VIVA

2025 TECHNOLOGY INNOVATION LEADER

Enhancing Customer Impact Through Powerful Technology Integration

RECOGNIZED FOR BEST PRACTICES IN THE APAC INTEGRATED INTELLIGENT DRUG DISCOVERY INDUSTRY

FROST & SULLIVAN

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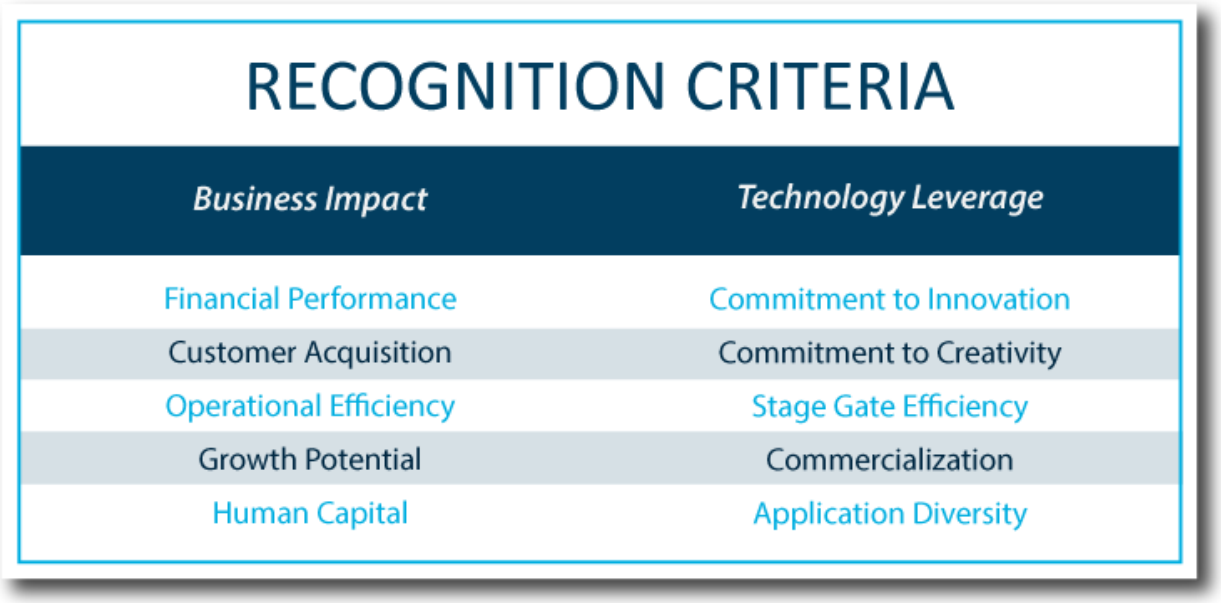
Best Practices Criteria for World-class Performance

Frost & Sullivan applies a rigorous analytical process to evaluate multiple nominees for each recognition category before determining the final recognition recipient. The process involves a detailed evaluation of best practices criteria across two dimensions for each nominated company. Viva Biotech excels in many of the criteria in the integrated intelligent drug discovery space.



The Transformation of the Integrated Intelligent Drug Discovery Industry

The global pharmaceutical research and development (R&D) pipeline accounted for more than 21,000 molecules in April 2023, representing a 5.8% increase from 2022, with more than 6,100 molecules in active development.[1] In general, however, the pharmaceutical and biopharmaceutical industry has stagnated with respect to R&D activity. Overall R&D expenditure totaled approximately $276.81 billion, with a slow 2.5% growth between 2023 and 2024.[2] The decline in the year-on-year growth rate is the result of a shift in focus from COVID-19 therapies to more mainstream therapies including oncology, neurology, and respiratory, resulting in overall market normalization with respect to growth rates. Furthermore, the industry witnessed a decline in the average return on investment for R&D to as low as 1.2% while peak sales per asset valued just above $350 million, indicating a need to build more efficient drug development processes through the implementation of newer technologies.[3]

Of total R&D expenditure, the top 10 pharma companies accounted for just 4% to 5% of the pipeline, while the top 25 contributed to less than 10%.[4] In contrast, small-to-mid segment and emerging biopharma players (companies with 1 or 2 molecules in the pipeline) are the major contributors, accounting for more than 16% of the active pipeline.[5] As a result, the demand for outsourcing activities is

[1] *Growth Opportunities in Drug Discovery and Early Development Outsourcing Services* (Frost & Sullivan, February 2024)
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] Ibid.

on the rise globally, with contract research organizations (CROs) and contract development and manufacturing organizations (CDMOs) contributing to the strong industry growth.

