Drug Development® & Delivery

November/December 2022 Vol 22 No 8 www.drug-dev.com

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Joe Dervan, PhD
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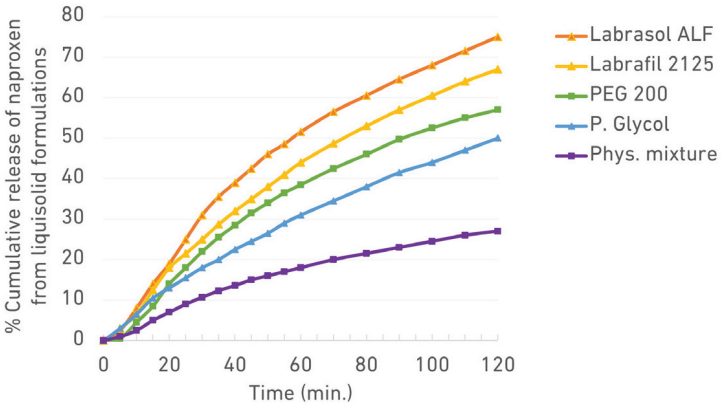
NOBU SHIMBA, PHD

GATTEFOSSÉ

Solid SELF Dispersion by Adsorption

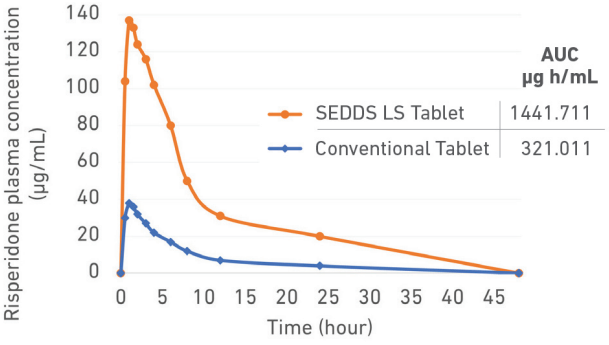
Liquisolid technologies

Liquid SELF formulations may be converted into solid dosage forms by a number of adsorption techniques. The approach has produced satisfactory results for enhancing the dissolution of several drug actives, including naproxen:



Naproxen dissolution profiles obtained from liquisolid pellets of various liquid vehicles (Lam, 2019)

In another example, a liquisolid formulation of risperidone in the form of a SEDDS tablet was evaluated *in vitro* and *in vivo*, where bioavailability of the SEDDS tablets was 4.5 times higher than that observed with the commercial tablets. (Khames, 2017)



Pharmacokinetic parameters of risperidone liquisolid (LS) tablet from Labrasol/ Labrafil (1:1) mixture compared to conventional tablet (Khames, 2017)

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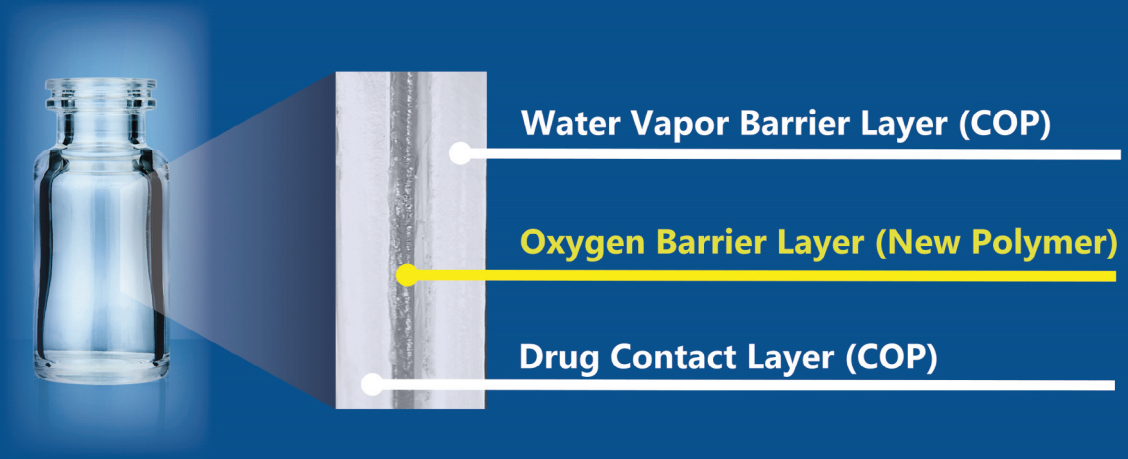

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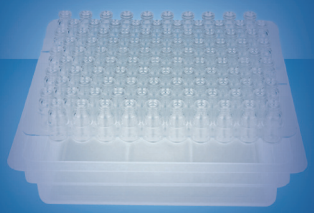

Nest & Tub for Vial

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XOMA Acquires Royalty & Milestone License to Ebopiprant, a Preterm Labor Asset, Being Developed by Organon

XOMA Corporation recently announced it has acquired all rights and title to ebopiprant held by ObsEva for $15 million plus certain earn-out payments. XOMA has assumed the ebopiprant intellectual property (IP) estate and all license agreements, including the 2021 exclusive license agreement from ObsEva to Organon related to the development and commercialization of ebopiprant.

"We are very pleased to add ebopiprant to XOMA's royalty and milestone portfolio. Preterm labor is extremely stressful for expectant parents and their families. The costs to care for premature babies can quickly escalate to hundreds of thousands of dollars, resulting in long-term financial distress for many families," said Jim Neal, Chairman and Chief Executive Officer of XOMA. "The economics in the ebopiprant license acquisition have the potential to deliver significant returns to XOMA and our stockholders from the clinical development milestones alone. We wish Organon, a global women's health company, success in its development activities with ebopiprant."

Under the terms of the agreement, XOMA has acquired all rights to ebopiprant held by ObsEva, including the Organon/ObsEva license agreement and the IP associated with the asset. XOMA will now be entitled to receive up to $475 million in development, regulatory, and sales-based milestone payments under the ObsEva/Organon license agreement. XOMA will pay to ObsEva a portion of the development and regulatory milestones, as well as certain sales milestones, up to $98 million. Upon commercialization, XOMA will receive royalties that range from low- to mid-teens from Organon and will make a mid-single-digit royalty payment to Merck KGaA, Darmstadt, Germany.

Ebopiprant (OBE022) was licensed by ObsEva from Merck KGaA, Darmstadt, Germany, in 2015. ObsEva previously announced positive results from PROLONG Part B, a 113-patient Phase 2a proof-of-concept, randomized, double-blind, placebo-controlled trial in women experiencing spontaneous preterm labor that compared atosiban (ex-US standard of care) plus ebopiprant versus atosiban plus placebo for 7 days. In the study, ebopiprant plus atosiban reduced delivery in singleton pregnancies at 48 hours after the start of dosing by 55% compared to atosiban plus placebo. Overall, 12.5% of women receiving ebopiprant plus atosiban delivered within 48 hours of starting treatment compared to 21.8% receiving atosiban plus placebo (OR 90% CI: 0.52 (0.22, 1.23)). The incidence of maternal, fetal, and neonatal adverse events were comparable between both the ebopiprant and placebo groups.

XOMA is a biotechnology royalty aggregator playing a distinctive role in helping biotech companies achieve their goal of improving human health. XOMA acquires the potential future economics associated with pre-commercial therapeutic candidates that have been licensed to pharmaceutical or biotechnology companies. When XOMA acquires the future economics, the seller receives non-dilutive, non-recourse funding they can use to advance their internal drug candidate(s) or for general corporate purposes. The company has an extensive and growing portfolio with more than 70 assets (asset defined as the right to receive potential future economics associated with the advancement of an underlying therapeutic candidate).

RxCelerate Acquires Methuselah Health & Launches ProQuant World-Beating Proteomics Service

RxCelerate recently announced the acquisition of drug discovery company Methuselah Health UK Ltd for an undisclosed sum. Methuselah Health was founded in 2015 to discover drugs for age-related diseases driven by proteomic instability and has developed the world's most powerful proteomics platform to power its discovery efforts.

"Until now, the ProQuant proteomics technology has only been available for the internal discovery programs at Methuselah Health," said Jill Reckless, CEO at RxCelerate. "But as soon as we saw just how powerful this technology was, we had to add it to our service offering. Through this acquisition, the proprietary ProQuant platform will be exclusively available to our clients, giving them access to the best proteomics technology available anywhere."

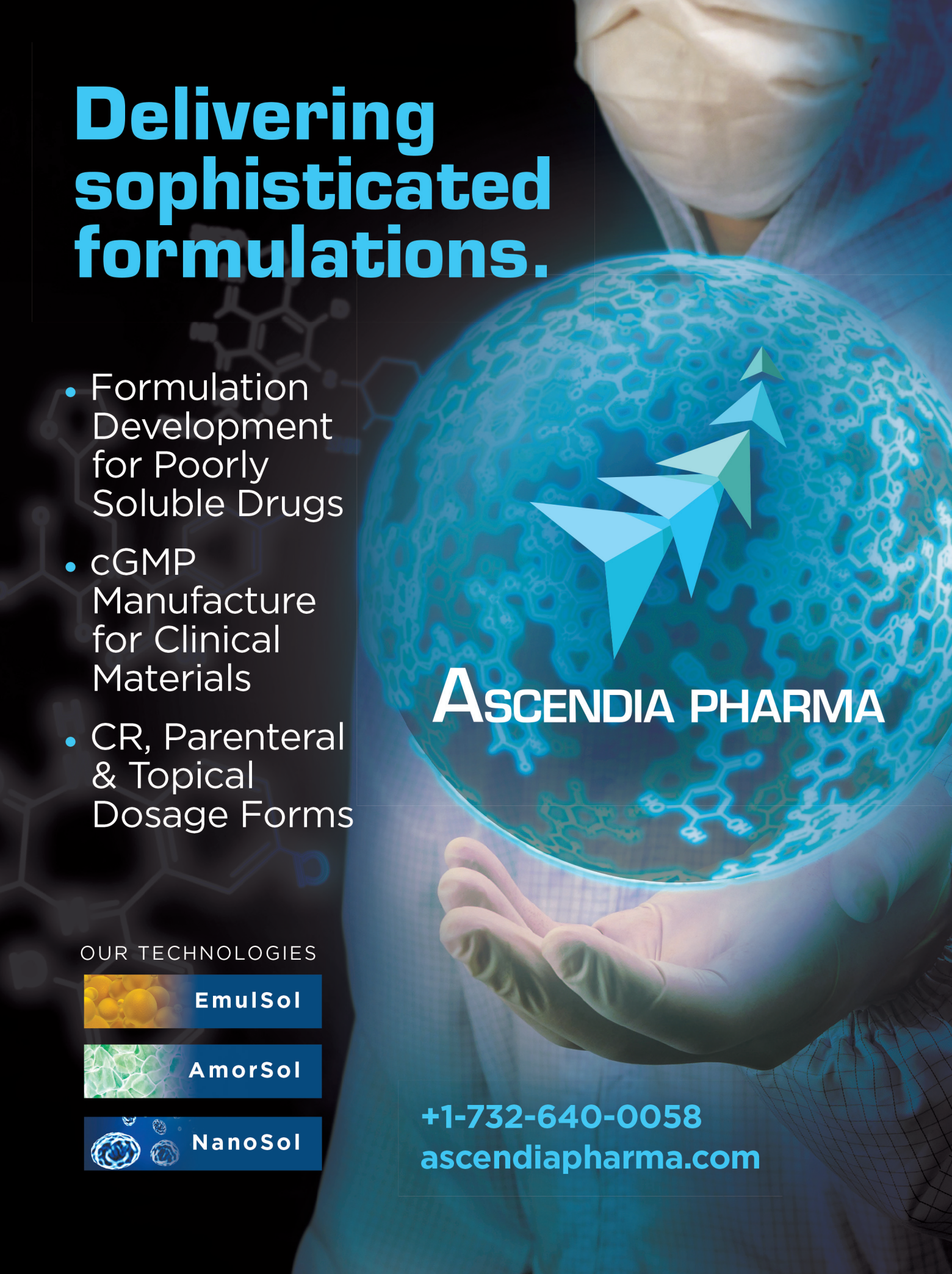
The development of ProQuant was led by David Mosedale, Chief Technical Officer at Methuselah Health since its foundation in 2015. "Proteomics has been an important tool in drug discovery for decades, but existing methods typically focus on the number of proteins identified at the expense of quantitative accuracy. ProQuant is a step-change in quantitative accuracy for bottom-up LC-MS-MS-based proteomics, which enables a whole range of applications that are difficult or impossible with existing technology. For example, ProQuant can better quantify post-translational modifications, including proteolytic cleavages, in complex protein mixtures, which opens up a new domain for target identification and validation, biomarker discovery and reaction monitoring."

ProQuant moves the goalposts for proteomics through proprietary improvements in both the analytical and bioinformatic domains. "The key development," says Mosedale, "was identifying a way to assess quantitative accuracy across the whole proteome simultaneously, even without knowing the true concentration of any of the components. That allowed us to optimize the methodology beyond anything that has been possible before."

