver better outcomes for patients.

Chapter 3

AI and Data

3

From Information to Wisdom: How Digital Twins are Becoming the GPS for Healthcare

"Current healthcare is like reading a paper map: static and retrospective"

Health data today is often a passive repository, treated as an operational overhead rather than a strategic asset. However, tools such as digital twins are redefining how life sciences organisations extract genuine value from this information. The central challenge is distinguishing true technological potential from industry hype.

For Professor Alejandro Frangi, Bicentenary Turing Chair in Computational Medicine at The University of Manchester, a digital twin acts as a GPS for health, transforming data from a reactive repository into an active roadmap for health.

From Raw Data to Validated Wisdom

"Current healthcare is like reading a paper map: static and retrospective," Frangi says, but the emergence of digital twins is changing this trajectory, from observation to prediction. High quality data is critical to this shift, and Frangi draws on the DIKW (Data, Information, Knowledge, Wisdom) pyramid to highlight how digital twins can convert raw measurements into actionable understanding.

Professor Alejandro Frangi
Bicentenary Turing Chair in Computational Medicine,
The University of Manchester

"A digital twin isn't just a copy; it is a tool for validated wisdom. It converts raw information into a predictive score of action. Like a GPS, it uses data plus a physics-based understanding of the 'road' (the human anatomy) to predict the best route and update in real time."

The implication is clear: value only emerges when data is structured, contextualised, and validated into insight that clinicians and patients can trust.

The Marriage of AI and Mechanism

While we generate data at a rapid pace, our understanding of human biology complexity grows even faster, limiting how far data alone can take us. **"Pure data-driven AI is not mechanistic; it sees patterns but doesn't know why,"** Frangi notes.

This 'black box' phenomenon is often unsatisfying for clinicians and a hurdle for decision-makers who demand strict interpretability. Other approaches to mechanistic modelling bridge this gap by embedding an understanding of the biological factors that drive health outcomes. **"We need AI to speed up the process, but we need mechanistic modelling to ensure the answers adhere to physiological and physical principles."**

For leaders, this means investing beyond AI alone, building capabilities that combine data science with domain expertise to ensure outputs are interpretable, explainable, and clinically meaningful.

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‘Failing Faster’ with In Silico Trials

The hybrid approach of data and mechanism is not just theoretical; it is already reshaping how we design and test medical devices. Bringing new devices to market is traditionally capital intensive and sluggish. Critical flaws are frequently discovered too late, carrying severe consequences. A sobering 2018 investigation revealed nearly 83,000 deaths and over 1.7 million injuries linked to post-market medical devices. **“We have an ethical duty to test devices to (virtual) destruction in a computer, not in a patient,”** Frangi asserts, highlighting the imperative to shift risk discovery earlier in the lifecycle.

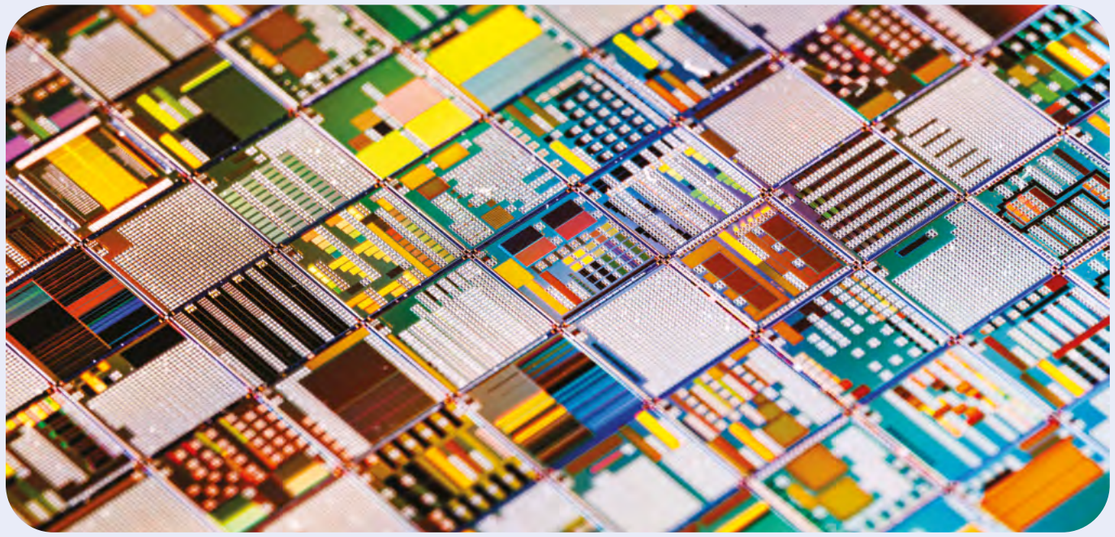
In silico trials allow companies to front-load risk, testing virtual cohorts across a spectrum of anatomical and physiological variability before constructing physical prototypes. This enables design teams to ‘fail faster’ and eliminate weak designs early. Furthermore, real-world trials systematically struggle with inclusivity, limiting evidence to those who live near hospitals and can afford to attend. In silico technologies combat this inequity by engineering virtual populations that reflect global demographic nuance and complex comorbidities.