Moreover, advancements in multiple emerging biotechnology platforms, such as ribonucleic acid (RNA) technology, protein degradation (PROTAC), and antibody engineering technologies, coupled with the application of digital health technologies in the form of artificial intelligence (AI) and machine learning, are supporting unprecedented innovation, ascertaining increased success of a molecule. This activity is improving the partnership landscape across the global drug discovery and preclinical development industry.

Overall, the sector is witnessing the emergence of specialized lab testing and bioanalytical CROs. With capabilities like next-generation sequencing and high throughput screening, crucial to drug development, a steady rise in CRO and central lab partnerships is underway. Additionally, several specialized bioinformatics CROs are emerging and creating greater partnership opportunities. The larger CROs have developed separate lab testing divisions, allowing them to focus on specific drug discovery and preclinical development testing services.

Moving forward, CROs/CDMOs will likely focus on targeted scale-up of preclinical capabilities through cross-industry and academic partnerships, ascertaining knowledge transfer to pharma companies through licensing opportunities. They will therefore support greater innovation while transitioning from a vendor model to a partnership model.

Viva Biotech: Integrating AI- and Laboratory Driven Drug Discovery

Founded in 2008 and headquartered in Shanghai, China, Viva Biotech is a leading contract research organization (CRO) specializing in AI-driven drug discovery (AIDD) and structure-based drug design (SBDD). The company combines computational modeling, generative AI, and extensive wet lab capabilities to accelerate the discovery of small molecules, antibodies, peptides, fusion proteins, PROTACs, molecular glues, and RNA-targeting compounds. Viva Biotech emphasizes iterative workflows that link *in silico* predictions directly with experimental validation, allowing for rapid refinement of drug candidates. By maintaining in-house expertise across all preclinical drug discovery stages and providing seamless integration of AI-driven lab-in-the-loop solutions, the company helps partners explore and advance diverse drug modalities efficiently.

Transforming R&D Through Multimodal Discovery

Viva Biotech established its AIDD platform in 2021 to address strong client demand and leverage the transformative potential of emerging AI tools. The initiative builds on the platform leader Yue Qian's expertise in computational chemistry and drug discovery, drawing from top academic and research institutions, including Yale University and the Broad Institute of MIT and Harvard. The AIDD team brings together top talents with diverse scientific backgrounds and comprehensive skill sets to pioneer new AI methodology development. The team’s experience provided early insight into how AI could accelerate the R&D process such as hit identification and lead optimization and ultimately reshape the entire drug discovery paradigm.

The AIDD platform evolves in tandem with Viva's world-leading structural biology capability. Structure-based drug design (SBDD) as an inseparable principle in driving successful drug discovery campaigns is leveraged by AI technology that translates structural insights into rational *in silico* design. This unique

synergy between AIDD and SBDD reaches its full potential at Viva with its focus on preclinical drug discovery, where AI tools have demonstrated the largest impacts. Since its establishment, the AIDD platform addresses key industrial challenges by shortening discovery timelines, reducing costs, and supporting a full range of therapeutic modalities throughout the preclinical stage. Unlike many AI-focused biotech firms that prioritize investor expectations, Viva Biotech implements AIDD into its contract research operations, focusing entirely on validated experimental outcomes, upholding the drug candidate delivery as the golden standard rather than external pressures for rapid commercialization.

Viva Biotech differentiates its platform through methodology developments grounded in real-world challenges. Rather than chasing model performance metrics and building tools in isolation, the team innovates solutions arising from ongoing research collaborations. Models are trained on carefully curated datasets with deep understanding of underlying mechanisms of action coupled with state-of-the-art model architectures. These internally built tools are tailored, practical, and reliable. At Viva's May launch event, *Enchantment of AIDD*, Dr. Qian presented these core capabilities that the team has developed and been using routinely. These models as the backbone of the AIDD platform are split into three modules: V-Scepter, V-Orb, and V- Mantle.