ProQuant has numerous applications across the drug discovery and development domains. It turbo-charges chemoproteomics during discovery of covalent binders (including protacs), allows the accumulation of post-translational modifications on biologic drugs to be accurately monitored during manufacture, storage and, most importantly, after administration in vivo, and delivers accurate quantitation of protein labelling.

"Unfortunately, many drug developers do not realise the extent to which the poor quantitative accuracy of traditional proteomics has limited its usefulness. ProQuant really is a game-changer," explains Mosedale.

"Over the last several years, we have acquired or developed a unique toolkit of cutting-edge technologies to improve drug discovery and development," said Nick Tait, Chief Financial Officer at RxCelerate. "Galaxy, our platform to discover better monoclonal antibody drugs at RxBiologics, and RxNfinity, our dynamic chemical space to improve small molecule discovery, deliver best-in-class capabilities to our clients. With the acquisition of Methuselah Health and its ProQuant proteomics technology, we have taken another step towards our vision of making the best technologies out there available to everyone."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Evaxion Announces Promising Results From Phase 1/2a Clinical Trial of Personalized DNA Cancer Immunotherapy

Evaxion Biotech A/S recently announced promising clinical data from the Phase 1/2a first-in-human study of its DNA-based cancer immunotherapy, EVX-02. In the clinical study, EVX-02 is given in combination with a checkpoint inhibitor and targets cancer mutations, neoantigens, in patients with resected melanoma. The Company reported encouraging interim safety and immunogenicity data from the Phase 1/2a study of its personalized DNA-based immunotherapy, EVX-02. The results are summarized below.

"We are thrilled to announce promising interim data from the first eight patients in our Phase 1/2a study of EVX-02. We believe that these results serve as validation of our DNA technology for personalized cancer immunotherapy. All patients demonstrated a specific T-cell immune response induced by the treatment, confirming the potential capabilities of our AI platform technology. And importantly, the treatment appeared to be well tolerated in all patients, with only very mild adverse events (AEs) observed," said CEO Per Norlén.

Personalized cancer immunotherapy, like EVX-02, is particularly challenging to produce because a new and unique drug is manufactured for each patient.

"This is a tremendous achievement. Our team has successfully completed this complex process, from biopsy, through genome sequencing, a selection of the most promising cancer targets through our AI platform technology, to manufacturing, quality testing, and drug product production and delivery. And they succeeded with every single step for each patient," says Mr. Norlén. "The promising EVX-02 data, demonstrating both proof of mechanism and an encouraging safety profile, give us exactly what we need for our upcoming clinical trial of EVX-03 and our next-generation DNA technology." Interim results in summary: Safety: Treatment appeared to be well tolerated in all patients, with only very mild adverse events (AEs) observed in relation to EVX-02 treatment, EVX-02 induced CD4+ and CD8+ specific T-cell responses in all patients, providing proof of mechanism for our DNA-delivery technology, in that the delivered EVX-02-DNA gave rise to immune reactions to its encoded neoantigen peptides, and the T-cell responses were robust and long-lasting.
A full clinical trial report for the EVX-02 Phase 1 study is expected in the second quarter of 2023.

Evaxion Biotech A/S is a clinical-stage biotech company developing AI-powered immunotherapies. A proprietary and scalable AI technology is used to decode the human immune system to discover and develop novel immunotherapies for cancer, bacterial diseases, and viral infections. Evaxion has a broad pipeline of novel product candidates, including patient-specific cancer immunotherapies. It is located in Hørsholm, Denmark, with 70 employees.

Attralus & Ossianix Announce Option & License Agreement Using the TXP1 Brain Shuttle for Targeted Delivery of a Pan-Amyloid Removal Therapeutic for Neurodegenerative Disorders

Attralus, Inc. and Ossianix recently announced they have entered into a definitive agreement using Ossianix' brain shuttle technology to enhance the targeted delivery of novel pan-amyloid removal candidates for use in neurodegenerative disorders such as Alzheimer's Disease. Under the terms of the agreement, Attralus will use the patented VNAR antibody developed by Ossianix to help deliver AT-04, its developmental pan-amyloid removal (PAR) therapeutic candidate, across the BBB to the brain.

"Encouraging preclinical data for AT-04 indicates that it potently binds to all types of amyloid, including synthetic fibrils composed of Aβ, tau, and α-synuclein, pathologic aggregates common to neurodegenerative disorders such as Alzheimer's," said Gregory Bell, MD, Chief Medical Officer at Attralus. "The addition of the TXP1 brain shuttle has the potential to significantly improve CNS penetration and efficacy. While most therapies in development target individual pathologies, such as Aβ, tau or α-synuclein, AT-04 can target all amyloid pathologies in each patient and has the potential to transform the lives of patients living with neurodegenerative disorders."

AT-04, a peptibody, is a fusion of the company's PAR-peptide technology with the fragment crystallizable region (Fc) component of an immunoglobulin G1 (IgG1) antibody. The latest preclinical data for AT-04 demonstrate potent binding to multiple types of amyloid, as well as Aβ, tau, and α-synuclein fibrils in neurodegenerative disorders. This interaction can induce phagocytosis, which is anticipated to lead to clearance from the body.

"We are very excited to be working with Attralus and combining Ossianix' patented VNAR antibody-based brain shuttle TXP1, which is capable of delivering high levels of therapeutic products to the central nervous system utilizing the transferrin receptor, with their novel pan-amyloid removal technology," said Dr. Frank Walsh, CEO of Ossianix. "We look forward to developing a successful collaborative relationship with Attralus."

AT-04 is a fusion of our pan amyloid removal (PAR) peptide technology with the Fc component of a human IgG1 antibody. The PAR-peptide mediates binding to all types of amyloid as well as Aβ, tau, and α-synuclein fibrils. The Fc stimulates the immune system to remove amyloid.

Ossianix' brain shuttle platform is based on single domain VNAR antibodies and TXP1 is the most advanced brain shuttle ready for clinical translation. TXP1 was developed to be paired with CNS drug candidates to improve their brain penetration and therapeutic efficacy, while also potentially reducing dosing and side effects.

Extracellular aggregates of Aβ amyloid and phosphorylated tau are common pathologic deposits in the brains of patients with Alzheimer's disease (AD). The removal of Aβ amyloid plaques is an intensively pursued therapeutic target for the treatment of AD, with one FDA approved therapeutic. Preventing the accumulation of hyperphosphorylated tau, and perhaps removal of the aggregates, may prevent progression of AD and may potentially reverse cognitive decline. In addition, α-synuclein is believed to play a role in Parkinson's disease, Dementia, and Lewy Body diseases.

Key Patent Issued on Eligo's Gene-Editing Breakthroughs Applied to Skin Disorders

Eligo Bioscience recently announced the issuance by the USPTO of the first patent in a wide family covering genetic engineering of a key skin microbiome species, Cutibacterium acnes, to support therapeutic interventions in multiple serious skin disorders. This pioneering work also provides unique opportunities to leverage the skin's immune system for oncological, vaccination or desensitization applications.

US Patent No. 11,473,093 stems from the WO2022096596 patent family filed in 2020 and fully owned by Eligo Bioscience that covers the use of genetically engineered C. acnes and any derived products to address skin disorders, and an exploration of the potential of leveraging the skin's immune system for oncological, vaccination or desensitization applications. No genetic toolbox was yet in existence for this notoriously difficult-to-engineer bacterial species before Eligo achieved these long-awaited genetic engineering breakthroughs. Indeed, over the last three years, Eligo has developed unique capabilities and know-how that provide significant potential, not only to engineer C. acnes in the lab, but also to functionalize C. acnes directly on the skin of patients in order to impact host responses.

C. acnes is a key and ubiquitous species of the skin microbiome that provides many health benefits for the host, such as maintenance of skin barrier and protection against pathogens. Interestingly, it also resides in the hair follicle, in the vicinity of the host immune and stem cells. Using its versatile gene editing platform, and supported by this additional patent family, Eligo is in the position to either eliminate or modify genes from the skin microbiome, or introduce new genes to the microbiome to express therapeutic proteins at the skin/host interface. Eligo has already obtained preclinical proof of concept for its first program in moderate-to-severe acne vulgaris with the development of a first-in-class modality capable of delivering a CRISPR system directly into C. acnes, to kill with high efficiency only the strains of this species that are known to drive inflammation in the hair follicle. Eligo is progressing this program rapidly, with an expected clinical proof of concept in moderate-to-severe acne patients in 2024. Patent family WO2022096596 fully supports Eligo's acne program and many other serious skin disorders such as skin cancer, alopecia and vitiligo, as well as a tool for potential vaccination and desensitization.

"Thanks to the quality of our science and the unmatched expertise of our team, we have been able to develop unique and highly differentiated tools to address skin disorders in record time. We are extremely proud of the pioneering work accomplished by the team, now recognized by the USPTO, and that offers Eligo a dominant position in the field of C.acnes genetic engineering and its vast therapeutic applications," said Dr. Xavier Duportet, Chief Executive Officer of Eligo Bioscience. "The grant of this first patent is a very important milestone for the company as we progress towards the clinic with our proprietary modality in the treatment of moderate-to-severe acne vulgaris."

Indivior PLC to Acquire Opiant Pharmaceuticals

Opiant Pharmaceuticals Inc. recently announced it has entered into a definitive merger agreement to be acquired by Indivior Inc, a subsidiary of Indivior PLC (LON: INDV). Under the terms of the agreement, Indivior will acquire all of the outstanding shares of Opiant for upfront consideration of $20.00 per share in cash at closing, plus contingent value rights (CVRs) representing, if achieved, potential additional payments over a period of 7 years of up to $8.00 per share. Achievement of the CVR payments, if any, are based on attaining certain revenue thresholds for OPNT003, nasal nalmefene, Opiant's investigational treatment for opioid overdose, as detailed below.

The upfront payment at closing of $20.00 per share represents a premium of approximately 111% to Opiant's closing share price on November 11, 2022, and 99% premium to the 30-day volume-weighted average share price. Inclusive of each of the CVR payments, the total potential transaction value represents a premium of up to 195% and 178%, respectively. The transaction has been unanimously approved by the Boards of Directors of each company.

Under the terms of the merger agreement, Indivior will acquire all outstanding shares of Opiant for upfront consideration of $20.00 per share in cash, plus up to $8.00 per share in CVRs that may become payable if certain net revenue milestones are achieved by Opiant's lead asset OPNT003 over the applicable 7-year period.

Pursuant to the CVRs, Indivior will pay $2.00 per CVR if OPNT003 achieves the following net revenue thresholds during any period of four consecutive quarters prior to the seventh anniversary of the US commercial launch: (i) $225 million, (ii) $300 million, and (iii) $325 million. The remaining $2.00 per CVR will become payable if OPNT003 achieves net revenue of $250 million during any period of four consecutive quarters prior to the third anniversary of the U.S. commercial launch. There can be no guarantee that the CVR payments will be achieved as the future performance of OPNT003 is subject to several risks and uncertainties.

The transaction is subject to customary closing conditions, including US antitrust clearance, clearance by the Committee on Foreign Investment in the United States (CFIUS) and receipt of approval of Opiant's shareholders. The members of the Board of Directors of Opiant, who hold approximately 4.5% of the outstanding Opiant shares, have entered into a voting agreement with Indivior and agreed to vote their shares in favor of the transaction. Pending approvals, the parties anticipate completing the transaction in the first quarter of 2023.

Opiant Pharmaceuticals, Inc., is building a leading franchise of new medicines to combat addictions and drug overdose.

Insilico Medicine Signs Strategic Research Collaboration With Sanofi Worth up to $1.2 Billion

Insilico Medicine recently announced a multi-year, multi-target strategic research collaboration with Sanofi. Under the terms of the agreement, the collaboration will leverage Insilico Medicine's AI platform, Pharma.AI, to advance drug development candidates for up to six new targets.

"We look forward to working with Insilico Medicine, a demonstrated leader in AI-powered drug discovery," said Changchun Xiao, Head of China Research at Sanofi. "This collaboration will leverage our complementary capabilities, as well as the co-location of our scientific teams, to boost the drug discovery efforts of the Sanofi Institute for Biomedical Research (SIBR), Sanofi's R&D center in China."

Under the terms of the agreement, Sanofi will pay Insilico Medicine a total of up to $21.5 million covering the upfront and target nomination fees to benefit from Insilico's end-to-end Pharma.AI platform and gain access to a team of interdisciplinary drug discovery scientists to identify, synthesize, and advance high-quality lead therapeutic compounds up to development candidate stage. Additional payments will be made if key research, development, and sales milestones are met, and could total more than $1.2 billion. The collaboration also establishes mid-single to up to low double-digit tiered royalties for any products developed.

"We are very happy to collaborate with Sanofi, a company with a clear strategy in AI-powered drug discovery," said Alex Zhavoronkov, PhD, CEO and Founder of Insilico Medicine. "This close collaboration will allow Sanofi to immediately gain the capabilities of one of the top AI startups in addition to enriching their drug discovery pipeline."