Organisations adopting these methods will reduce timelines, lower costs, and secure a decisive competitive advantage.

Making Predictive Medicine a Reality

The implication for life science organisations is fundamental: predictive medicine cannot scale without robust digital foundations. **“We might dream of the FedEx service, but we haven’t laid the tarmac yet,”** Frangi emphasises.

Investment in infrastructure, data integration, interoperability, and secure connectivity, is no longer an ambition, but an immediate priority. Without it, even the most advanced AI and digital twin technologies will remain constrained by the weakest link in the system, limiting its ability to deliver meaningful, equitable predictive care.



Magnus Oxenwaldt
VP Group AI,
Columbus Global

AI in Life Sciences: Two Horizons of Transformation

“Plan for the tools we have today, not the tools we hope for tomorrow”

The promise of AI transforming life sciences from reactive to predictive is real – but its practical value is often misunderstood. The challenge for life sciences today is not whether to adopt AI, but how to apply it realistically and responsibly. According to Magnus Oxenwaldt, VP Group AI at Columbus Global, AI’s role in analytics in unfolding across two distinct horizons: as both a support partner, and truly independent analytics tool.

Horizon 1: AI as an Efficiency Partner

Today, AI excels as a support tool, not a replacement for human expertise. Despite impressive demonstrations – from AI winning mathematical Olympiads to DeepMind’s AlphaFold underpinning Nobel Prize winning breakthroughs in structural biology – we face what researchers call a ‘jagged frontier’. AI can solve complex mathematical problems yet stumble on simple questions.

In regulated industries like pharma and healthcare, this matters enormously. **“AI cannot yet replace the human ability to ask the right questions, validate responses, and apply contextual judgment,”** Oxenwaldt emphasises. **“What AI offers now is efficiency: accelerating documentation, guiding methodological processes, and highlighting gaps in our understanding. It supports decision-making but should not make decisions autonomously.”**

A critical challenge remains robustness. **“When you ask the same question 100 times, you need the same correct answer 100 times. Humans aren’t perfect at this either, but current AI systems are less reliable.”** Pioneers like Mira Murati’s Thinking Machines Lab are tackling this exact problem – building AI systems we can trust in regulated environments. But until these technologies have matured, leaders today should not race to replace human expertise with AI; rather, it should be deployed as an efficiency and decision-support partner, particularly in environments where accuracy and accountability are critical.

Horizon 2: Autonomous AI Research

The second horizon – where AI conducts analysis independently and generates truly novel insights – remains uncertain. Demis Hassabis at Google DeepMind envisions AI contributing original ideas to research, while OpenAI has announced timelines for research-capable AI –yet predictions range from three to 30 years. Oxenwaldt argues: **“We cannot bank on this timeline.”** This reinforces a critical point: strategies should be built around current capabilities, not future promises.

The Opportunities for AI Analytics

For predictive analytics today, success requires narrow, domain-specific models. **"General AI that delivers reliable predictions across all problems doesn't exist yet,"** Oxenwaldt points out. And while data integration is improving, with AI helping to transcend traditional silos, context limitations persist. Models can only process so much information at once.

However, concrete examples are emerging:

Drug discovery:
AI models screen millions of compounds in days rather than years, rapidly identifying promising candidates for clinical trials.