V-Scepter forms the foundation. It consists of automated parameterization for biological systems such as small molecules and peptides including noncanonical amino acids, critical for both physics-based simulations and data-driven generative models. It incorporates predictive modules such as Absorption, Distribution, Metabolism, Excretion, and Toxicity (ADMET) to evaluate pharmacokinetics early, balancing affinity optimization with drug-like properties. Simultaneous optimization of multiple objectives—including binding affinity, ADMET properties, and pharmacokinetics—ensures higher success rate and less back-and-forth iterations. In addition, Toolkit as part of the V-scepter module is constantly updated with new features, all of which function as indispensable tools for drug discovery endeavors.

V-Orb encompasses physics-driven modeling, applying Newton's Law to capture protein dynamics and atomic interactions. Molecular Dynamics (MD) with enhanced sampling provides insights into subtle differences between closely related targets, such as homologous enzymes that require selective inhibition. It uncovers the full conformational landscape when combined with Viva's expertise in solving X-ray and cryo-EM structures, particularly for membrane proteins. Free Energy Perturbation (FEP) is widely adopted as the most accurate affinity prediction tool in the lead optimization stage. Viva's proprietary FEP calculation suites are optimized for non-covalent and covalent binders as well as biologics. V-Orb further integrates active learning with virtual screening to accelerate drug discovery, speeding up the hit identification campaign with high enrichment factors.

V-Mantle hosts generative AI capabilities, including protein large language models for protein, antibody, peptide, and their derivatives. It functions as the foundation of V-Mantle's primary capabilities: structure prediction, small molecule *de novo* design, epitope prediction, and the antibody engineering workflow. Specifically for antibody, a streamlined process is incorporated that includes *de novo* design, affinity maturation and detuning, antibody format selection and conversion, and a range of developability index predictions. The antibody design workflow represents Viva's revolutionary approach to AI-driven drug discovery.

Viva Biotech's lab-in-the-loop AI-driven antibody discovery workflow begins with AI-generated sequences rather than traditional methods such as animal immunization or in vitro display. This data- and principle-driven approach reduces the number of required sequences from billions to a manageable set and establishes the foundation for closed-loop learning. Lab validation takes only a few weeks, and iterative experimental feedback enables model refinement, completing a full cycle in under a month while increasing the likelihood of success in subsequent rounds. In-house scientists express and test sequences using biophysical and functional assays, feeding experimental results back into iterative design cycles. A series of developability measurements is taken to ensure favorable antibody drug-like properties and clinical viability. This process accelerates antibody discovery and refines AI predictions and continuously.

Likewise, Viva's unique AI-driven small molecule discovery combines generative design with experimental feedback. This is enabled by structural determination coupled with dynamic sampling or joint-folding followed by pocket identification. Small molecule *de novo* design tools conditioned on binding pockets give access to a vastly larger chemical space. The efficient design-make-test cycle sends hit compounds to the lead optimization stage, which is further advanced under the guidance of *in silico* affinity predictions such as FEP. The ADMET predictions are carried out simultaneously to optimize the overall drug profile and reduce trial cycles. These tools collectively represent the new paradigm of small molecule discovery workflow at Viva.

Together, the three modules function as a unified platform, with V-Scepter handling data preparation and force field parameterization, V-Orb focusing on first-principle calculations, and V-Mantle providing the generative AI engine and streamlined AI-driven design workflows. The integration of AI-guided design with experimental validation enhances accuracy, reduces design iterations, and improves hit-to-lead conversion. This dry-lab and wet-lab synergy has led to notable successes across diverse therapeutic modalities, guiding projects from initial design through preclinical stages.