"We are thrilled to collaborate with Sanofi. Leveraging Sanofi's strong drug research and development expertise and Insilico's powerful AI platform, we believe we can accelerate novel therapeutics discovery to address diseases with unmet medical needs," said Feng Ren, PhD, co-CEO and Chief Scientific Officer of Insilico Medicine. "Together we will use cutting-edge AI technologies to make significant breakthroughs in drug R&D."

Insilico Medicine, a clinical-stage end-to-end artificial intelligence (AI)-driven drug discovery company, is connecting biology, chemistry, and clinical trials analysis using next-generation AI systems. The company has developed AI platforms that utilize deep generative models, reinforcement learning, transformers, and other modern machine learning techniques to discover novel targets and to design novel molecular structures with desired properties. Insilico Medicine is delivering breakthrough solutions to discover and develop innovative drugs for cancer, fibrosis, immunity, central nervous system (CNS) diseases and aging-related diseases. For more information, visit www.insilico.com.

Tjoapack Strengthens its Injectables Offering With Addition of Prefilled Syringes Assembly & Packaging Services

Global pharmaceutical contract packaging organization (CPO), Tjoapack has invested in a new high-speed packaging line for prefilled syringes and vials at its production facilities in both Europe and the US. The recently validated PFS line can pack prefilled syringes of 1 ml to 5 ml, with or without safety devices, and other customer-specific components can also be added. The move is in response to increasing customer demand for prefilled syringes, which is a market expected to grow at a compound annual growth rate (CAGR) of 11.95% from 2022 to 2030.

As part of several recent investments and expansions across the wider business, the CPO said this funding will further enhance its integrated packaging offering. Marcelo Cruz, Vice-President of Business Development and Marketing, said "The pressure to develop vaccines and treatments for Covid-19 has helped spur strong growth in the prefilled syringe market. As the market expands, this latest investment in our prefilled syringe line is an important step to meeting the growing needs of our customers. Packaging solutions are fundamental to the safe, effective delivery of almost every pharmaceutical product and I am proud that our new prefilled syringe line will help bring even more products to market safely."

The CPO, which specializes in primary and secondary packaging of oral solids and injectables, has doubled its capacity with the addition of 10 new production rooms and increased the size of its Netherlands facility from 8,400 sqm to 11,500 sqm over the past year. The addition of packaging for PFS complements the recent investments in a fully automated packaging line for vials, with the capacity of packing 12 million vials per year. There are also two new high-speed production lines for oral solids, capable of packing over 500 blisters per minute each. The Tjoapack Netherlands facility now has a total of 18 packaging lines for blisters, vials, and bottles.

In addition to increasing its production capacity, Tjoapack has also invested in its warehousing and cold chain capabilities to meet increased customer demand for its added-value logistics services. The investment follows the acquisition of US healthcare packaging firm, Pharma Packaging Solutions (PPS) last year. For more information, visit http://tjoapack.com/.

Formulation Forum

Lipid Nanoparticles: Tackling Solubility Challenges With Lipid-Based Technologies for Oral & Injectable Formulations

By: Jim Huang, PhD, Founder & CEO, and Shaukat Ali, PhD, Sr. Director, Scientific Affairs & Technical Marketing, Ascendia Pharmaceuticals Inc.

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INTRODUCTION

Throughout the years, tremendous progress has been made in drug formulations with the launch of new excipients and formulation technologies. Yet, with an increasing number of new chemical entities (NCEs), challenges remain at hand, and the drug manufacturers are open for adapting new technologies to expedite the clinical development and commercialization of these molecules.[1] With increased regulatory compliances, drug manufactures are also taking innovative approaches in designing and developing formulations to reduce pill burden and improve safety and efficacy of drug molecules. It not only applies to drug manufacturers, but also to contract manufacturers, including Ascendia Pharma.[2]

More than 80% of NCEs are poorly soluble compounds, thus, solubilization remains one of the important topics in formulation and drug development. The factors responsible for poor solubility are activity coefficient and crystal terms. Activity coefficient is the amount of drug partitioned between organic and aqueous phase, Octanol/water; and crystal term defines the melting point of drug. In other words, both the higher melting point (MP) and higher partitioning of an API in organic phase (or logP), will dictate the solubility of compound, which is simplified by Equation 1.[3]

Solubility in Water = Activity coefficient + Crystal term
Log S_w (M/L) = 0.5 – log K_{ow} — 0.01 (MP – 25) …. (Eq. 1)

Where, K_{ow}, the partitioned coefficient between organic (octanol) and aqueous phases; higher K_{ow} (log P) means drug prefers to partition more in organic phase compared to aqueous phase; whereas, MP represents the melting point of drug, meaning the higher the melting point, the lower the solubility, and hence, poor absorption and bioavailability. The melting points and logP truly represent the physical characteristics of an API upon which many of the enabling solubilization technologies are based on. For instance, depending on lower or higher melting or logP, preferably one over the other technology can be amenable.[4]

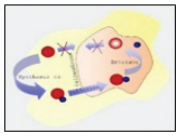
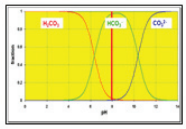
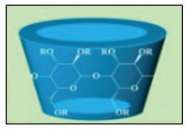
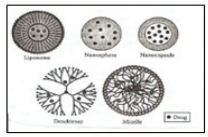
FORMULATION TECHNOLOGIES

Conventional technologies, such as micronization/micromilling, pH modifications/salt formation, and complexation with cyclodextrins, have been used successfully for many commercial drugs in oral tablets, oral liquids, and parenteral formulations. However, the challenges stem from the lack of inherent compatibility with excipients and processing conditions used in manufacturing. As more hydrophobic or brick dust and/or lipophilic or waxy molecules come out of the discovery, the situation is more dire. In those cases, given the limited choices, the widely used innovative technologies are amorphous solid dispersions and lipid based self-emulsifying microemulsions, nanoemulsions, liposomes, and nanoparticles for oral and injectable formulations, (Figure 1).

ADVANCEMENT IN FORMULATION TECHNOLOGIES

Polymers have been used in development of several drug products through amorphous solid dispersions (ASDS) prepared by hot melt extrusion, spray drying, and co-precipitation among others.[6] There are some advantages of selecting the polymers for such enabling

FIGURE 1

Micronization/ Micromilling	Prodrug/Hydrophilic Moiety	pH Modification/ Salt Formation	Complexation/ Hydrophobic Cavity	Solid Dispersions/ HME, Spray Drying, Co-Precipitation, Kinetisol®	Encapsulation Technologies/ SEDDS/SMEDDS, Liposomes, Micro/Nano-Emulsions/Lipid Nanoparticles
					

Options for formulating poorly soluble NCEs with different technologies.

technologies due to their stability and solubilization capabilities, ease of handling, and long-term stability. This article will not cover the ASD technologies but instead will focus on innovative lipid-based enabling formulation technologies for oral and injectable formulations of poorly soluble compounds.

In the recent past, lipids have gained importance due to better suitability and more efficient delivery of drugs by overcoming challenges often associated with stability and food effects. In fact, recently, Crew showed that lipid-based formulations are growing two-fold faster than ASDs, due to lesser complexity, biocompatibility, easier formulation, and scale up than polymeric ASD technologies.[6] For example, lipids used as proliposomes in dry, free-flowing powder, following re-constitution in buffer, formed multilamellar vesicles (MLVs) with higher drug loading, improved efficacy in oral formulation.[7] Katare et al. have also demonstrated that indomethacin in pro-liposomes improve efficacy when administered orally.[8] Likewise, the lipid based SEDDS/SMEDDS also have gained importance for improving the efficacy of many marketed drugs.[9] The following will describe lipid nanoparticles, the next generation of liposomes, and their relevance in delivery of drugs (oral and injectable routes of administration) for immediate- and controlled-release applications.

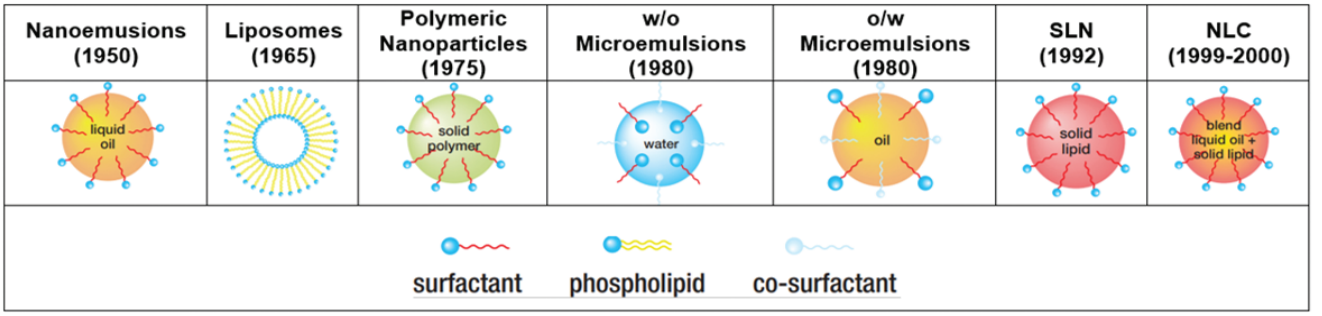
LIPID NANOPARTICLES - AN IMPACT ON ENHANCING SOLUBILITY & BIOAVAILABILITY OF NCES

Before defining the LNP, it is relevant to understand the nanosizing of APIs. It is equally important because the size reduction could lead to higher surface area, faster absorption, and greater bioavailability. Nanosizing or nanonization by microfluidics, for example, can create higher energy fine particles in liquid suspension. For instance, danazol nanosuspension with a particle size of 169 nm increased solubility and enhanced 15-fold bioavailability compared to regular liquid suspensions (82.3% ± 10% vs. 5.1% ± 1.9%).[10] Atovaquone resulting from nanosizing with 100-300 nm in particle size, enhanced the bioavailability by 2.5-fold compared to the marketed drug (Wellvone®). Evidently, nanosizing increases the surface area and in vivo exposure, which results in enhancing the bioavailability of APIs. These are all equally important as many NCEs possess poor solubility, and developing them in medium to high dosages could lead to undesired toxicity and side effects, which may lead to long-term health risks. Therefore, finding the appropriate formulation technologies and strategies to help prevent unwanted side effects in clinical studies and in post launch marketed drugs are highly warranted for immediate release, controlled release, and lifecycle management, in general. In such cases, lipid particulates could play an important role in increasing the bioavailability of drugs via lymphatic absorptions and thereby avoiding the first-pass metabolism.[11]

Lipid and surfactant-based particulates have been identified as alternative delivery systems other than polymeric excipients. We often find in literature interchangeable terminologies of these aggregates; namely, nano-emulsions versus microemulsions; microemulsions versus macoremulsions, macroemulsions versus emulsions, and nanoparticles versus nanocarriers among others. Figure 2 clarifies some of the misconceptions and sheds light on the evolution of these assemblies and their relevance in drug delivery throughout the years.

Some classic differences obviously exist between all these assemblies. For instance, microemulsions versus nanoemulsions may sound very similar but are different in particle sizes, method for preparations, and/or stability; whereas, macro versus micro emulsion may differ in particle size and stability (thermodynamically vs kinetically) and encapsulation efficiency. Likewise, polymeric nanoparticles are stable but different than lipid aggregates though preparations for polymers, and lipid/surfactant-based particulates may require the same, low or higher shear energy

FIGURE 2



Progression of colloidal drug delivery systems over 5 decades.[12]

mixing. Larger lipid droplets, such as emulsions and/or macroemulsions (> 1 microns), could lead to Oswald ripening, yielding much larger droplets, which could squeeze out encapsulated drugs from the interior core, leading to precipitate at the outer particulate surface. Therefore, the smaller particle droplets are preferred in drug delivery, which are critical for stability, higher drug loading, and faster dispersibility and absorption in the GI tract and/or longer systemic circulation.