Patient monitoring:
Predictive algorithms flag deterioration risks before symptoms manifest, shifting care from intervention to prevention.

Clinical trial design:
AI identifies optimal patient cohorts and predicts dropout risks, accelerating time-to-market for critical treatments.

The opportunities are substantial: faster innovation cycles, reduced R&D costs, and genuinely personalised patient care. But the risks are equally real: over-reliance on immature systems, data privacy concerns in healthcare settings, and the regulatory complexity of validating AI-driven decisions.

What This Means for Life Sciences

For life sciences leaders, the key is to embrace AI as a powerful collaborator while maintaining rigorous human oversight, and building trust incrementally through narrow, well-validated applications.

The shift from reactive to predictive medicine will not happen overnight, but organisations that invest thoughtfully today – in robust data infrastructure, domain-specific AI tools, and skilled teams who understand both the technology and its limitations – will lead the transformation toward better patient outcomes.

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From Discovery to Disposal: How Digital Threads Are Redefining the Pharmaceutical Supply Chain

From AI-driven drug discovery to autonomous manufacturing and connected supply networks, digital technologies are reshaping how medicines are developed, produced, and delivered. But what does a truly digital pharmaceutical value chain look like, and what capabilities must organisations build to realise its promise?

According to a leading global pharmaceutical company, the future is defined by one concept: the digital thread, a continuous, integrated data backbone that connects every stage of a product's lifecycle.

The Digital Supply Chain of the Future

A digitally native pharmaceutical supply chain begins long before manufacturing and extends far beyond distribution. **"It needs to be end-to-end digitally enabled, from discovery to patient, and even to device disposal,"** explains the company's Senior Director of Digital and Technology.

Four domains underpin this transformation:

1. R&D and asset development
2. Technology transfer to manufacturing
3. Autonomous and interoperable supply chain execution
4. Quality and compliance systems embedded across the lifecycle

This holistic approach moves beyond siloed digital initiatives toward an integrated digital enterprise.

Core Technologies: From ERP to AI

Despite the hype around AI, the foundations of digital transformation remain surprisingly pragmatic. **"We need to get our ERP strategy right... and have the right manufacturing stack: MES, process management, and product lifecycle management."**

Pharma lags behind industries such as aerospace and automotive in product lifecycle management (PLM), despite similar lifecycle complexity. Standardisation is another major gap: while other sectors have established interoperable digital standards across suppliers, pharmaceutical manufacturing remains fragmented.

AI sits on top of this digital backbone as an augmentation layer rather than a 'silver bullet'. Its impact is already visible in drug discovery, but supply chain and manufacturing applications are only beginning to mature. **"Don't just expect AI to do everything, embed it in the right use cases."**

Lessons from Other Industries

Other sectors offer valuable lessons for life sciences. Aerospace and automotive industries have spent decades developing digital threads, model-based definitions, and interoperable standards. Pharma is beginning a similar journey but faces unique challenges, including heavy M&A activity that creates fragmented IT landscapes. Some organisations operate dozens of ERP systems following acquisitions, complicating digital integration efforts.

Conversely, pharma leads in innovation velocity, especially in AI-driven research. The challenge is translating that innovation into operational excellence.

Skills, Leadership, and Continuous Learning

The pace of technological change is outstripping workforce capabilities, making skills gaps inevitable. However, the solution is not static training programmes, but continuous learning embedded in daily work. Global operating models can mitigate talent shortages by accessing diverse skill pools, but geography still matters. Organisations must also invest in early talent pipelines and flexible working models.

Perhaps more critically, digital literacy is becoming a leadership requirement. Senior leaders must understand technology to make informed strategic decisions. The future digital enterprise demands digital leadership, not just digital specialists.

AI in Pharma, Manufacturing and Supply Chains: The Next Decade

Over the next decade, AI will reshape operational decision-making. Expect:

- Human-in-the-loop automation, where AI executes routine processes with oversight
- AI-assisted decision support for safety-critical operations
- Exception-driven workflows, improving responsiveness and efficiency

Time-to-market for new therapies will shrink as virtual experimentation reduces physical trial cycles. AI-driven modelling can simulate thousands of experiments, narrowing candidates before laboratory validation.

