

**I want to understand the current emerging techs and ideas in the CES 2025 or from other places, as my senior research fellow, chart out all the techs, ideas in a tabular format, mentioning the emerging techs / ideas / tools. Use case where it can be used for. Particularly for Pharma industry and mentioning which all places it can applied too. Add in the tech limitations and challenges and ways of implementation**

Here’s a structured analysis of emerging technologies from CES 2025 and adjacent innovations, focusing on pharmaceutical applications, limitations, and implementation strategies:

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| **Emerging Tech/Idea** | **Pharma Use Cases** | **Other Applications** | **Tech Limitations/Challenges** | **Implementation Strategies** |
| **Agentic AI** | - Autonomous clinical trial management  - Drug repurposing via real-world data analysis  - Pharmacovigilance automation [[1]](#fn1)[[2]](#fn2) | Healthcare diagnostics, Supply chain optimization | - Regulatory compliance risks  - Data privacy concerns  - High computational costs | - Integrate with EHR/LIMS systems  - Develop ethical AI governance frameworks |
| **Quantum Computing** | - Simulating ligand-protein binding dynamics  - RNA folding prediction for mRNA drugs [[3]](#fn3) | Cryptography, Financial modeling | - Limited qubit stability  - High infrastructure costs  - Specialized skill gaps | - Partner with quantum providers (IBM, Pasqal)  - Adopt hybrid quantum-classical systems |
| **Digital Twins** | - Bioreactor process optimization  - Patient-specific treatment simulations [[4]](#fn4) | Manufacturing, Smart cities | - Data integration complexity  - High computational demand  - Model validation issues | - Deploy IoT sensors in labs  - Use ML for predictive analytics |
| **Neuromorphic Computing** | - High-throughput compound screening (e.g., SpiNNaker2)  - Adverse event prediction [[5]](#fn5)[[6]](#fn6) | Autonomous vehicles, IoT devices | - Limited hardware availability  - Algorithm compatibility issues | - Collaborate with neuromorphic chip developers  - Optimize DNNs for parallel processing |
| **Wearable Biosensors** | - Decentralized trial glucose monitoring (Dexcom Stelo)  - Digital endpoints for neurodegeneration [[7]](#fn7)[[8]](#fn8) | Fitness tracking, Chronic disease management | - Biofluid-blood correlation gaps  - Short battery life  - User compliance challenges | - Integrate with AI analytics platforms  - Train healthcare staff on data interpretation |
| **AI-Driven Lab Automation** | - High-throughput screening (Recursion Pharma)  - Robotic synthesis planning [[9]](#fn9)[[10]](#fn10) | Chemical engineering, Materials science | - High upfront costs ($2M+/lab)  - Maintenance complexity  - Limited flexibility | - Adopt modular robotic systems  - Upskill lab technicians in AI oversight |
| **Extended Reality (XR)** | - Surgical training simulations  - Molecular structure visualization [[11]](#fn11) | Engineering design, Retail | - Hardware bulkiness  - Motion sickness  - High GPU requirements | - Start with AR-assisted equipment training  - Partner with XR platforms (Microsoft HoloLens) |
| **Blockchain & Post-Quantum Cryptography** | - Clinical trial data security  - Anti-counterfeit drug tracking [[12]](#fn12) | Financial transactions, IoT security | - Scalability issues  - Energy-intensive consensus mechanisms  - Regulatory uncertainty | - Pilot private/permissioned chains  - Train IT teams on quantum-resistant algorithms |
| **Robotic Process Automation (RPA)** | - Automated batch record reviews  - Regulatory submission formatting [[10]](#fn10) | Banking, Insurance | - Struggles with unstructured data  - Requires process standardization | - Map high-volume repetitive tasks first  - Implement RPA with human validation checkpoints |

**Key Observations for Pharma:**

1. **Cost vs. ROI**: Quantum computing and neuromorphic systems require significant investment but promise 30-50% faster drug discovery cycles [[3]](#fn3)[[6]](#fn6).
2. **Regulatory Hurdles**: Agentic AI and blockchain need alignment with FDA 21 CFR Part 11 and GDPR compliance [[1]](#fn1)[[2]](#fn2).
3. **Skill Gaps**: 68% of pharma firms lack in-house expertise for AI/quantum integration; partnerships with tech firms are critical [[4]](#fn4)[[9]](#fn9).
4. **Data Challenges**: Wearables and digital twins generate 2-5TB/day per trial site, necessitating edge computing solutions [[7]](#fn7)[[8]](#fn8).

**Implementation Roadmap:**

1. **Pilot Programs**: Start with low-risk areas (e.g., RPA for batch records) before scaling to AI/quantum systems.
2. **Cross-Industry Collaboration**: Partner with NVIDIA (Cosmos AI), IBM Quantum, or startups like Qubit Pharmaceuticals [[3]](#fn3)[[13]](#fn13).
3. **Talent Development**: Invest in upskilling programs for computational biologists and AI ethicists.
4. **Infrastructure Modernization**: Transition to cloud-native platforms with quantum-safe encryption by 2026 [[12]](#fn12)[[14]](#fn14).

This analysis synthesizes CES 2025 innovations with practical pharma applications, addressing technical constraints and actionable adoption pathways.

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1. <https://www.rialtes.com/insights/blogs/agentic-pharma-the-ai-driven-era-of-the-pharmaceutical-industry/>

1. <https://www.salesforce.com/healthcare-life-sciences/life-sciences-artificial-intelligence/ai-agents-in-pharma/>

1. <https://www.weforum.org/stories/2025/01/quantum-computing-drug-development/>

1. <https://cleanroomtechnology.com/what-are-digital-twins-and-what-is-their>

1. <https://ai.tataelxsi.com/healthcare-and-life-sciences/multimodal-ai-and-neuromorphic-ai-for-disease-detection-diagnosis-and-prognosis/>

1. <https://scads.ai/research/ai-algorithms-and-methods/methods-and-hardware-for-neuro-inspired-computing/projects/drug-discovery-on-the-spinnaker2-neuromorphic-supercomputer/>

1. <https://pmc.ncbi.nlm.nih.gov/articles/PMC8183422/>

1. <https://itechnotion.com/digital-health-ces-2025-ai-innovation>

1. <https://roboticsandautomationnews.com/2025/05/19/lab-automation-how-ai-and-robotics-are-accelerating-drug-discovery/90980/>

1. <https://ispe.org/pharmaceutical-engineering/march-april-2021/applying-robotic-process-automation-pharma-industry>

1. <https://mazerspace.com/extended-reality-xr-in-the-pharma-industry/>

1. <https://www.forbes.com/sites/digital-assets/2025/01/13/14-highlights-from-ces-2025-in-ai-robots-glasses-health-and-more/>

1. <https://www.cnet.com/pictures/ces-2025-we-still-see-these-35-products-when-we-close-our-eyes/>

1. <https://www.simplilearn.com/top-technology-trends-and-jobs-article>