SURFACTANT & LIPID-BASED FORMULATIONS FOR POORLY SOLUBLE APIS

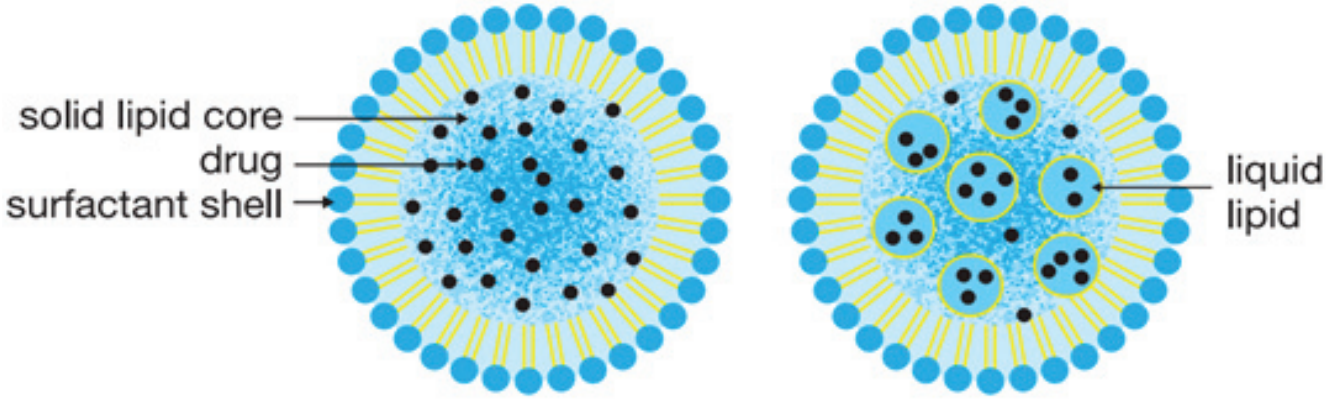
A number of drugs have been developed and marketed in surfactant/lipid suspensions and nanoparticles with the aim at enhancing solubility and bioavailability, stability, and/or minimizing the food effects.[13] For example, aprepitant, marketed as Emend®, was developed in nanoparticles/nanosuspension at 80-mg and 125-mg doses to overcome food effects. Abraxen, formulated in albumin, for example, with a particle size of 130 nm, is better tolerated than paclitaxel formulated in polyoxyl 35 castor oil and ethanol.[14] Cyclosporine A, for instance, formulated as Sandimmune® versus Neoral® (particle size <200 nm) showed different bioavailability due to differences in lipid types and compositions used, and most interestingly, with faster emulsifying nanoparticle capabilities that led to rapid absorption, minimizing food effects compared to Sandimmune® with larger particles.[15]

SOLID LIPID NANOPARTICLES (SLNS) & NANOSTRUCTURED LIPID CARRIERS (NLCS)

Lipid nanoparticulates are widely applied in drug delivery compared to self- emulsifying microemulsions, nanoemulsions, and/or liposomes due to their inherent greater stability and higher encapsulation efficiency. LNPs in the recent years have emerged as promising delivery vehicles for a variety of therapeutics, including playing an important role in Covid-19 vaccines by protecting, carrying mRNA and delivering to target cells.[16] Figure 3 illustrates the similarities/dissimilarities of these lipid assemblies in terms of drug encapsulation capabilities.

Lipid nanoparticles (LNPs) - SLNs and NLCs, because of their higher drug

FIGURE 3

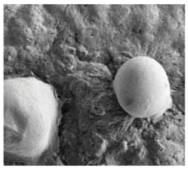


SLNs (left) and NLCs (right)

encapsulation efficiency, stability, ease of preparation, biocompatibility, non-immunogenicity, and most importantly, controlled release, tissue targeting, and maximum drug entrapment efficiency are highly preferred. SLNs primarily created by 0.5%-5% surfactants as emulsifying agents, with solid low melting lipids, are spherical in diameter (>50 nm) in which the inner core is saturated fatty acid (solid) embedded with API, and the outer surface is surrounded by emulsifying agents, surfactants, or PEGylated lipids. These SLNs are prepared by cold or hot homogenization and solvent injection processes.[17] In the cold homogenization process, drug dissolved in lipid melt is quenched rapidly in liquid nitrogen or dry ice, causing it to solidify, which is then milled to 50-100 nm in size and dispersed with surfactant solution to pre-suspension. Following high pressure homogenization at cold temperature, it yields SLNs.[18] In the hot homogenization process, the melt lipid with API is dispersed in hot aqueous surfactant solution by ultrasonication or high shear mixing to pre-emulsions, leading to SLNs. There are other methods to produce SLNs and NLCs including ultrasonication or high-speed homogenization, supercritical fluid extraction of emulsions, and by spray drying.

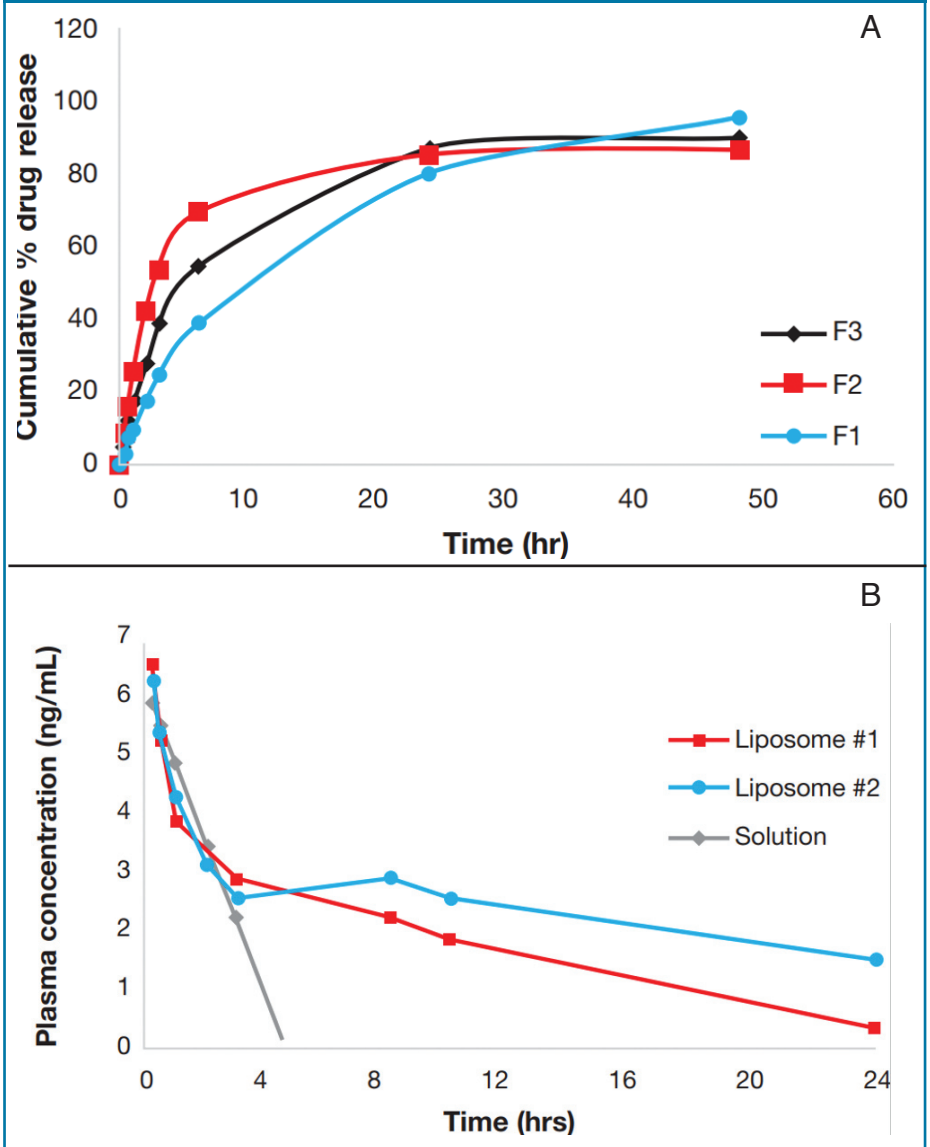
NLCs are next-generation modified SLNs and have been used widely in oral, pulmonary, gene, injectable, and topical applications. Structurally, NLCs are composed of both solid (fat) and liquid (oil) lipids at ambient temperature that help improve drug loading and stability by accommodating APIs in the interior core better than hydrophobic SLNs' interior core.[19,20]

TABLE 1

Formulation	Drug Loading	Particle Size
1	0.12 mg/ml	128 nm
2	0.25 mg/ml	123 nm
3	0.38 mg/ml	101 nm
SEM image of encapsulated drug in LNP		

LNP formulations containing carvedilol and SEM images of particulates.

FIGURES 4A&B



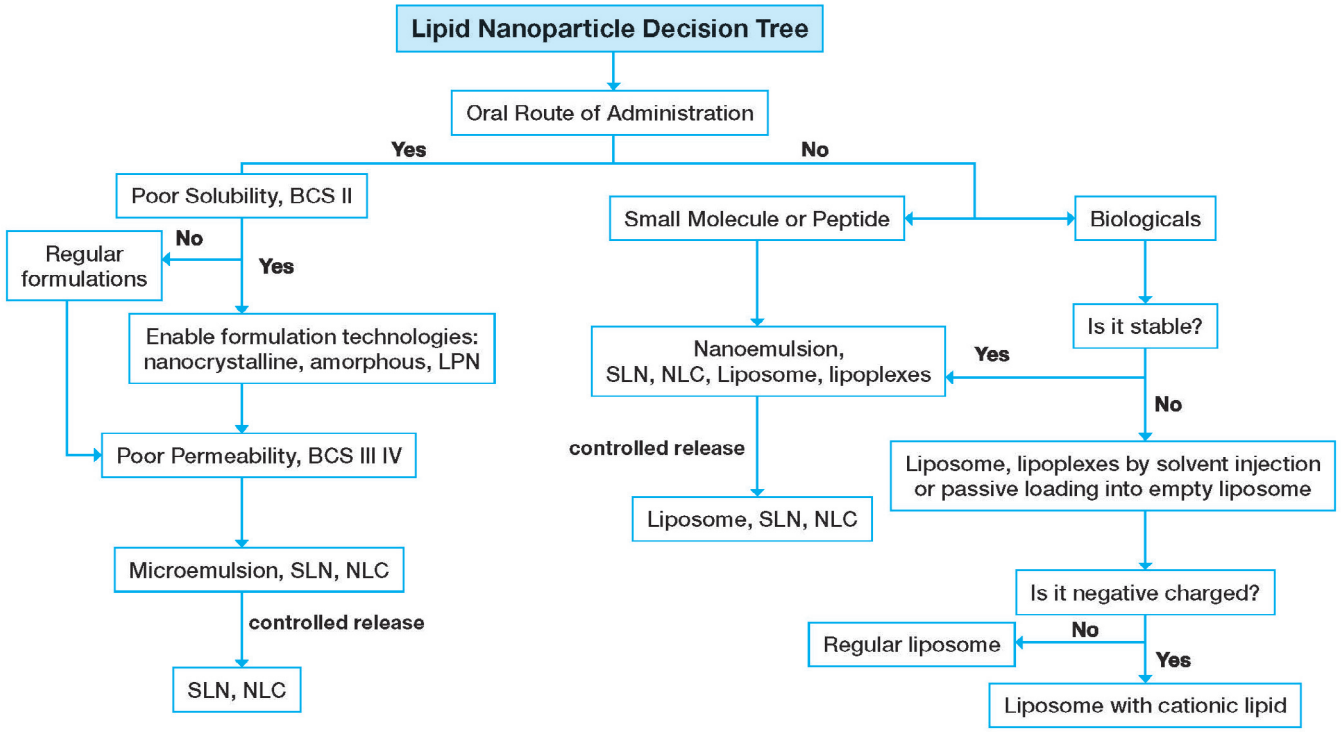
Dissolution (A) and PK profile in rat (B) of carvedilol in liposomal preparations composed of phospholipids.

CASE STUDIES

Carvedilol, marketed as Coreg®, is a poorly soluble, weakly alkaline molecule. Ascendia developed this drug using its proprietary solubilization technology as sustained release, stabilized injectable lipid nanoparticle formulations with three different drug loading and particle sizes as shown in Table 1.

Dissolution profile (Figure 4A) shows an extended release over 24 hours for all three formulations. The *in vivo* PK data from two formulations show these lipid nanoparticles when administered IV in two groups of rats delivered drug over an extended period (>24 hours) compared to drug in solution (Figure 4B). Taken collectively, these data further suggest the lipid compositions play an important role in controlling the release of drugs over extended periods.[21]

FIGURE 5



Decision tree for selecting the lipid nanoparticles.