The Bottom Line

Digital transformation in life sciences is not about isolated AI pilots or cloud migrations. It is about building an integrated digital thread, reengineering processes, cultivating digital skills, and establishing trust across a complex ecosystem.

The race is on for life sciences leaders to synchronise people, processes, data, and technology, and define what the digital future of healthcare looks like.

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At Columbus, we are clear that AI only delivers value when it is grounded in trusted data, clear governance, and human decision making. Organisations that focus first on data quality, transparency, and purposeful use of AI will move faster.

The digital pharmaceutical supply chain depends on a connected data backbone linking discovery, manufacturing, quality, and distribution. Organisations that build end to end digital threads are best positioned to translate innovation into scalable, compliant operations.

Chapter 4

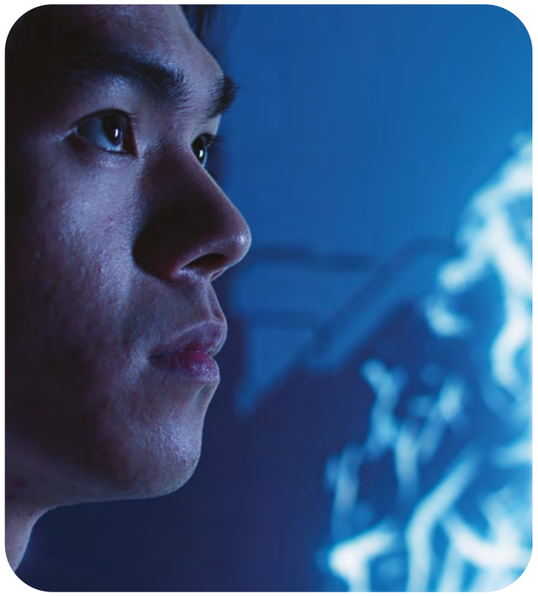
The Digital Transformation of Life Sciences

4

AI and Automation: How Digital Transformation Fuels Faster Decisions

“Don’t be afraid of the science that can make lives better”

The mainstream adoption of digital technologies such as AI and automation has fundamentally changed how life sciences operate. But according to Divya Vijay Pratheek, Vice President of Product and Marketing at Ribbon Bio, the power of digitisation isn’t automation: it’s faster, safer decision-making.



Divya Vijay Pratheek
Vice President of Product and Marketing, Ribbon Bio

Streamlined Workflows for Seamless Collaboration

This shift is already reshaping how organisations approach design and manufacturing. Tools such as digital twins enable faster iterations of the traditional ‘design, build, fail’ model, allowing teams to simulate scenarios, test outcomes, and make decisions much earlier.

“We have a machine learning algorithm that immediately takes the sequence that a customer has given, and breaks it down into fragments,” Pratheek explains. **“It then takes these instructions and passes them to an automated manufacturing line, so there’s no reason for error.”** The result is not just efficiency; it’s the compression of decision cycles.

For Ribbon Bio, this translates into a tightly integrated workflow:

- Customer enquiry received
- Rapid feasibility check by R&D
- 24-hour decision on timelines, cost and viability
- Clear, informed customer choice
- Coordinated execution across teams

When data, systems, and teams are connected, decision-making moved from weeks to hours, directly impacting speed-to-market and customer experience

At Ribbon Bio, this model is being extended beyond centralised manufacturing, giving laboratories the ability to leverage the machine learning algorithm to bring some sequence production in house.

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The Human-Digital Partnership

Despite these advances in efficiency, digital tools do not replace human expertise: their value depends on it.

> "Automation and digital tools learn from experience... But if they haven't seen something before, you need a human being to tell them how it's done the first time,"

Pratheek emphasises. This creates an iterative loop: human insight defines the solution manually, and digital systems learn and scale it. This partnership improves both speed and consistency.

Investment in technology must therefore be matched in expertise – without the ability to guide and refine systems, automation will plateau.

Speed vs Trust: The New Constraint

As innovation booms, the primary constraint is no longer technical, but trust-based. **"When you're dealing with biological systems... everything needs to be checked, checked, and checked again,"** Pratheek explains.

