BIOVIA

3DEXPERIENCE®

ACCELERATING DRUG DISCOVERY
BIOVIA'S VALIDATED PREDICTIVE SCIENCE SOLUTIONS

White Paper

DASSAULT SYSTEMES

DIGITAL TRNASFORMATION IN THE PHARMACEUTICAL INDUSTRY

Pharmaceutical industry has been undergoing an unprecedented digital transformation that has revolutionized several areas of research and development, including drug discovery. Those who embrace digital technologies and analytics tools stay competitive in the rapidly evolving landscape. Some of the factors driving this transformation include:

- **Impact of the COVID-19 Pandemic:** The COVID-19 pandemic emphasized the need for rapid response and collaboration across teams to develop vaccines and therapies. In addition, the discovery of genetic factors associated with susceptibility and severity of disease in certain populations highlighted the importance of personalized medicine. Lessons learned from COVID-19 are expected to influence future drug discovery processes. Digitized lab data, predictive modeling with artificial intelligence (AI) and machine learning (ML) for drug design, along with access to collaborative, secure cloud-platforms for data exchange will play a crucial role in development of new therapies and repurposing existing drugs.[1,2]
- **Advances in Science and Technology:** Developments in structural biology, sequencing, omics, and systems biology, and the advances in data science, bioinformatics and computational modeling have allowed researchers to better understand molecular and genetic drivers of human disease. Pharmaceutical companies are adopting digital and analytics tools to reduce the time and resources required to identify potential drug candidates, overcome diagnostic challenges, and develop targeted therapies.
- **Emergence of Biologics and Gene Therapies:** The growing prominence of biologics, including monoclonal antibodies, bispecifics, antibody drug conjugates, and cell and gene therapies, has expanded the therapeutic armamentarium for complex diseases, such as cancer. Many biopharma companies are shifting their focus toward discovery and development of these novel therapies.[3] Although these therapies exhibit higher specificity compared to the small molecule drugs, their development poses several unique challenges. Predictive modeling and analytics tools for optimizing therapeutic designs and delivery mechanisms (e.g., prediction of formulation properties, immunogenicity, toxicity, etc) and complex manufacturing processes will become more valuable for designing of biotherapeutics.

- **Personalized Medicine:** Precision medicine focuses on understanding and treating disease by using individual variability in genes, environment, and lifestyle of each person.[4] Advances in systems biology, omics, and next-generation sequencing are important factors driving personalized medicine; however, powerful computational and data analytics tools are necessary to identify therapeutic targets and other disease-related patterns from these large biological datasets. Drug developers are slowly embracing AI/ML-driven predictive approaches and computational modeling and simulation (MODSIM) for exploring complex biological systems to develop the most appropriate treatment for an individual patient.

These factors are driving a new, patient-oriented business model, where pharmaceutical companies are increasingly engaging in collaborative efforts inside and outside of their organization to pool resources and expertise. Open innovation models encourage sharing of knowledge and data, leading to more complex, integrated solutions that can be tailored to the specific needs of a patient.

A NEW ERA OF PREDICTIVE SCIENCES ON A UNIFIED PLATFORM

The predictive algorithms can help with a broad range of R&D challenges, while enabling scientists to evaluate many more hypotheses more quickly than is possible with experimentation alone. *In silico* methodologies not only enhance the quality and speed of decision making, they also provide a less expensive and more scalable approach to improving R&D efficiency, especially when deployed with a holistic vision in mind.

BIOVIA offers end-to-end business solutions across the entire drug discovery process, where researchers can easily capture, organize, and analyze chemical and biological data, make data-driven decisions, and eliminate pinch-points and errors resulting from manual data exchanges. Powered by AI and world-class *in silico* tools for 3D MODSIM, BIOVIA accelerates life-changing therapies to the market. Furthermore, extending these tools in a collaborative workspace, the **3D**EXPERIENCE platform on cloud, enables multidisciplinary project teams to share data and standardized analysis methods across the enterprise and among networked partners.

THE KEY BIOVIA SOLUTIONS FOR ACCELERATING DRUG DISCOVERY

BIOVIA Generative Therapeutics Design for small molecule therapeutics

BIOVIA Generative Therapeutics Design (GTD) is an AI-driven solution that automates the virtual creation, testing and selection of novel small molecules with a view to reducing expensive real-world testing. Research organizations can achieve true business transformation in molecular discovery by simultaneously improving lead quality and shortening discovery timelines, resulting in potential savings of millions of research dollars per program.