SUMMARY

The decision for selecting the right and most suited technology for formulating a complex molecule could be challenging as it depends on the physico-chemical properties of an API. In instances where the API is thermally labile and poorly soluble, the choices are limited for ASDs like hot melt extrusion (HME), Kinetisol®, or even spray drying (SD) unless carried out under controlled temperature. In such cases, the lipid-based technologies might be more relevant, wherein, the decisions can be made swiftly and tailored to meet the specific formulation needs with regard to excipients' suitability and compatibility with the API. Long-term stability and minimizing API degradation and impurities could be of relevance when selecting SLN vs NLC formulations for oral and injectable formulations. To expedite further, computer-based simulation models are used to predict stability and degradation of APIs and help select the appropriate excipients to design better and smarter formulations to select and streamline the process and expedite the development. Lipid-based excipients for parenteral formulations, requiring phospholipids and long-circulating phospholipids and sterols for liposome stability, further help in creating the most stable API environment within encapsulated lipid nanoparticles from the formulation toolkit of the decision tree as shown in Figure 5. Thus, an understanding of an API's characteristics will shorten timelines (to help advance in the clinic phases and commercialization) of drug candidates using the appropriate solubilization technologies. ◆

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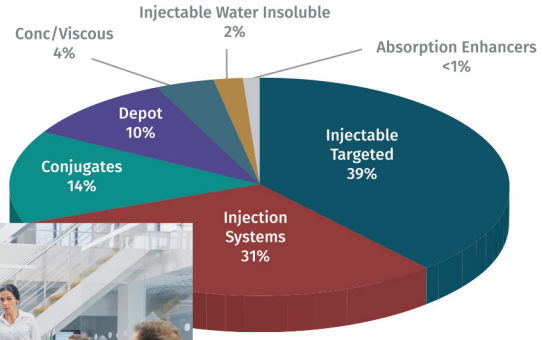
CROSCARMELLOSE SODIUM **(Core/Content)**	30.3 mg
MICROCRYSTALLINE CELLULOSE **(Core/Content)**	75.76 mg
SODIUM STEARYL FUMARATE **(Core/Content)**	29.29 mg
COLLOIDAL SILICON DIOXIDE **(Core/Content)**	7.58 mg
POLYVINYL ALCOHOL, UNSPECIFIED **(Tablet/Capsule coat)**	11.72 mg
POLYETHYLENE GLYCOL **(Tablet/Capsule coat)**	5.92 mg
TALC **(Tablet/Capsule coat)**	4.33 mg
FERRIC OXIDE YELLOW **(Tablet/Capsule coat)**	0.32 mg
TITANIUM DIOXIDE **(Tablet/Capsule coat)**	7 mg
FD&C RED NO. 40 **(Tablet/Capsule coat)**	
FD&C BLUE NO. 2 **(Tablet/Capsule coat)**	

Evaluate New and Promising Technologies



Injectable Drug Delivery Technologies

Screen Potential Partnering and Investment Opportunities

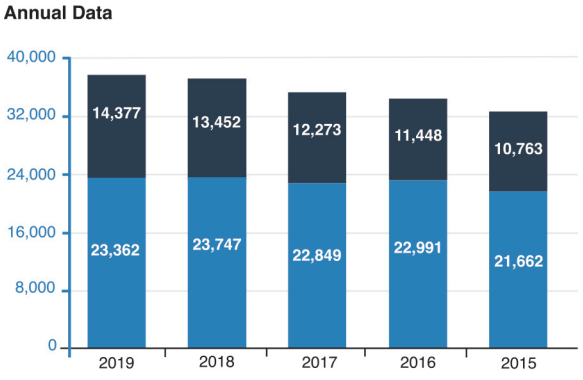
Select Companies

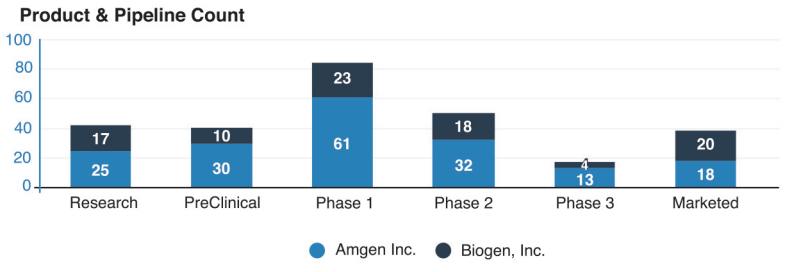
Amgen Inc. x

Biogen, Inc. x

Attribute Type

- Gross Profit
- Net Income
- Number of Employees
- Operating Income
- Research and Development Expenses
- Sales, General and Admin. Expenses
- Total Assets
- Total Current Assets
- Total Current Liabilities
- Total Equity
- Total Liabilities
- Total Revenue





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With more than 40 years of CDMO experience, Ajinomoto Bio-Pharma Services has a long history of partnering with clients for their unique drug programs requiring prompt attention, strong regulatory support, and focused quality. Ajinomoto Bio-Pharma Services is dedicated to providing high-quality drug process development and manufacturing services to biotechnology and pharmaceutical companies worldwide.

Drug Development & Delivery recently interviewed Dr. Nobu Shimba, CEO and President of Ajinomoto Bio-Pharma Services US, to discuss the company's recent areas of focus as well as current plans for expansions.

Q: Aji Bio-Pharma is a global company. Can you describe Aji Bio-Pharma's business and how those global functions work together?

A: Aji Bio-Pharma is a fully integrated contract development and manufacturing organization with sites in US, Japan, Belgium, and India. We work in tandem to leverage our global infrastructure to provide innovative solutions and reliable service to biotechnology and pharmaceutical companies worldwide. Our services span comprehensive development, cGMP manufacturing, and aseptic fill finish services for small and large molecule APIs and intermediates. We also offer a broad range of innovative platforms and capabilities for preclinical and pilot programs to commercial quantities, such as oligonucleotide synthesis, high potency APIs (HPAPI), biocatalysis, continuous flow manufacturing, and sterile drug product fill and finish.

Q: What differentiates Aji Bio-Pharma from other CDMOs?

A: Aji Bio-Pharma is unique in the CDMO space because we are the right size for most customers – not too big and not too small. With small CDMOs, you are taking on risk from a business stability standpoint. They do not have a strong history or resources that a larger manufacturer would have. With large CDMOs, they are often more focused on Big Pharma business, caring more about large projects. The Big Pharma clients may receive priority, leaving your product neglected and delaying your timeline.

With Aji Bio-Pharma's size, we can provide flexibility for all product phases. We have the size to provide the resources, along with a strong proven track record, to make your therapeutic vision a reality – from preclinical studies through commercial supply. For early phase projects, we have the capabilities to fill small batch sizes and the manufacturing slots available for quick turnaround time. To support late-phase/commercial projects, we have higher speed lines to accommodate larger batch sizes, scale-up, PPQ, and commercial experience.

We also pride ourselves on being one of the few CDMOs with complex formulation expertise and a strong formulation team with extensive knowledge to help guide clients when manufacturing lipid nanoparticles (LNPs).

Q: Has Aji Bio-Pharma had any recent expansions?

A: We are making additions across all of our sites. In San Diego, we have expanded our aseptic filling capacity with a new high-speed multi-purpose filling line. The new fill line offers a range of configurations, including prefilled syringes, cartridges, and vials, and utilizes ready-to-use components that provides component flexibility as well as scheduling flexibility for our clients. Additionally, we have invested in automated and semi-automated inspection services to help speed up batch release and get our clients' products to market sooner.

Globally, we are expanding our small molecule API development and manufacturing facilities, including HPAPIs, in Belgium and India. In Japan, our recent expansions have focused on increased capacity for purification of oligonucleotide manufacturing.

Q: What is Aji Bio-Pharma's commitment to quality?

A: Quality is our strength. Aji Bio-Pharma's quality management system focuses on continuous improvement. We always strive to provide services that are meeting or exceeding the satisfaction of our customers. We accomplish this through routine reviewing and trending of operational metrics and in developing actions to drive the optimization of processes. We are proactive in our communication with regulatory and industry organizations with regard to industry improvements and establishing policies. Aji Bio-Pharma makes no compromises respecting compliance and safety, health and environment (SHE), faithfully complying with applicable laws and regulations, and always delivering products and services of uniform quality.

We take a collaborative audit approach with our customers and encourage feedback and suggestions. We pride ourselves on providing adaptive solutions, responsive service, and trusted partnerships so we can deliver the highest quality products and services.

Q: What are the current challenges in the industry, and how do you believe those will shape the upcoming market trends?

A: The biggest challenge the industry faces is supply chain availability, which was highlighted by the pandemic. Currently, there is a renewed interest in understanding the health of our supply chains and real-time understanding of how suppliers are performing and scenario planning, which has helped elevate procurement and risk mitigation activities. Supplier relationships and collaboration are critical to the long-term success of a business as they are a key element of resiliency planning. At Aji Bio-Pharma, we work closely with clients to de-risk the supply chain up front by identifying second sources, utilizing preferred and standard ISO components, agreeing safety stock levels, future proofing contracts, and collaborating on forecasting.

Another factor impacting the pharmaceutical industry is the high cost of APIs, especially for biologics products. The higher cost emphasizes the importance of strong quality systems, cautious analytical method transfer, and reduced line loss during manufacturing activities. We work closely with our customers to reduce product loss from sampling, analytical activities, and manufacturing line loss. Our manufacturing equipment is specifically designed for high-value API to minimize product loss

and ensure every drop of product is filled into the final container. Lastly, in recent years, the pharmaceutical industry has significantly increased its focus on sustainability. The industry is known to have a significant impact on environmental factors, such as greenhouse gases, water and energy consumption, and pollution. Each company has a responsibility to ensure it is doing everything it can to continue making high-quality products while reducing environmental impacts. Finding a CDMO partner committed to working toward net zero will be crucial for companies trying to stay ahead of emissions requirements.

Q: Can you please expand more on your sustainability efforts?

A: Sustainability is a key consideration in everything we do. Minimizing the environmental impact of our operations and business practices is at the core of this goal. As a baseline for any activity, we ensure that regulatory compliance, integrity, and ethical conduct are the foundations in every place we operate. Aji Bio-Pharma has established an innovative, effective approach to emissions mitigation that incorporates pioneering technologies, cross-functional teams, and ambitious internal emissions goals to help customers reach carbon neutrality.

One of Aji Bio-Pharma's most promising tools to achieve net zero targets is our Aji Bio-Pharma Eco Passport, which is spearheaded by our Belgium facility. This tool, used as the basis for identifying continuous process improvements, can also model scenarios during the Request for Proposal (RFP) phase, accurately reporting the positive climate impact of alternative scenarios. By calculating carbon footprint down to the process step level, the Eco Passport helps companies achieve greater insight into the incremental improvements, serving as a steppingstone to carbon neutrality. Calculations comparing the use of virgin solvent versus regenerated solvent, for example, can help companies understand the cost and benefits of enacting a single change to a manufacturing paradigm. ◆

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PLATFORM TECHNOLOGY

Versamune®: A New Generation of Cancer Immunotherapies

By: Joe Dervan, PhD

INTRODUCTION

Despite recent progress in fighting cancer, it remains a leading cause of morbidity and mortality. Cancer immunotherapies have significant potential to treat a broad range of cancers, whether it is via small molecules, antibodies, fusion proteins, autologous, or cell/gene-based therapies. However, significant challenges limiting their clinical effectiveness remain.

Considerable hurdles impeding the ability of immunotherapy to effectively harness the body's immune system persist. For example, approved checkpoint inhibitors are effective for those patients who respond, but the rates of response reported are in the range of 15%-20%. Immune therapies, including checkpoint inhibitors, CAR-Ts, and live-vector vaccines, are burdened with systemic toxicities limiting their use either in the early-stage cancer setting or in combination with other approved anti-cancer treatments.

The following will discuss Versamune®, a proprietary T cell-activating platform engineered and developed to overcome some of these challenges to improve the treatment outcomes of patients with cancer.

IMMUNOTHERAPY

Cancer immunotherapy utilizes the power of the body's own immune system to recognize, attack, and eliminate or regress cancer.

Once the body's immune system recognizes an organism or cell as foreign or dangerous, it begins a series of complex reactions to identify, target, and eliminate them by mounting an immune response. Cancer immunotherapy takes advantage of the discovery that most cancer cells express unique proteins, called tumor antigens, not normally expressed by healthy cells and thus can be recognized as abnormal and dangerous. As the immune system is precise, it can target these cancer cells exclusively while sparing healthy cells. However, the challenge remains that cancer cells are often not perceived as dangerous or foreign, so the immune system becomes tolerant to them.

An ideal cancer immunotherapy should have the following attributes to maximize the opportunity for clinical effectiveness in patients:

- Generate a humoral (antibody) and cellular (tumor-specific killer and helper T cells) mediated response within the body,
- Activate, arm, and expand large numbers of multi-cytokine-inducing (polyfunctional) T cells that recognize the specific tumor,
- Alter or de-camouflage the tumor microenvironment (TME) to make the cancer cell more visible or susceptible to attack by the immune system,
- Generate immune memory, so that a durable and long-term anti-tumor response may result, and
- Optimize safety and tolerability by limiting systemic inflammation and toxicity.

Versamune® incorporates each of these attributes, leading

to superior anti-tumor responses in preclinical (Gandhapudi S, et. al. 2019, J. Immunol.) and clinical studies (ASCO 2022). PDS Biotech's Versamune® technology platform is unique in its ability to successfully encompass the mechanistic attributes required to induce a safe and effective anti-cancer immune response.

OVERCOMING THE CHALLENGES OF CANCER IMMUNOTHERAPY - WHAT IS VERSAMUNE®?

Versamune® is a proprietary novel T cell-activating platform that effectively stimulates a precise immune system response to a cancer-specific protein. Versamune® based immunotherapies promote a potent targeted killer (CD8+) T cell attack against cancers expressing the protein by accessing both the MHC class I and II pathways and upregulating Type I Interferon. Targeted immunotherapies built on the Versamune® platform demonstrate significant disease control with minimal toxicity. The Versamune® platform is broadly applicable to multiple targets in development.