Regulatory requirements, data privacy concerns, and validation processes mean that even small changes can take years to implement – but digitisation is beginning to ease this burden. **"There are tools that can screen a molecule for a biosecurity assessment, check it against different regulatory bodies across the world, and within 24 hours say whether it's safe to make. You couldn't have done that 10 years ago."**

This underscores a critical reality for the sector: advances in digital capability must be matched by equally robust frameworks for validation, regulation, and trust before their full impact can be realised.

Looking Ahead: Digital Ecosystems Driving Speed-to-Market

As digital ecosystems mature, the ability to design, manufacture, and test at speed will become a defining competitive factor. AI-driven collaboration will compress development timelines from years to months.

But the differentiator will not be access to technology alone – it will be how effectively organisations use it to make better decisions, faster. Those that build connected, insight-driven systems will lead on speed, innovation, and ultimately, patient impact.

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Digital Change as a Partnership: Orchestrating Healthcare Ecosystems

"Patients, businesses: they are collections of humans"

Digital transformation in healthcare is often framed as a technology story: new platforms, automation, and AI reshaping the way organisations operate. But for many leaders, sustainable digitisation depends on something less visible – the relationships that connect organisations, clinicians, and partners across the healthcare ecosystem.

For Daniel Garner, Director of IT at Dental Directory Group, true digital ecosystems are not built through one sweeping transformation. Instead, they emerge through partnerships, incremental innovation, and a focus on the people using the systems.

Modernising Digital Infrastructure Through Tactical Intervention

Digitisation often centres around a single significant technology implementation, but achieving digital maturity at scale requires strengthening the entire digital backbone. **"Rather than focusing on a single, very influential transformation, a lot of what we do is about incremental modernisation and tactical interventions,"** Garner explains.

Prioritising continuous improvement over disruptive overhaul allows systems to adapt alongside regulatory demands and operational pressures. Organisations looking to digitise should treat transformation as an ongoing capability, not a one-off programme.

A robust ERP plays a key role in this foundation, but its value extends beyond system consolidation. When implemented effectively, it connects people as much as processes, enabling smoother collaboration across the organisation and its partners.

"Businesses are just groups of people," Garner points out. **"And people working in that business context are increasingly expecting the customer experience they get as consumers."**

Connected Clinical Ecosystems

Despite these opportunities, life sciences still lags behind other industries in connectivity. **"Within the supermarket type model, if you're not trading on fully automated platforms... you're not trading at all,"** Garner explains. **"That's just not true within the healthcare space."**

This gap represents a significant opportunity. Moving towards connected supply chains, through tools such as electronic data interchange (EDI), can unlock more reliable data, reduce manual error, and streamline operations across manufacturing and distribution. Without connected ecosystems, organisations will struggle to scale automation, integrate partners, or gain the full value of digital investment.

"Businesses are just groups of people, And people working in that business context are increasingly expecting the customer experience they get as consumers"

Daniel Garner
Director of IT,
Dental Directory Group

Designing Trusted Digital Environments

As ecosystems become more connected, the importance of trust increases – yet many organisations still overlook foundational capabilities over more advanced technologies. **"The majority of attacks are still vectored by phishing,"** Garner explains. **"The place to start is security as a baseline capability."**

With healthcare supply chains increasingly targeted by cyberattacks, embedding security into digital architecture from the outset is critical – not only to protect data, but to build confidence across the ecosystem. Frameworks such as UK government-backed Cyber Essentials Plus provides a structure way to validate this.

Driving Digital Adoption

To drive digital adoption, Garner looks to people. **"Our consultants work in partnership with the people in the clinic to bring value,"** he says, highlighting the importance of working closely with end users to refine systems based on real-world use.

When digital adoption slows, it's a signal that systems may need further refinement. **"It generally means we haven't hit the mark, and we need to work through it to understand that,"** Garner notes.

This reinforces the idea that transformation should be designed with users, not for them. Continuous feedback and iteration are essential to ensuring digital tools deliver meaningful outcomes.

Looking Ahead: Resilience Through Collaboration

Over the next decade, data-driven supply chains, automation, AI-enabled clinical workflows, and API-driven ecosystems are set to accelerate digitisation across healthcare.

"Resilience as a strategic priority is going to emerge more and more," Garner points out. As organisations respond to supply chain volatility and rising patient expectations, the ability to integrate digital tools across the value chain will become a key competitive differentiator – but achieving this will require collaboration across the healthcare ecosystem.