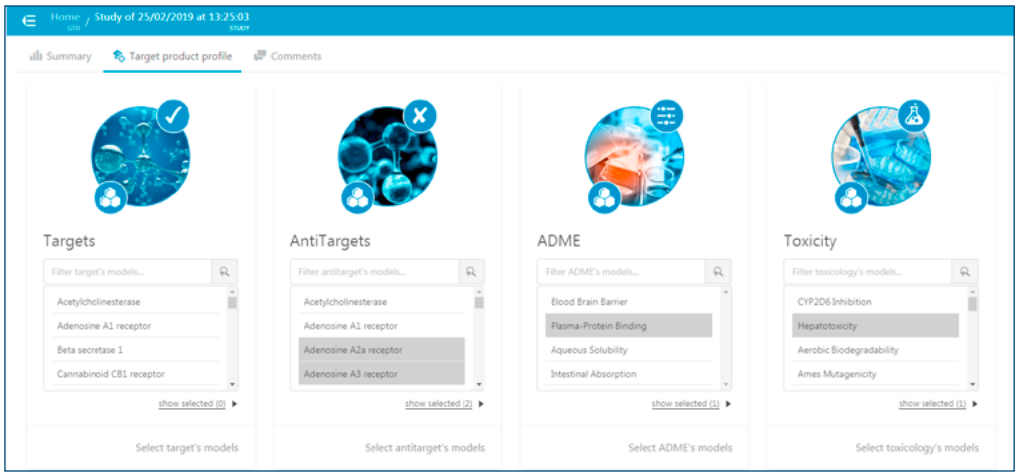


Figure 1. Target product profile is defined by selecting pre-built models for common targets, anti-targets, ADME (absorption, distribution, metabolism, excretion) and toxicity properties

The GTD discovery cycle combines virtual and real (V+R) activities in which the results of virtual generation and evaluation combined with real world synthesis and testing to allow active learning. Novel molecules advanced by the virtual generate-test-score-prune process move to the lab for synthesis and screening. Real world screening results allow the update of predictive models for subsequent cycles. Optimization continues until the target therapeutic profile is met. This iterative V+R cycle accelerates lead candidate design with improved quality, significantly reducing costs of experimentation and advancing only the most promising candidates to clinical trials. Scientists can also collaborate more easily who have worked with similar compounds.

Being available on the cloud provides organizations with a secure, validation-ready research informatics solution. Furthermore, users can build 3D pharmacophore models, use these models to score virtual compounds in the multi-objective optimization process, and publish custom-built models for use by team members. Other methods such as molecular docking, multisite lambda dynamics (MSLD), and free energy perturbation can provide additional ways to score the molecules for selecting the best candidates.

This comprehensive, knowledge-based drug discovery solution dramatically increases the impact of an AI-driven approach, truly helping to transform the efficiency of discovery efforts.

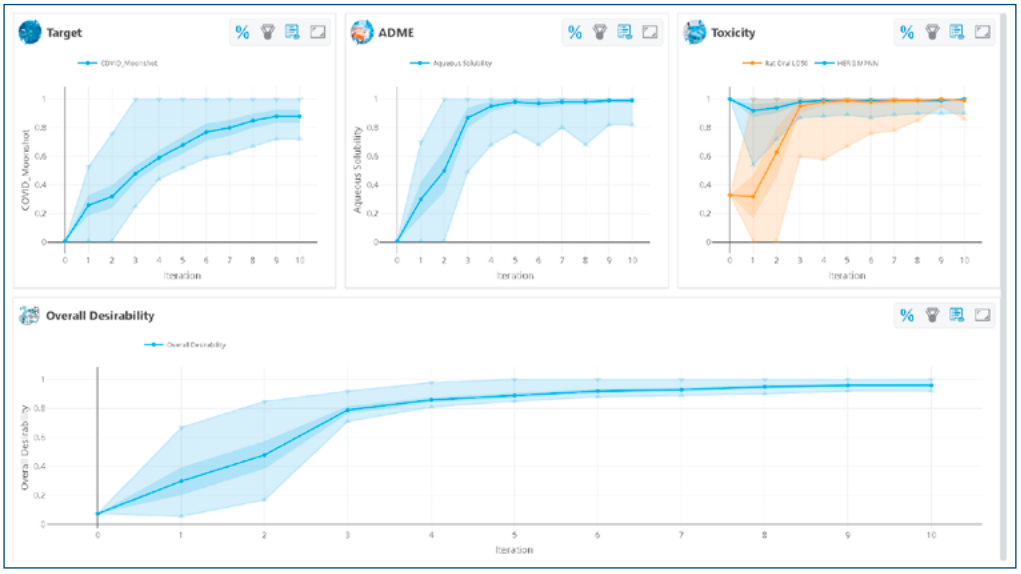


Figure 2. The optimization progress is monitored for individual objectives for virtually generated molecules