Versamune® nanoparticles are based on positively charged (cationic) and immune-activating lipids that form spherical nanoparticles in aqueous media. These lipids include the R-enantiomer of 1,2-di-oleoyl-e-trimethyl-ammonium-propane (R-DOTAP). R-DOTAP provides the first demonstration of enantiomeric specificity related to immunological activation. Cationic lipids are positively charged molecules that have a water-soluble portion (head group) attached to a water-insoluble tail. The water-soluble portion of the molecule has a positive charged and the water-insoluble portion is made up of hydrocarbon chains. The nanoparticles, which are coated with a positive charge, are deliberately sized to mimic viruses, facilitating detection by the body's immune system and uptake by dendritic cells. To treat a specific cancer, the unique or over-expressed antigen found on the surface of the cancer cells is manufactured, then formulated with the Versamune® nanoparticles to create a pharmaceutical product for simple subcutaneous injection.

Versamune® is designed specifically to be taken up by dendritic cells in the skin. Studies evaluating the uptake of Versamune® nanoparticles by dendritic cells and epithelial cells, found almost exclusive uptake by the dendritic cells. Four hours following a single subcutaneous injection, ~80% of the dendritic cells in the draining lymph node were found to have taken up the Versamune® based immunotherapy.

When dendritic cells take up Versamune® nanoparticles, they become activated, mature, and begin recruiting additional dendritic cells. Once inside the dendritic cell, the tumor-associated antigen is released and processed into the requisite small peptides in the cytoplasm. An important advantage of Versamune® is its ability to fuse with and destabilize endosomes in the cytoplasm, promoting efficient entry of the antigen into the cell compartment, where processing can take place. Processed antigen is turned into peptides that then utilize both the MHC class I and class II pathways. The MHC class I pathway is critical to programing CD8+ killer T cells and the MHC class II pathway to programming CD4+ helper T cells to recognize tumor antigens. When Versamune® induced maturation occurs, the dendritic cells express costimulatory

FIGURE 1

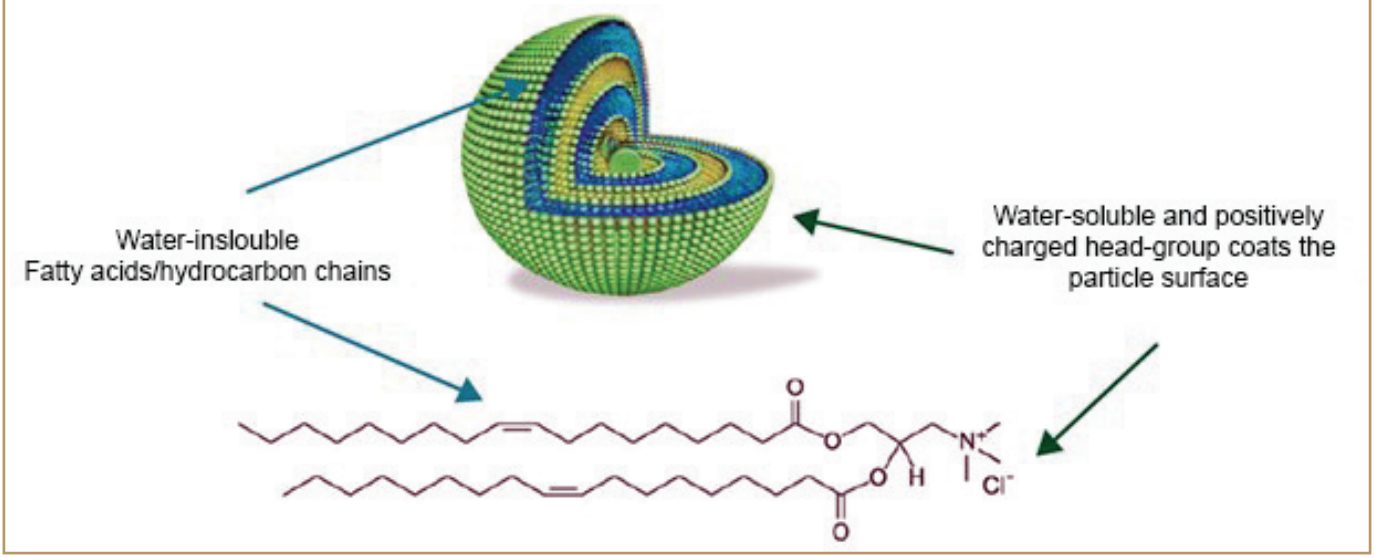
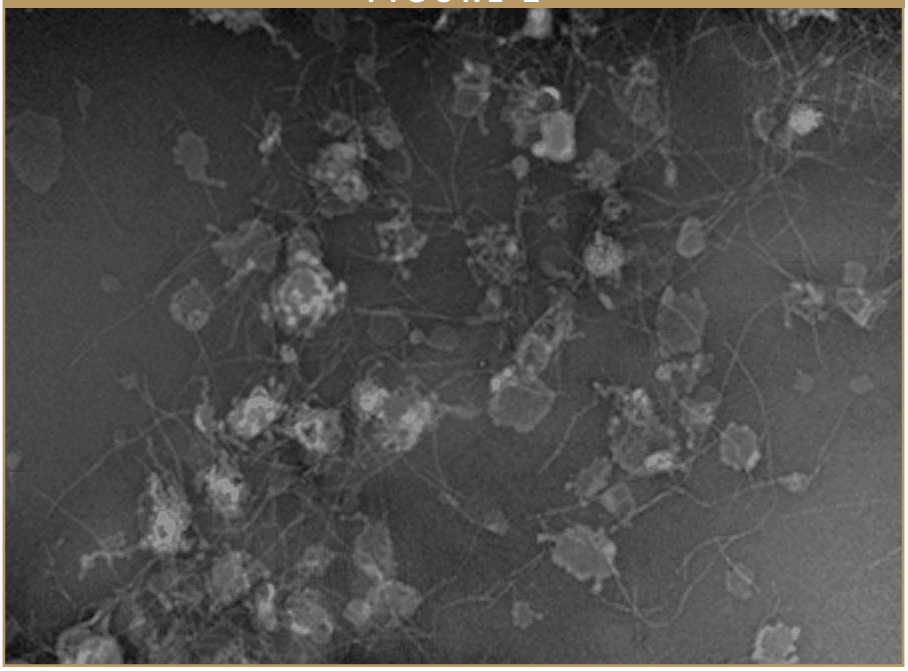


FIGURE 2



molecules on their surface, which facilitate the highly efficient uptake and presentation of antigens to the T cells. This activity overcomes one of the most significant limitations of current immunotherapy development, the efficient priming of critical CD8+ killer T cells against specific tumor antigens. Importantly, Versamune® has also been shown to promote the induction of antigen-specific CD4+ helper cells. The induction of both CD4+ and CD8+ T cells is important for a robust, durable, and clinically relevant immune response.

Figure 2 shows Versamune® nanoparticles interacting with antigen agonist peptides. Ultimately, mature dendritic cells migrate into lymph nodes, small glands located throughout the body containing white blood cells including T cells, where much of the key immunological activity pertaining to the priming and expansion of T cells takes place.

In the lymph nodes, the dendritic cells present the tumor antigens to T cells, resulting in activation of the T cells to recognize the particular antigen expressed by the cancer. Importantly, Versamune® also upregulates type 1 interferon genes (type I IFN), which are responsible for critical immunological processes. This induces an important immunological protein, CD69 that facilitates interactions between the dendritic cell and T cells in the lymph nodes. Upregulation of type I IFN signaling also induces multiple immune messengers, cytokines, and chemokines that further signal T cells to infiltrate into the lymph nodes. Powerful activators of CD8+ killer T cells, such as CCL2 and CXCL10, are documented to be induced by Versamune®. As the Versamune® induced production of chemokines appears to be restricted to the lymph nodes, the site of T cell activation, it provides for both superior activation and expansion of CD8+ killer T cells. Localization of these immune messengers within the lymph nodes and their limited presence in the blood circulation enhances the safety of the Versamune® based immunotherapies. Thus, through the versality of its mechanisms of action, Versamune® safely promotes the efficient and robust expansion in-vivo of large numbers of highly potent polyfunctional CD8+ killer T cells, both critical factors in developing a successful immunotherapy.

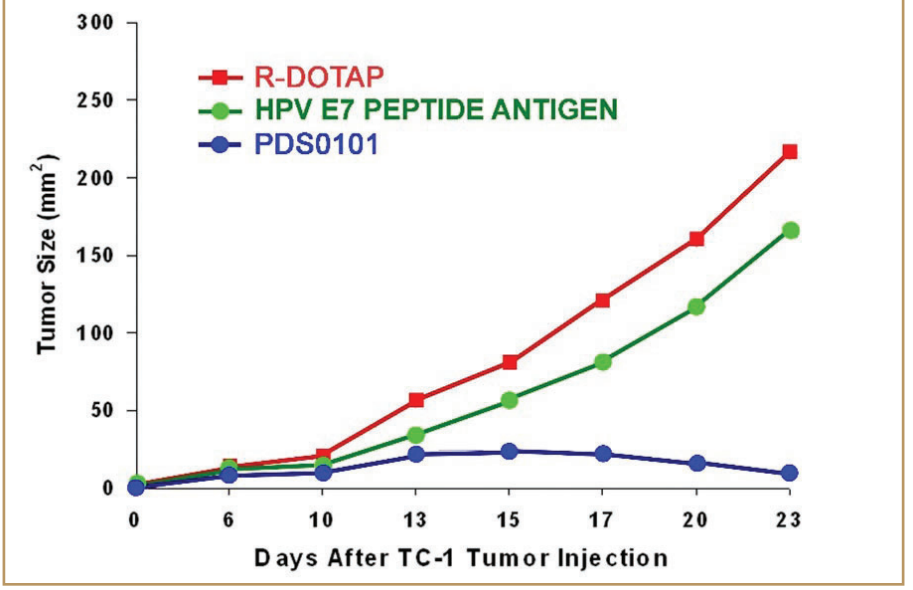
Regulatory T cells (Treg) are a subpopulation of white blood cells normally responsible for recognizing normal healthy cells and for preventing autoimmune disease. In cancer, however, they are utilized by the cancer cells to evade immune detection. Versamune® results in significant alteration of the tumor microenvironment to significantly reduce the Treg to killer CD8+ T cell ratio, making the tumors more susceptible to destruction by killer T cells. Preclinical studies have demonstrated lowering the Treg to CD8+ killer T cell ratio with polyfunctional CD8+ killer and CD4+ helper T cells promotes effective tumor lysis and regression.

Figure 3 shows the significant reduction in tumor size following treatment with PDS0101, compared to R-DOTRAP alone or antigen alone controls.

Overcoming a tumor's immune tolerance and minimizing its ability to evade detection is a significant goal of a successful cancer immunotherapy that together with potent T cell induction has the potential to translate to enhanced tumor elimination.

Memory T cells allow the body to maintain tumor-recognizing and attacking T cells for an extended period after treatment, with the ideal outcome of long-term clinical benefit. Preliminary studies demonstrated Versamune® protected mice that had experienced tumor regression against tumor reestablishment even when the mice were reinjected with the tumor cells. This sustained protection was evidence of immune memory: persistence of antigen-specific T cells to recognize tumor proteins associated with a particular cancer, as the animals were not protected against establishment of different tumors. Evidence of

FIGURE 3



the potential for Versamune® based immunotherapies to induce immune memory has also been demonstrated in a Phase 1 clinical trial in humans. Enhancing tumor-specific memory responses to monitor for and eradicate cancer cells well following initial treatment provides potential for long-term clinical benefit with the potential to reduce the incidence of tumor recurrence.

Many cancer immunotherapies produce serious systemic autoimmune effects as well as inflammatory toxicities due to the increased off-target T cell activity and spikes of inflammatory cytokines in the blood circulation. The mechanism of action of Versamune®, as well as its design, both contribute to the localization of cytokines in the lymph nodes and specific targeting of CD8+ killer T cells to antigens in tumor tissue. Therefore, the expectation is that Versamune® based immunotherapies will exhibit an improved and favorable safety profile compared to currently available treatments.

Versamune® is injected subcutaneously, and its mechanisms of action are localized primarily in the lymph nodes. Further supporting these observations are data demonstrating that negligible levels of Versamune® induced cytokines were detected in the blood of mice. Very low quantities of Versamune® were detected in the blood or in any organ outside of the lymph nodes.

Additionally, Versamune® is broken down by hydrolysis in the body into fatty acids and excreted, thus mitigating the potential for short- or long-term accumulation of the nanoparticles. These preclinical observations have been confirmed by early clinical data documenting this localized and highly specific cascade of immune activity was associated with an absence of systemic toxicity at all doses tested. In a Phase 1 clinical study designed to evaluate safety, all patients had transient swelling and redness at the injection site due to initiation of the immunological cascade at the injection site, which cleared completely within 3-7 days. No dose-limiting toxicities or long-term safety concerns were observed.

In choosing and designing a Versamune® based therapy, careful attention is paid to selecting specific, appropriate antigens because, as previously described, Versamune® induces a strong T cell response to the antigen. All of the antigens currently being evaluated in combination with Versamune® are present primarily in cancer cells, which should result in tumor-specific T cell attack, minimizing off-target toxicity and minimizing potential for destruction of healthy cells and tissue.