Ultimately, digital transformation is a partnership. Only when organisations communicate and innovate together can the full potential of connected healthcare be realised.

"Resilience as a strategic priority is going to emerge more and more"

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From Analogue to Digital: Turning Digital Maturity into Better Care

"Digital maturity is no longer optional"

Across Pharma, MedTech, and healthcare delivery, the shift from analogue to digital is no longer focused on isolated transformation programmes: it's about building connected, intelligent ecosystems.

Oliver Johnson, Editor at MedTech Insights, highlights that digital maturity is fast becoming essential to competitiveness, compliance, and improved patient outcomes. The organisations leading this shift are not simply digitising processes; they are rethinking how care is delivered through integrated, data-driven systems.

From Data Fragmentation to Flow

A defining feature of analogue healthcare is fragmentation: data locked in silos, manual workflows, and limited visibility across the patient journey. Digitisation changes this fundamentally, enabling information to flow seamlessly between systems.

Where this is done well, the impact is tangible. Johnson cites the AI-powered My Staff App as a powerful example of connected systems streamlining how staff access information at Mid and South Essex NHS Foundation Trust. The impact is clear:

- Instant access to over 1,500 policies and guidelines
- Over 864 documents accessed daily through the app
- 90% of the 15,000-strong workforce actively using the app
- An average of 10 minutes saved per document search

"By using AI to streamline access to critical information, we're not only saving time, but also improving compliance, patient safety, and governance across the Trust," says CEO Matthew Hopkins. Better access to information doesn't just improve efficiency – it directly enhances clinical quality and decision-making.

Redefining the Patient Experience

Digitisation is also reshaping the role of the patient, from passive recipient to active participant. Johnson points to SPARK Fusion – a connected platform that enables more personalised, responsive care – to demonstrate how services are adapting in real time to patient needs.

"They use the platform to run modern nurse call systems that allow patients to indicate what they need before busy staff head for their bedside, ensuring the correct staff member is assigned to the task," says Jane Stephenson, CEO of Spark TSL. Similarly, integrated meal ordering systems allow patients to choose food in line with their preferences and clinical needs, reducing waste and improving patient satisfaction.

For leaders, this signals a broader trend: digital transformation is not just operational, it is experiential. The quality of the interaction is becoming as important as the outcome itself.

Oliver Johnson
Editor,
MedTech Insights

The Infrastructure Challenge

Despite clear progress, legacy infrastructure remains a major constraint for life sciences. While many organisations have invested in digital tools over the past decades, outdated systems often limit their ability to scale or integrate new capabilities. This creates a growing divide between organisations that can operationalise digital effectively, and those held back by technical debt.

The NHS 10 Year Plan, alongside the Life Sciences Sector Plan, outlines the UK government's ambitious plans to drive modern healthcare – but the shift from analogue to digital can only happen when digital ambition is matched by sustained investment in core infrastructure.

From Projects to Operating Model

The most mature organisations are moving beyond experimentation. Rather than treating digital as a series of projects, they are embedding it into their operating model; continuously evolving, integrated, and aligned to strategic outcomes.

This distinction will soon define industry leaders. Those that embed digital into how they operate will unlock faster innovation, greater resilience, and better patient outcomes.

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Autonomous Digital Factories: Standardising Processes Drives Automation Success

"Standardisation is a key launchpad to automate just about anything"

Automation is transforming manufacturing – but as organisations race to adopt new technologies, the real challenge is delivering consistent, scalable value. For Steve Rozow, Co-Founder at Mach Medical, the foundation of any successful digital factory is not automation, but the standardisation of processes and quality systems.

Process Before Automation

"We process thousands of different products that can look quite different... but we can run all those off virtually the same process," Rozow explains, highlighting a key principle: that automation delivers the most value when built on a standardised operating model.

Embedding quality directly into business processes is equally critical: **"We didn't automate waste,"** Rozow says. **"We strip the process and get it to the best state of quality first, then think about automating it."**

People as the Driver of Transformation

Despite the clear benefits of automation, Rozow highlights that people, not technology, determine transformation success.

"The real work is the change management through people, and that's 80% of any project."