BIOVIA Discovery Studio Simulation for biotherapeutics and small molecule drugs

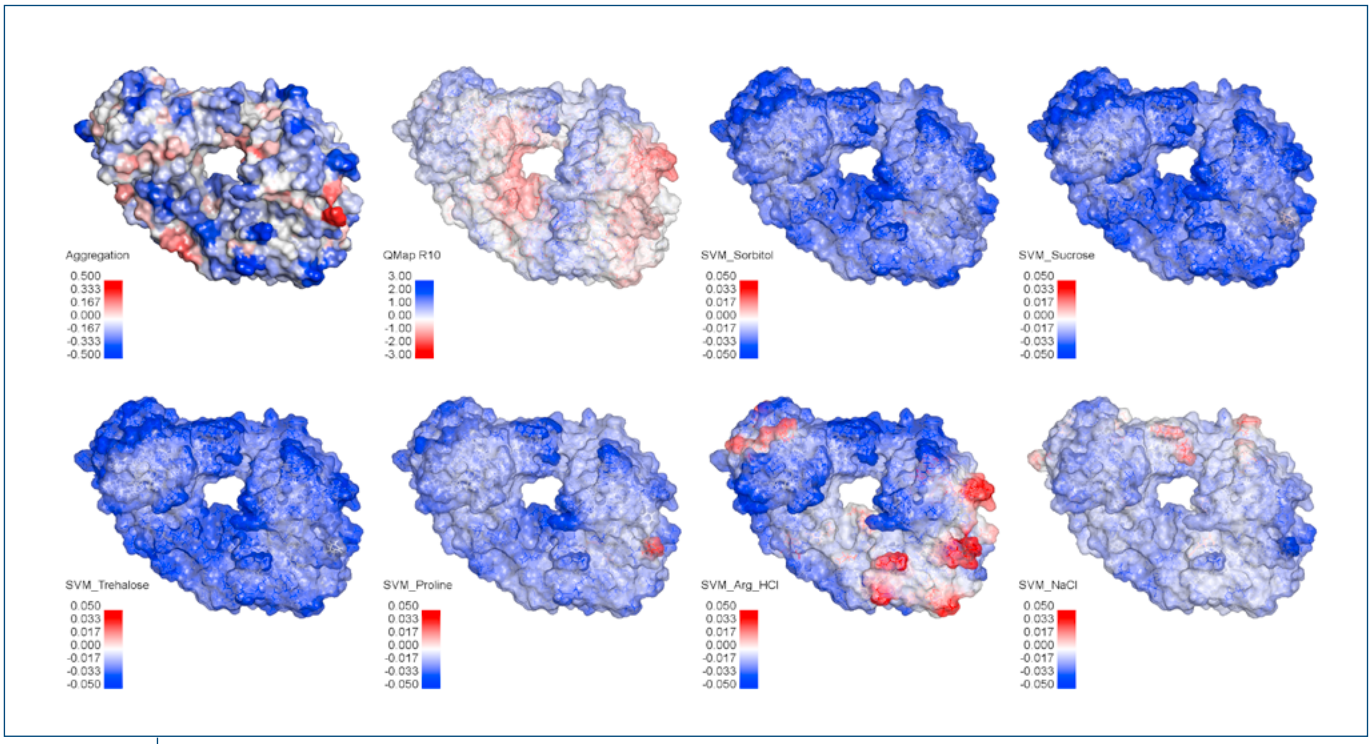


Figure 3. Predicted Aggregation and Charge QMap surfaces, and preferential excipient interactions of an antibody structure for optimizing protein formulation

BIOVIA Discovery Studio Simulation on the **3D**EXPERIENCE platform offers a wide range of powerful tools that enable computational chemists and computational structural biologists to engineer stable and optimized novel biotherapeutics and small molecule drugs with desired safety profiles. Using protein sequences, **BIOVIA Discovery Studio Simulation** users can perform motif predictions, generate high-quality 3D models with the market leading MODELER homology modeling algorithm, or evaluate the effect of combinatorial mutagenesis on protein stability or binding affinity. When designing biotherapeutics, users can improve antibody formulation by optimizing biophysical properties such as solubility, viscosity and Developability Index or the prediction of excipient interaction using machine learning models. With the ability of predicting humanizing mutations, they can minimize the immunogenicity of an antibody, without compromising its stability or efficacy.