THE NEXT FRONTIERS FOR VERSAMUNE®

The unique ability of Versamune® to modulate and enhance numerous critical steps required for an effective clinically relevant immune response and to be combined with targeted antigens found on tumor cells offers several exciting opportunities to treat a variety of cancers. Further, its diverse mechanisms of action together with its favorable safety profile suggest therapeutic promise when used in combination with other treatment modalities or immunotherapies, such as checkpoint inhibitors as well as in the single-agent monotherapy setting.

To date the preclinical data appears to translate well to human clinical results. Phase 2 safety and efficacy data was presented for PDS Biotech's lead therapy, PDS0101, for treatment of Human Papillomavirus (HPV)-related cancers at the American Society for Clinical Oncology (ASCO) in 2022 (posters 2518 and 6041) for two ongoing clinical trials. In one trial, PDS0101 is being evaluated in a triple combination and as a dual combination in the second. Both studies showed predominantly low-grade treatment-related adverse events. The dual PDS0101 + checkpoint inhibitor (CPI) combination therapy showed an objective response rate (ORR) in 41% of patients, which compares

favorably with a 13%-24% reported in for CPI therapy (ASCO poster 2501). The triple PDS0101 combination therapy showed survival in 17/22 (77%) of CPI refractory patients at 12 months, which compares favorably with the historical survival of a median 3-4 months (Strauss J, et al. 2020 J Immunother Cancer).

In addition to PDS0101, the current PDS Biotech pipeline of Versamune® based therapies focus on key antigens associated with a broad variety of solid tumors that remain challenging to treat, including T cell receptor gamma Alternate Reading frame Protein (TARP)-Related Cancers (PDS0102), Mucin-1 (MUC1)-Related Cancers (PDS0103), and others in development. ◆

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BIOGRAPHY

Dr. Joe Dervan joined PDS Biotechnology as VP of R&D in April 2022. He has more than 20 years of biopharmaceutical drug development expertise, from bench to commercialization, including development of a broad range of immuno-oncology therapeutics. He has held varying positions of increased responsibility at Pfizer, F. Hoffmann-La Roche, Protalex, Inc., and GSK. He earned his PhD in Molecular Medicine from Sheffield University Medical School, UK, completed post-doctoral work within the department of Molecular Biophysics & Biochemistry at Yale University, and completed his MBA at Warwick University Business School, UK.

MACHINE LEARNING

Applying Machine Learning Techniques: Gaining Meaningful Life Sciences Insights From Genomics Data

By: Lucas Glass

INTRODUCTION

Through advancements in high-throughput technologies and data management systems, we have access to a vast and varied collection of datasets in the biomedicine space, including genomics data. In generating massive amounts of genomics data, there is a tremendous opportunity to gain meaningful insights to personalize medicine to a patient's particular genomic makeup. However, genomics data is complex, and the data alone is not going to advance therapeutic development toward personalized medicine. For example, to pinpoint the right disease target, we need to know about the entire suite of biological processes. Personalizing therapies requires accurately classifying disease sub-types and the investigational compound's sensitivity to various genomics profiles. Machine Learning (ML) offers a useful set of tools to glean these valuable insights from genomics data.

We organize our perspective of the complex space by diving into how genomics data interacts with other types of data, including compounds, proteins, electronic health records (EHRs), cellular images, and text, as well as by the stage of the R&D lifecycle, in which experts are leveraging the genomics ML. Given the scale and variability of data, experts may not find all the novel patterns ML can help pinpoint, improving prediction capabilities on varying tasks, such as drug response prediction. Uncovering unique and useful patterns can also help lead to the discovery of novel biological insights. Given that therapy discovery often consists of larger, resource-intensive experiments with a limited scope, many potential therapies may be missed. The predictive capabilities offered by ML solutions can help pharmaceutical and biotech companies shift focus onto additional experiments — providing an opportunity to catch or generate potential options.

As companies look for ways to unlock the potential of assets they may consider developing through genomics data, understanding how ML can help enable the process is critical.

USEFUL ML APPLICATIONS

In helping to identify patterns within varying interactions to extract insights from genomics data, ML applications can support faster and more effective drug development. And, it is possible to leverage ML applications throughout the entire therapeutic lifecycle. We have shared a few key applications below based on a systemic literature review published in the October 2021 issue of the data science journal Patterns.

Target Discovery

Pharmaceutical and biotech companies focus on the discovery of novel disease targets to determine how an investigational treatment might hone in on a molecule to produce a therapeutic effect, such as inhibition, to ultimately block the disease process all together. Relying heavily on the basics of human biology, these companies focus on target discovery to help identify target biomarkers, which aid in designing therapeutics to potentially stop the disease pathway and provide treatment to patients.

Druggable Biomarker Identification

Given diseases are driven by complex biological processes, biomarkers play a key role in helping researchers better understand and navigate these processes. It's from these deeper insights that pharmaceutical and biotech companies can design therapeutics to stop the disease process and potentially cure it.

By mining through large-scale biomedical data, ML can help identify these biomarkers to accurately predict genotype-pheno-

type associations. Probing trained models of complex patient data can uncover potential biomarkers and identify patterns related to the disease mechanisms that may not be feasible through manual processing and analysis. Some key tasks related to biomarker identification via ML applications, include the following:

- Variant calling, the first step before relating genotypes to diseases, is used to specify which genetic variants are present in each individual's genome from sequencing.
- Prioritization of pathogenic variants from an entire variant set that can include at least 1 million per person can potentially lead to disease targets. ML approaches can help by either predicting the pathogenicity given a set of features for a single variant or by using each genome profile as a data point to then predict disease risks from this profile.
- An ML-based model can be trained for rare disease detection, if sufficient data from patients with a rare disease and suitable controls exist. Formulating rare disease detection as a classification task, ML can help identify if a patient has a rare disease from his/her genomic sequence and other insights, including EHR data.
- As many diseases are driven by a specific set of genes forming pathways, it is useful to perform pathway analysis to identify these gene sets to have a more complete understanding of disease mechanisms.

Therapeutic Discovery

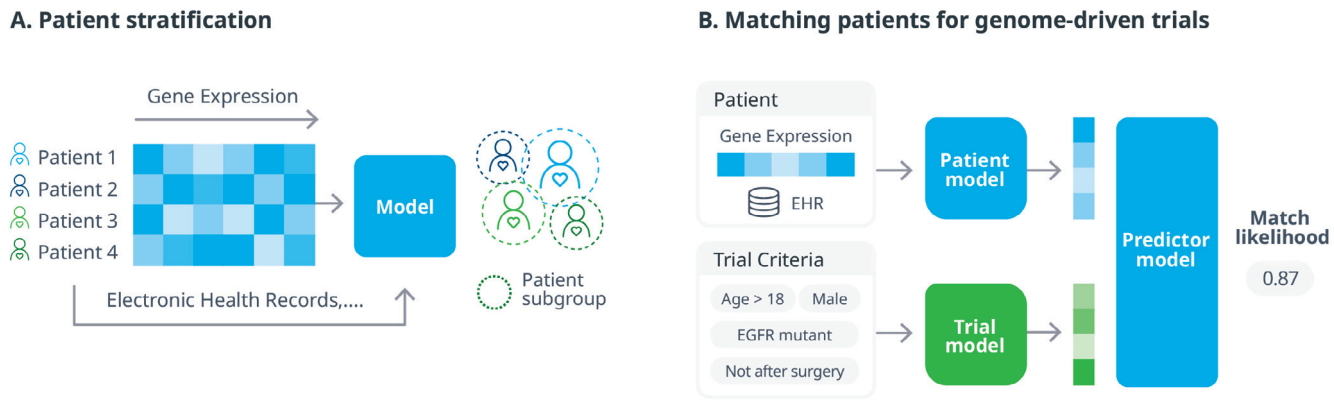
After identifying a treatment's target, therapeutic discovery is the next step. In this discovery stage, working to design a therapy — a small molecule, antibody, gene therapy, and more — to control the disease target and block its pathway is key. This can include numerous phases and layers of tasks to help ensure the treatment is safe and effective.

There are several ways the use of an accurate ML model can help sponsors in this stage of drug development, including the following:

- Identify new molecules faster to reduce development timing by de-risking the research aspects of finding new therapies.
- Better prediction of a therapy's response in a variety of cell lines in silico or in virtual cohorts for testing purposes to guide smarter decision making.
- Potential to greatly narrow down the drug screening space and reduce experimental costs and operational resources.
- Optimize the probability of clinical trial success, as therapy response insights are uncovered, to enable greater visibility to better protocol design.
- Enable the design of various gene therapies.

Additionally, as combination therapies can help modulate multiple targets to provide a novel mechanism of action in cancer treatments, it is possible to reduce adverse effects for the patient, given there are reduced dosages of each therapy. Screening the entire space of possible drug combinations is not feasible experimentally. Relying on ML models that can predict responses due to the drug combination and the genomic profile for a cell line can be valuable.

FIGURE 1



Machine learning applications for therapeutic tasks with genomics data.

Clinical Studies

In the comprehensive literature review conducted by several life sciences professionals and published in Patterns journal, as previously noted, there are three areas of focus for genomics in clinical trials:

1. Animal-to-human translation
2. Cohort curation
3. Causal effects

ML is regularly exploring the challenges of domain adaptation like that of the animal-to-human challenge. The ability to leverage machines to learn how phenotypic responses in mice translate to the responses in humans can greatly reduce the failure rate of early phase clinical trials.

Through ML, study teams can distinguish important factors for the primary endpoints and quickly identify them in patients by predicting patient profiles that will respond to treatment. ML-based approaches have been tackling this problem at a cellular and molecular level. Also, to address the problem of successfully identifying the right patients for the right trials, automated patient-trial matching using ML models are worth considering for sponsors to improve enrollment by taking heterogeneous patient data and trial eligibility criteria into account.

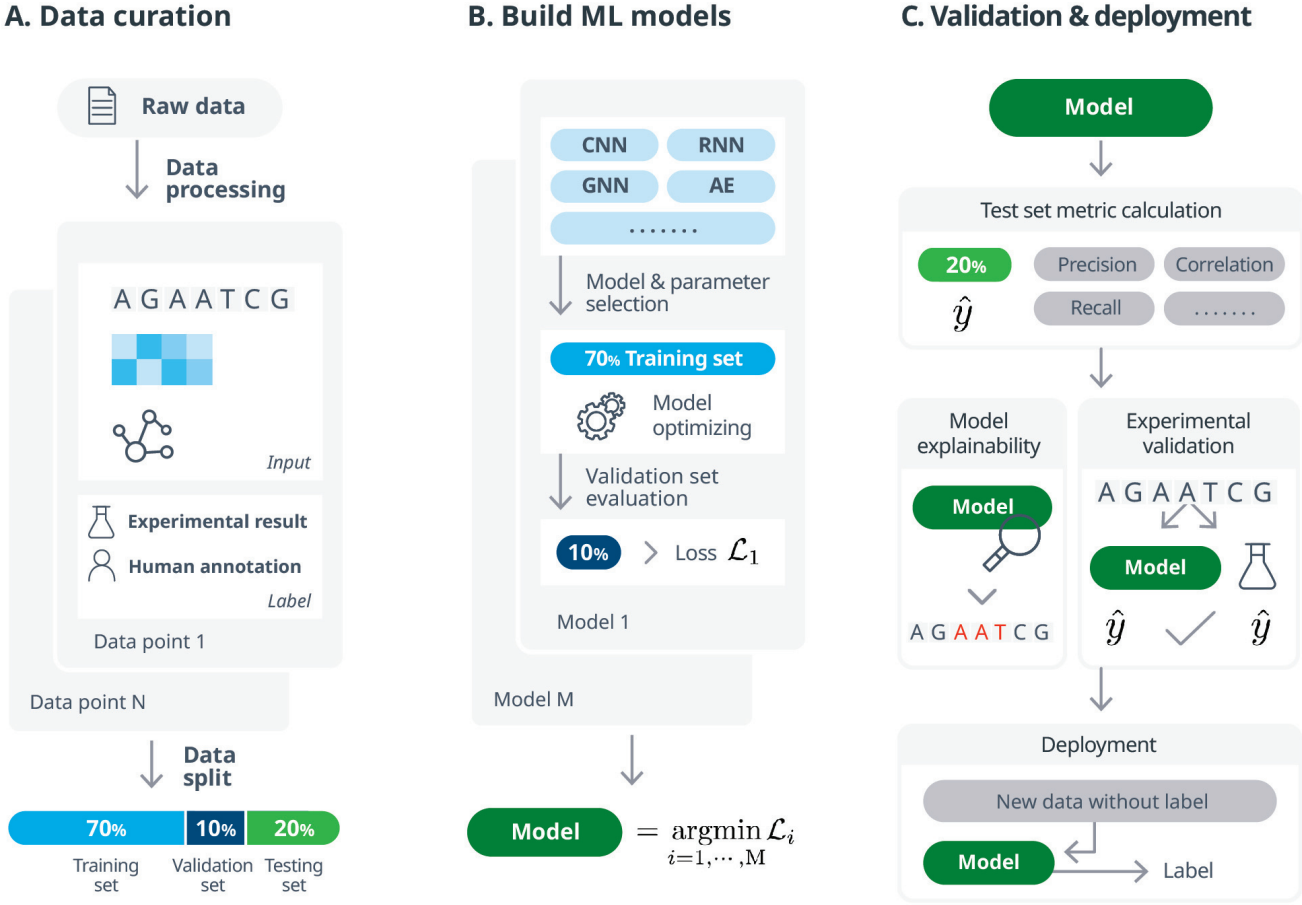
Mendelian randomization is a particular method that uses a measured variation in genes with already known function to evaluate the causal effect of modifiable exposure on a disease. If the gene is associated with the exposure and the outcome due to the exposure, genes can be an instrumental variable to simulate randomization. This method can help sponsors bypass clinical trials all together, add support for trials, and/or validate drug targets. ML methods are showing promise over more traditional regression approaches.