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>
> ***- Marcos Ainchil***
> ***BPR Analyst***

Antibody-drug conjugates (ADCs) sit in the intersection of small molecule chemistry and antibody engineering, where Viva's AIDD engine powers both. From the small molecule perspective, AI guides linker and payload selection with linker stability forecasts and molecular property predictions. From the antibody perspective, the platform's generative techniques drive antibody discovery and optimization, developability improvement (aggregation, immunogenicity, half-life), and the introduction of conjugation sites to preserve function post-linkage. Viva's cross-functional teams involve expression, analytical characterization, biophysical and functional assays, immunoassays and cytokine profiling, and ADC characterizations. In addition, preclinical support spans five-species PK, safety/tox, and in vitro/ex vivo mechanism and biomarker studies for clients worldwide. Overall, the AI-led platform translates into rapid design and refinement of ADC/AOC/APC and broader XDC programs.

Viva Biotech supports a broad range of antibody format construction, including monoclonal, bispecific, trispecific, nanobodies, variable domain of heavy-chain-only antibodies (VHHs), Fab and single-chain variable fragments (scFvs), applying tailored solutions to stability and developability challenges. Examples include extending heavy chain complementarity-determining region 3 (CDR3) regions in VHHs, stabilizing scFvs, optimizing bispecific antibodies through aggregation assessment, and Fc engineering to improve antibody stability and half-life.

Viva Biotech extends its platform beyond small molecules and antibodies to emerging modalities. Viva's dedicated peptide sets the standard high in complex peptide synthesis that covers multiple cyclic peptides, modifications with various unnatural moieties, as well as cross conjugation between distinct peptides. To date, the team has delivered thousands of peptides and hundreds of peptide–small molecule conjugation (RDC). This is an organic complement to the AIDD technique where the cyclic peptide discovery incorporates unnatural amino acids and cyclization to improve bioavailability and cell permeability. A comprehensive *in silico* unnatural amino acid database is constantly updated to ensure chemical diversity and enable automated peptide design. Furthermore, the company employs its DNA-encoded library (DEL) platform for peptide screening, where a series of cyclic peptide libraries are made, totaling thousands of billions of compounds.

In addition to the aforementioned cases, specialized workflows support protein degraders, such as PROTACs and molecular glues, enabling rational design of ternary complexes and addressing previously undruggable targets. It is worth mentioning that the platform supports RNA-targeting small molecules using a unique molecular dynamics workflow to capture high-flexible mechanisms.

Viva Biotech provides feasibility assessments to identify the most promising modality for each target, leveraging expertise across therapeutic classes. The integrated AI-driven platform reduces discovery timelines by 30–50%, with small molecules around 30% and biologics accelerated up to 50%.[6] Antibody discovery, which typically takes months via animal immunization or phage display, can generate initial candidates within two weeks, with subsequent optimization cycles lasting less than a month. This AI-first approach accelerates timelines by a factor of two to three and reduces overall development costs by 50–70% as projects advance toward the preclinical candidate stage. The company proposes project timelines of nine to twelve months, even for complex first-in-class programs, providing partners with faster decision-making, lower risks, and reduced R&D expenditure.

The versatility in drug modality allows Viva Biotech to support various innovation strategies, reinforcing global competitiveness and enabling clients to explore new modalities with educated expertise, greater confidence, and faster timelines. The AIDD platform contributes significantly to the company’s revenue, reflecting strong client demand, while integrated service models offer milestone-based collaborations that lower upfront costs and align incentives for long-term success.

Built on physics-informed and data-driven models within a lab-in-the-loop framework, Viva Biotech’s AIDD platform combines scientific expertise, proprietary methodologies, and mechanism-aware curation of data to accelerate timelines, improve accuracy, and provide efficient, end-to-end drug discovery solutions across multiple therapeutic classes.

[6] Frost & Sullivan’s Best Practices Research Interview of Viva Biotech (August 2025)

As a contract research organization, Viva Biotech does not retain intellectual property for client molecules, while frequently leading fully integrated projects. The company assumes responsibility for discovery, experimentation, decision-making, and project management, while clients retain ownership of the molecules. Client projects vary in scope: some have predefined targets and modalities, while others rely on Viva Biotech to determine strategy. Viva Biotech provides feasibility assessments to identify the most promising modality for each target, leveraging expertise across therapeutic classes. The company adapts to requests ranging from fast-follow programs to best-in-class and first-in-class initiatives by proposing modality-specific strategies, providing target-relevant compound libraries, and picturing clear experimental roadmaps, all within accelerated timelines.