Validated force field-based methods (e.g., Molecular Dynamics methods: CHARMm, NAMD) ensure that computational experts can also study the biophysical characteristics of solvated macromolecules to understand mechanisms of action and optimize essential biomolecular interactions. These physics-based simulations complement existing offerings in small molecule design including ligand-based (Catalyst) and protein-based (GOLD, CDOCKER) virtual screening methods. Small molecules can be designed by ligand-enumeration and scaffold-hopping workflows, and triaged with ADMET property calculation and toxicity and environmental effects assessments.

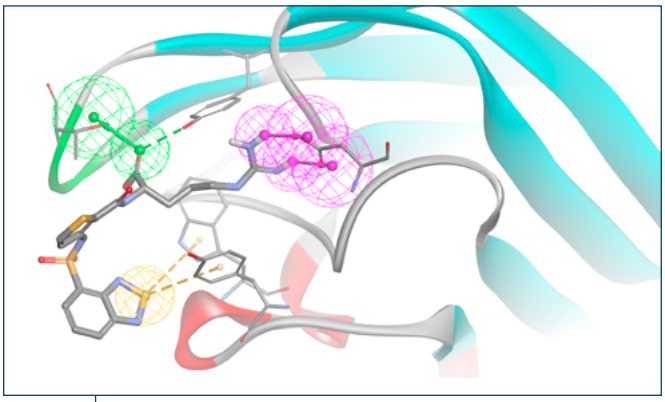


Figure 4. Pharmacophore models, structure-based or ligand-derived, for fast and powerful virtual screening

COMPLETE SUITE OF INNOVATIVE SOLUTIONS FOR AN END-TO-END DRUG DISCOVERY

In addition to **Discovery Studio Simulation** and **Generative Therapeutics Design**, BIOVIA provides scientists with advanced, end-to-end business solutions on a single cloud-based platform, to support the discovery and development of biotherapeutics and small molecule drugs. The **3D**EXPERIENCE platform improves collaboration across cross-functional teams within the organization or external organizations such as CROs.

BIOVIA solutions supporting drug discovery and development on the **3D**EXPERIENCE platform include:

- **BIOVIA Generative Therapeutics Design** – Generate ideas for what to make next with AI to accelerate small molecule therapeutics design.
- **BIOVIA Discovery Studio Simulation** – Accelerate small molecule and biotherapeutics design with a comprehensive portfolio of validated molecular 3D MODSIM tools.
- **BIOVIA Insight for Research** – Gain insight into your research data to make fast informed decisions while collaborating with internal teams and across networked external organizations.
- **BIOVIA Scientific Notebook** - Transform your lab with a cloud-native Electronic Lab Notebook (ELN) that takes a data-centric approach, instead of the traditional document-centric one.
- **BIOVIA Machine Learning Workbench** – Advance drug discovery by building and managing chemistry-based machine learning models that refine your molecular design exploration space.

CONCLUSION

The leaders in the Life Sciences industry are increasingly turning to integrated, platform-based solutions to solve their challenges in drug discovery and accelerate drug development.

BIOVIA solutions on the **3D**EXPERIENCE platform offers a holistic and transformative approach to drug discovery and development with:

- **End-to-End Integration**: Streamlining workflows, data management, and collaboration to work more efficiently and make data-driven decisions.
- **Advanced Modeling and Simulation**: Accelerating early-stage discovery of biotherapeutics and small molecule drugs with a comprehensive set of validated, integrated predictive science solutions built on over 25 years of expertise in MODSIM, Data Science, and Informatics.
- **Personalized Medicine and Biomarker Discovery**: Integrating advanced capabilities for analyzing large datasets to identify potential targets and patient subgroups; enhance the precision and efficacy of developed therapies.
- **Enhance Quality and Efficiency**: Identifying undesirable pharmacological and biological developability issues early in discovery before progression to development; accelerating better drugs to market with fewer resources consumed.
- **Collaborative Research Environment**: Collaborating across multidisciplinary teams seamlessly while increasing productivity and reducing time-to-market; enhancing efficiency without growing your team.
- **Data Management and Governance**: Ensuring data integrity, security, and traceability throughout the drug discovery lifecycle; managing data with compliance to regulatory requirements and good laboratory practices.
- **Efficient Laboratory Operations**: Automating and standardizing experimental workflows with BIOVIA's laboratory informatics solutions, while reducing manual errors and redundant tasks.
- **Scalability and Flexibility**: Access to scalable solutions, accommodating the needs of both small research teams and large pharmaceutical organizations; customizing and adopting workflows driven by the requirements of your own research.