Early involvement encourages employees to shape the systems they will ultimately use, ensuring new tools are practical, widely adopted, and embedded into daily workflows. **"Everybody brings their own level of expertise to the table, which ends up being extremely valuable to solving problems and deploying things in a way that will actually get used."**

A Shifting Regulatory Landscape

As automation and AI become more embedded in manufacturing, regulatory boundaries are shifting. The distinction between product and process software is beginning to blur, with greater scrutiny likely to be applied to operational systems in future.

"If companies are not using what's emerging on the product side in the way of quality and validation requirements to apply to the process side, there will be a lot of scramble work in the future," Rozow warns.

For life sciences organisations, this means acting early, embedding validation and compliance into process design, rather than retrofitting it later.

Steve Rozow
Co-Founder,
Mach Medical

Data, Security, and the Limits of AI

A related concern across the industry is security. **"We deal with a lot of intellectual property that's owned by our customers, and they entrust us to be the stewards of that,"** Rozow says. **"We've got to be careful that there are moats built around that."**

At the same time, AI adoption may be limited by data availability. **"There's a practical limit... simply because of data availability that we don't have,"** Rozow highlights. With much of the industry's innovation occurring in startups with limited datasets, there's a ceiling on how quickly AI tools can be deployed at scale.

The implication is twofold: organisations must prioritise both security by design and data readiness to unlock value and maintain trust.

A More Disciplined Approach to AI

As adoption accelerates, Rozow calls for a more targeted approach to AI. **"Right now, AI is the hammer, seeing everything in the world as a nail."**

But not every problem requires AI; in many cases, traditional automation remains more effective. **"I try to tease apart what can be automated through algorithm, and what may be a candidate for AI."** For leaders, the priority is focus: apply AI where it delivers clear advantage, rather than treating it as a universal solution.

Automation is no longer a question of capability, but of execution. The organisations that succeed will be those that combine process discipline, data readiness, and human alignment to achieve autonomous success.

Results That Matter

Mach Medical worked with Columbus to re engineer their supply chain operations using Microsoft Dynamics 365 and Industry 4.0 capabilities.

By prioritising process discipline, standardisation, and digital execution before automation, Mach Medical **reduced per part manufacturing costs by ~30%, cut inventory holding costs by ~80%, and accelerated time to market by 1–2 years**, demonstrating how disciplined digital foundations enable scalable automation in regulated environments.