Scaling Global Impact Through Proven Commercialization

The company's business model further sets it apart: by not retaining intellectual property, Viva Biotech ensures clients receive full ownership of outcomes, providing a clear value proposition that contrasts with competitors running proprietary pipelines.

The platform has demonstrated a success rate of more than 80%, with results delivered in weeks from *in silico* design and virtual screening followed by swift optimization, including for complex targets such as RNA DNAs and membrane proteins. Clients worldwide have leveraged the platform to address challenging therapeutic areas, with oncology historically leading demand. Increasing interest has emerged in autoimmune diseases, driven by the effectiveness of peptides as protein-protein interaction disruptors and by precedents set through validated antibody targets. Growth is also notable in metabolic diseases, spurred by advances related to GLP-1 and heightened global attention to health and wellness.

Viva Biotech's AI-driven drug discovery platform distinguishes itself through several key differentiators. Competitors, such as Insilico Medicine, Recursion, and XtalPi, often focus on narrower therapeutic areas or broader "AI-for-science" applications. In contrast, Viva Biotech emphasizes drug discovery across multiple modalities—including small molecules, antibodies, cyclic peptides, PROTACs, molecular glues, and RNA-targeting compounds—supported by dedicated teams for each modality. Its in-house wet lab and dry lab infrastructure enable seamless integration of computational design and experimental validation, allowing rapid project initiation without outsourcing delays. The AIDD platform also incorporates multimodal data, including proteomics, genomics, metabolomics, and clinical evidence, supporting both drug discovery and targeted drug repurposing. This integration enables the company to validate hypotheses experimentally rather than generating purely theoretical reports, enhancing translational value for clients.

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>
> ***- Priyanka Jain***
> ***Senior Research Analyst***

The impact of Viva's integrated solutions is demonstrated in clinical programs. These include a Proprotein Convertase Subtilisin/Kexin Type 9 (PCSK9) allosteric inhibitor, later acquired by AstraZeneca (AZD0780, now in Phase III) and the discovery of a first-in-class oral Mat2a inhibitor for oncology, where the clinical

candidate is obtained within 3 years and currently in Phase II. Viva Biotech enabled partners globally to secure high-profile partnerships with top pharmaceutical companies, many of which involve multi-million-dollar agreements. These breakthroughs leveraged the company's AIDD platform, specifically built to address challenging targets and novel mechanisms.

Viva Biotech's AIDD platform has supported 157 projects, with 51 clients procuring AIDD services, spanning both fast-follow and first-in-class programs.[7] These collaborations highlight the scalability of its approach across therapeutic areas, from oncology to metabolic and pH-dependent membrane protein targets, where the platform enables the discovery of multiple small molecules with distinct binding sites and mechanisms of action.

Empowering Teams Through Integrated Efficiency

Viva Biotech differentiates itself in the competitive AI-based drug discovery market by combining breadth of capability with operational efficiency. Unlike peers that focus on narrower areas, such as biologics or small molecules, the company supports diverse modalities and manages multiple projects in parallel. Its in-house wet lab and dry lab infrastructure enables immediate project initiation once a target is defined, significantly accelerating timelines.

All modules function within a lab-in-the-loop system that integrates seamlessly with Viva Biotech's extensive preclinical wet lab infrastructure. The company has built a comprehensive experimental environment that allows AI-driven predictions and designed compounds to be immediately validated and iteratively refined by bench scientists. This close collaboration between computational and experimental teams ensures rapid translation of design into validated outcomes.

Conclusion

Viva Biotech's unique ability to integrate advanced artificial intelligence-driven modeling with extensive wet lab validation led to one of the most versatile discovery platforms in the industry. By supporting diverse modalities, from small molecules, peptides and antibodies to emerging modalities like protein degradation, molecular glues, and ribonucleic acid-targeting compounds, the company accelerates timelines and reduces research and development costs for its global clients. Its proven track record, demonstrated by multiple clinical-stage programs and high-impact collaborations, underscores its commercial and scientific strength. With a business model that ensures full ownership for clients, Viva Biotech builds deep trust while driving innovation across therapeutic areas.