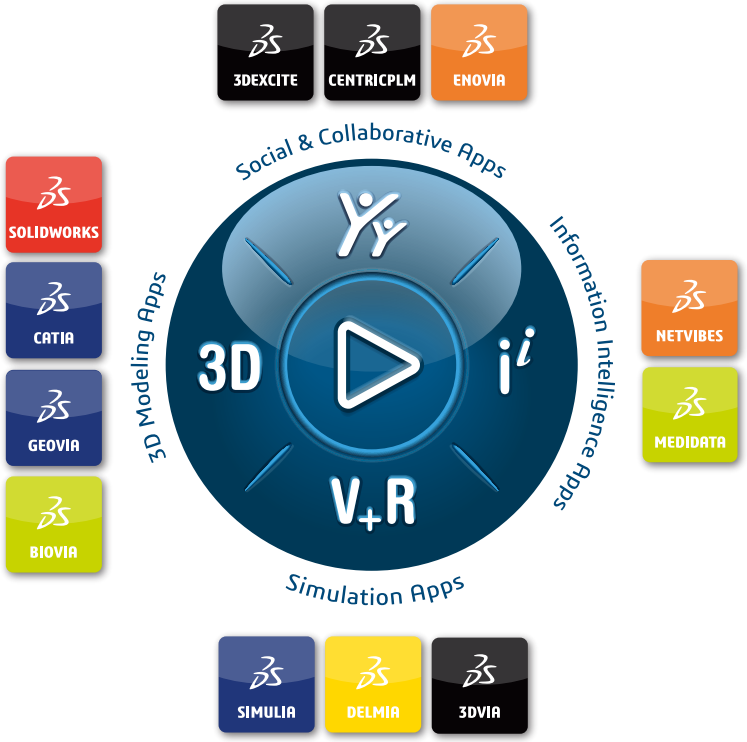
By leveraging the comprehensive functionality of the **3D**EXPERIENCE platform, BIOVIA provides scientists with a unified experience and a true end-to-end business transformation, which is completely unique in the marketplace.

Elevate your drug discovery research with BIOVIA.

LEARN MORE

REFERENCES

1. Billions to millions: Improving R&D productivity. Accenture. Published October 25, 2021. Available at https://www.accenture.com/us-en/insights/life-sciences/from-billions-to-millions-transformation.
2. Top ten observations from 2022 in life sciences digital and analytics. McKinsey & Company. Published January 31, 2023. Available at https://www.mckinsey.com/industries/life-sciences/our-insights/top-ten-observations-from-2022-in-life-sciences-digital-and-analytics.
3. Tom Yang, Sonal Shah, Christine Chang. The future of biopharma: Reimagining traditional business models in 2040. Published 23 March 2020. Available at https://www2.deloitte.com/xe/en/insights/industry/health-care/future-of-pharmaceutical-industry.html.
4. National Institute of Health. The Precision Medicine Initiative. https://www.nih.gov/sites/default/files/research-training/initiatives/pmi/pmi-infographic.pdf



Our **3D**EXPERIENCE® platform powers our brand applications, serving 11 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the **3D**EXPERIENCE Company, is a catalyst for human progress. We provide business and people with collaborative virtual environments to imagine sustainable innovations. By creating 'virtual experience twins' of the real world with our **3D**EXPERIENCE platform and applications, our customers push the boundaries of innovation, learning and production.

Dassault Systèmes' 20,000 employees are bringing value to more than 270,000 customers of all sizes, in all industries, in more than 140 countries. For more information, visit **www.3ds.com**.

Europe/Middle East/Africa
Dassault Systèmes
10, rue Marcel Dassault
CS 40501
78946 Vélizy-Villacoublay Cedex
France

Asia-Pacific
Dassault Systèmes K.K.
ThinkPark Tower
2-1-1 Osaki, Shinagawa-ku,
Tokyo 141-6020
Japan

Americas
Dassault Systèmes
175 Wyman Street
Waltham, Massachusetts
02451-1223
USA

DASSAULT SYSTEMES | The **3D**EXPERIENCE® Company