MACH MEDICAL®
Revolutionizing the Orthopedic Supply Chain.®

Chapter 5

The Road Ahead

5

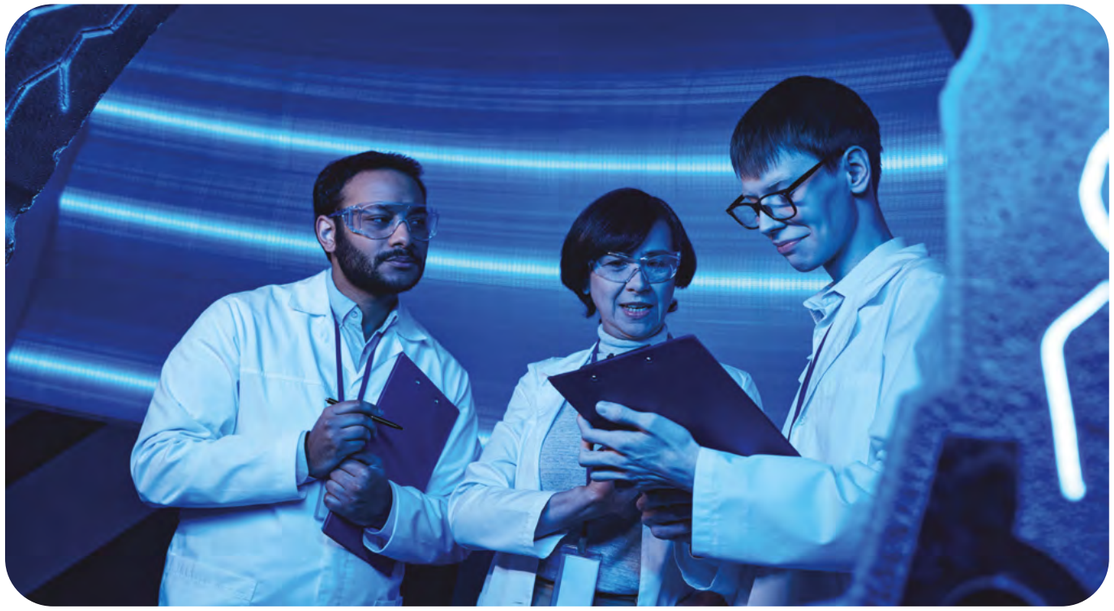
A Converging Future for Life Sciences

The future of life sciences will be defined by convergence: of science, technology, and data into fully connected, intelligent ecosystems. As AI, automation, and advanced analytics become embedded across the value chain, organisations will move from fragmented digital initiatives to integrated, end-to-end operating models. The future is faster discovery, adaptive manufacturing, and personalised patient care.

Regulatory frameworks will join this evolution, with compliance shifting from static validation to continuous, risk-based assurance. Keeping pace with dynamic technologies means more sophisticated compliance structures will emerge – and trust will be directly embedded into digital systems.

As patient expectations continue to rise, so too will the demand for faster access to therapies, greater transparency, and more personalised, outcome-driven care. This will push organisations to move beyond product-centric models towards holistic, patient-centred ecosystems that integrate prevention, diagnosis, treatment, and long-term health management.

In this future, success will depend on the ability to connect data, technology, and people – turning complexity into coordinated, intelligent action across the entire health landscape.



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Key Themes Shaping the Future of Life Sciences

AI-driven discovery and decision making

AI will increasingly augment human expertise across R&D, manufacturing, and clinical care – accelerating discovery, improving precision, and enabling faster, more informed decisions.

Data ecosystem convergence

The shift from siloed systems to integrated data ecosystems will underpin the next phase of transformation, enabling seamless data flows, real-time insights, and the emergence of true digital threads across the product lifecycle.

Patient-centred, hybrid care models

Healthcare will continue to move towards hybrid models that combine digital and physical care, with patients playing a more active role in managing their health through personalised, data-driven insights.

Sustainable, smart, and resilient operations

Sustainability and resilience will become core operational priorities, with organisations leveraging digital technologies to reduce waste, optimise resources, and build more adaptive, future-proof supply chains.

Trust, regulation, and digital governance

As innovation accelerates, trust will become a defining competitive factor. Organisations will need to embed robust governance, transparency, and validation into their digital systems to meet evolving regulatory expectations and maintain patient confidence.

The Future in the Eyes of Industry Experts

"Don't be afraid of the science that can make lives better. We're doing this for the sake of people and planet"

– Divya Vijay Pratheek

"The key is to embrace AI as a powerful collaborator while maintaining rigorous human oversight"

– Magnus Oxenwaldt

"The patient is the most important stakeholder. Don't fall in love with the algorithm; fall in love with the outcome"

– Gareth Willis

"Data integration across R&D, manufacturing, and supply chain is the backbone of digital transformation"

– Massimo Crudeli

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Final Statement

The life sciences sector stands at a pivotal moment. The voices in this report are clear about the very real challenges we face: increasing regulatory complexity, rising patient expectations, and the need to modernise legacy systems while maintaining absolute trust and compliance. Yet, what is equally clear is the momentum behind the industry – and the depth of talent driving it forward.

Across every part of the value chain, we're seeing a shift towards true digital maturity. Organisations are moving beyond experimentation to embed data, AI, and automation into the core of how they operate, make decisions, and deliver value. This is no longer about adopting technology for its own sake, but about building resilient, intelligent systems that can scale, adapt, and deliver measurable outcomes.

There is a growing confidence that the sector not only understands the scale of transformation required, but is increasingly equipped to deliver it. The convergence of science, technology, and human expertise is unlocking new possibilities for innovation, efficiency, and patient impact.

At Columbus, we are committed to supporting this journey – helping organisations turn ambition into action, and complexity into clarity. By focusing on practical, measurable transformation, we aim to ensure that digital progress translates into real-world outcomes for businesses, healthcare systems, and ultimately, patients.

The future of life sciences is not just digital –
it is intelligent, connected, and full of incredible possibility.

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Ready to move from insight to execution?

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