With its strong overall performance, Viva Biotech earns Frost & Sullivan's 2025 APAC Technology Innovation Leadership Recognition in the integrated intelligent drug discovery industry.

[7] Frost & Sullivan's Best Practices Research Interview of Viva Biotech (August 2025)

What You Need to Know about the Technology Innovation Leadership Recognition

Frost & Sullivan's Technology Innovation Leadership Recognition is its top honor and recognizes the market participant that exemplifies visionary innovation, market-leading performance, and unmatched customer care.

Best Practices Recognition Analysis

For the Technology Innovation Leadership Recognition, Frost & Sullivan analysts independently evaluated the criteria listed below.

Technology Leverage

Commitment to Innovation: Continuous emerging technology adoption and creation enables new product development and enhances product performance

Commitment to Creativity: Company leverages technology advancements to push the limits of form and function in the pursuit of white space innovation

Stage Gate Efficiency: Technology adoption enhances the stage gate process for launching new products and solutions

Commercialization: Company displays a proven track record of taking new technologies to market with a high success rate

Application Diversity: Company develops and/or integrates technology that serves multiple applications and multiple environments

Business Impact

Financial Performance: Strong overall business performance is achieved in terms of revenue, revenue growth, operating margin, and other key financial metrics

Customer Acquisition: Customer-facing processes support efficient and consistent new customer acquisition while enhancing customer retention

Operational Efficiency: Company staff performs assigned tasks productively, quickly, and to a high-quality standard

Growth Potential: Growth is fostered by a strong customer focus that strengthens the brand and reinforces customer loyalty

Human Capital: Leveraging innovative technology characterizes the company culture, which enhances employee morale and retention

Best Practices Recognition Analytics Methodology

Inspire the World to Support True Leaders

This long-term process spans 12 months, beginning with the prioritization of the sector. It involves a rigorous approach that includes comprehensive scanning and analytics to identify key best practice trends. A dedicated team of analysts, advisors, coaches, and experts collaborates closely, ensuring thorough review and input. The goal is to maximize the company's long-term value by leveraging unique perspectives to support each Best Practice Recognition and identify meaningful transformation and impact.

		VALUE IMPACT	
STEP		WHAT	WHY
1	**Opportunity Universe**	Identify Sectors with the Greatest Impact on the Global Economy	Value to Economic Development
2	**Transformational Model**	Analyze Strategic Imperatives That Drive Transformation	Understand and Create a Winning Strategy
3	**Ecosystem**	Map Critical Value Chains	Comprehensive Community that Shapes the Sector
4	**Growth Generator**	Data Foundation That Provides Decision Support System	Spark Opportunities and Accelerate Decision-making
5	**Growth Opportunities**	Identify Opportunities Generated by Companies	Drive the Transformation of the Industry
6	**Frost Radar**	Benchmark Companies on Future Growth Potential	Identify Most Powerful Companies to Action
7	**Best Practices**	Identify Companies Achieving Best Practices in All Critical Perspectives	Inspire the World
8	**Companies to Action**	Tell Your Story to the World (BICEP*)	Ecosystem Community Supporting Future Success

*Board of Directors, Investors, Customers, Employees, Partners

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The Growth Pipeline Generator™

Frost & Sullivan's proprietary model to systematically create ongoing growth opportunities and strategies for our clients is fueled by the Innovation Generator™.

Learn more.

Key Impacts:

- **Growth Pipeline:** *Continuous Flow of Growth Opportunities*
- **Growth Strategies:** *Proven Best Practices*
- **Innovation Culture:** *Optimized Customer Experience*
- **ROI & Margin:** *Implementation Excellence*
- **Transformational Growth:** *Industry Leadership*

The Innovation Generator™

Our 6 analytical perspectives are crucial in capturing the broadest range of innovative growth opportunities, most of which occur at the points of these perspectives.

Analytical Perspectives:

- Megatrend (MT)
- Business Model (BM)
- Technology (TE)
- Industries (IN)
- Customer (CU)
- Geographies (GE)