More advanced ML applications and causal inference methods, however, are challenging. For example, genes can associate with the outcome through another pathway beyond exposure, which then requires customized probabilistic models and a larger sample size for statistically significant estimation.

Post-Market Study

Once a treatment is approved for marketing and commercialization, phar-

FIGURE 2



Machine learning for genomics workflow.

maceutical and biotech companies continue to monitor its efficacy and safety in clinical practice through numerous studies.

Given these studies house important information about the treatment that was not evident before regulatory approval, ML models can help mine through a large collection of texts and pinpoint useful signals for post-market surveillance. This includes numerous documentation sources generated in EHRs, insurance billing systems and more, which is considered real-world data. Analyzing and extracting large collections of key insights about the treatment, including use responses from patients with varying characteristics, through EHR data alone may not get the full picture of the patient experience. Clinical notes from patient visits also need to be considered but can be difficult for study teams to manually weed through. ML can help automate clinical note data extraction to secure critical patient insights, allowing study teams and sponsors to delve deeper into treatment use and the patient experience.

OUTSTANDING CHALLENGES TO AI FOR GENOMICS

When used appropriately, ML can transform the use of genomics data in drug development. However, as with any solution, there are several key factors that sponsors need to consider and address to ensure success in use.

For one, when the training and deployment data follow the same data distribution, ML can help leverage genomics data successfully. But, data distribution shifts have long been a challenge in ML use. For example, with predicting human response from animal response, we must deliberately teach the algorithms to learn what information translates from one domain to another. Also, typically, there are only a few drug response data points for new treatments. Technologists and clinical teams have to determine how to make an ML model learn when only a few examples are available.

In terms of racial bias in training data, it has been shown that ML models do not always translate well across all subpopulations. Models that may perform well on the discovery patient population generally have much lower accuracy and are not adequate predictors in other populations. And, since most discovery is performed with European-ancestry cohorts, predictive models may exacerbate health disparities, as they will not be available for or have lower value for African and Hispanic ancestry populations. This level of imbalance for minority patient populations requires specialized ML techniques. As a solution, ML is defined to make the prediction independent of variables, such as race, gender, and sexual orientation, and recent works have been proposed to ensure this standard in the clinical ML domain.

Lastly, given the amount of genomics data generated on a daily basis, it is obvious ML models can help with data aggregation and annotations. However, sponsors need to keep data privacy compliance in mind, as these insights contain sensitive patient information and are not shareable directly. Techniques to anonymize and de-identify these data using differential privacy, can potentially enable sharing of genomics data. Recent advances in federated learning techniques allow ML model training on aggregated data without sharing data.

WHERE ML CAN TAKE THERAPEUTIC DEVELOPMENT

Though ML applications to aid in therapeutics development will have their challenges, technical and otherwise, we are able to see how ML models using genomics data can help us better understand therapeutic tasks. Through a variety of ML applications, sponsors and study teams can dive deeper into tangible ways to personalize medicines. As such, the variety of ML models using genomics data will only grow and diversify, leading to more breakthroughs in drug discovery and development and further personalizing medicine for patients in need. ◆

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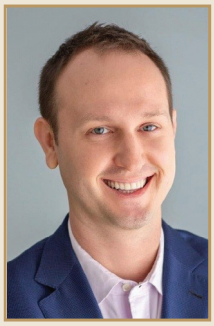


Lucas Glass is the Vice President of the Analytics Center of Excellence (ACOE) at IQVIA. The ACOE is a team of over 200 data scientists, engineers, and product managers that research, develop, and operationalize Machine Learning and data science solutions within the R&D space. He has launched more than a dozen Machine Learning offerings within R&D, such as site recommender systems, trial matching solutions, enrollment rate algorithms, drug target interactions, drug repurposing, and molecular optimization. His Machine Learning research, which is dedicated to R&D, has been published by AAAI, WWW, NIPS, ICML, JAMIA, KDD, and many others.

ARMED ONCOLYTIC VIRUSES

Instant Messaging Cancer With a TGF-Beta Trap Carrying Oncolytic Adenovirus

By: Bryan Oronsky, MD, PhD

INTRODUCTION

Fundraisers, celebrity endorsements, marches, speeches, essays, and the like aside, the most direct way to send a "message" to cancer, and to guarantee that it is received, understood, and possibly even followed, is to use DNA, the lingua franca of the tumor cell. From a deceptively simple four-letter alphabet of adenine **A**, cytosine **C**, guanine **G**, thymine **T**, it is possible to instruct tumors and their supporting cells or stroma to stop propagating and to return to normal. Unfortunately, however, that anticancer message or signal is often lost or obscured in a sea of competing protumor noise.

Hence, to amplify the signal-to-noise ratio in tumors requires a sort of biological megaphone, which one therapy, above all else, provides — armed oncolytic viruses. An oncolytic virus, with the prefix, "onco," meaning tumors and the suffix, "lytic," meaning lysis or destruction, is modified, repurposed, or re-engineered to spare normal tissues in favor of selective and specific infection, replication, and destruction of cancer cells. An "armed" oncolytic virus refers to one in which an additional DNA instruction has been inserted — that extra piece of DNA, called a transgene, which serves to stimulate the immune system, for example, when it is expressed as a protein, is copied and expressed repeatedly, thousands of times, even possibly tens of thousands of times, as the virus replicates in the tumor cells, amplifying or multiplying the anticancer DNA message, in a self-sustaining, rinse-and-repeat cycle of infection, replication and lysis. To date, one oncolytic herpesvirus has received FDA regulatory approval, talimogene laherparepvec (T-VEC, or Imlygic®). Two other oncolytic viruses are also approved outside of the US: H101, an adenovirus for the treatment of advanced head and neck cancer in China, and Rigvir, an oncolytic reovirus approved for the treatment of advanced melanoma in Eastern Europe.

ADAPT-001

A Type 5 experimental oncolytic adenovirus, referring to a modified agent of the common cold, called AdAPT-001, is under clinical investigation by our company, EpicentRx. AdAPT-001 was jointly invented by the company's two viro-oncologists, Dr. Tony Reid, MD, PhD, CEO of EpicentRx, and Dr. Christopher Larson, MD, PhD, Vice President of Viral Manufacturing. The company is focused on two complimentary platforms, ADAPT™ and CyNRGY™, that act alone or in combination with other treatments to treat cancer and chronic diseases. AdAPT-001 is the lead candidate of the ADAPT platform, into which different therapeutic transgenes have been inserted for the treatment not only of cancer but also other non-cancer indications like COVID-19.

The NLRP3 and CD47 small molecule inhibitor, RRx-001, currently in a Phase 3 trial for the treatment of small cell lung cancer (SCLC) and a soon-to-be-initiated late-stage clinical trial for protection against radiation- and chemotherapy-induced oral mucositis, is the lead candidate of the CyNRGY platform. As an NLRP3 inflammasome inhibitor, RRx-001 is described as active in cancer as well as autoimmune and chronic inflammatory conditions like Parkinson's, Multiple Sclerosis, and Crohn's Disease.

FORCE MULTIPLIER & NULLIFIER

AdAPT-001, which carries a TGF-β trap transgene, is currently under investigation in a Phase 1/2 clinical trial called BETA PRIME (NCT04673942) for the treatment of cancer both alone and in combination with other immunotherapies.

Dr. Reid describes AdAPT-001 as "a megaphone that serves as a 'force multiplier' against tumors, given that it robustly infects, replicates, and lyses them, and a 'force nullifier' against immunosuppression in cancer due to the production and release of the TGF-β trap transgene whose function is to bind to or 'trap' the protein TGF-beta (TGF-β)."

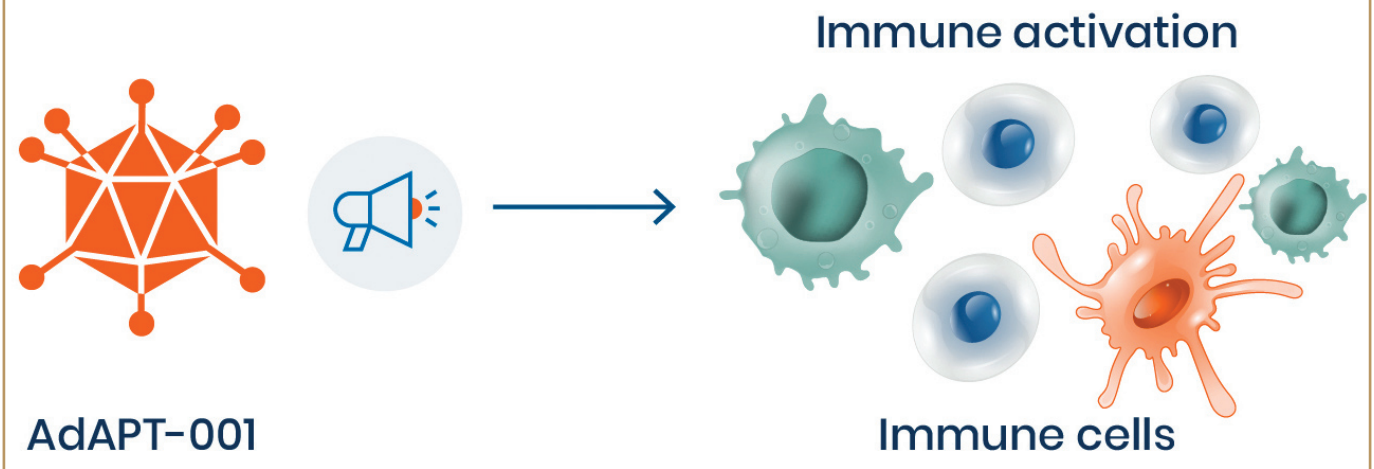
In tumors, TGF-β is overexpressed to serve several functions, all of which are detrimental to the host: 1) immunosuppression, a key determinant of therapeutic resistance 2) fibrosis, which compresses blood and lymphatic vessels, leading to reduced blood flow and hence, reduced drug transport including transport of checkpoint inhibitors and 3) angiogenesis, a sine qua non for tumor growth and metastasis.[1]

Dr. Reid is an internationally recognized oncolytic virotherapy thought leader who helped to develop the ONYX-015 adenovirus, precursor to the Chinese-approved H101 adenovirus. The AdAPT platform is built on a foundation of several decades of knowledge accumulated from earlier iterations of oncolytic viruses that he was involved with either as lead clinical investigator at Stanford University and University of California at San Diego (UCSD) or as a virotherapy researcher. He chose to work with adenoviruses over vaccinia, reoviruses, or herpes viruses firstly because the safety of oncolytic adenoviruses has been confirmed in many clinical trials, many of which he conducted, with mild, temporary flu-like symptoms, eg, fever, tiredness, and chills as their main side effect and secondly because of their large gene-carrying capacity.[2] As a virus, AdAPT-001 is highly immunogenic on its own, an effect that is augmented or amplified by the insertion of the TGF-β trap. Because the AdAPT viruses are engineered to specifically infect tumors, they are non-contagious for humans unless directly injected.

DISRUPTING THE VIRAL GENOME

The basic philosophical underpinning of the AdAPT platform is that the more the viral genome is altered, disrupted, or edited, the less efficient infection and transmission becomes. This is logical because viruses have developed highly honed mechanisms over millions of years with which to best infect and replicate themselves. Therefore, unlike several other oncolytic viruses in development or on the market, which are over-manipulated, leading to severe attenuation of viral replication and a many-fold lower output of infectious particles compared to wild type or native virus, the AdAPT platform minimally disrupts the adenoviral genome, resulting in higher viral titers, increased lethality to tumor cells, and a faster and stronger immune response.[3] Of particular interest to manufacturability and cost, the faster and the more efficient virus production is, the easier and cheaper it is to make it in-house, which our company is equipped to do in place of outsourcing to contract manufacturing organizations (CMOs).

FIGURE 1



The AdAPT-001 "megaphone" delivers a potent anticancer message to tumors.

Before initiation of the ongoing BETA PRIME Phase 1/2 clinical trial, our company studied the efficacy, safety, and biodistribution of AdAPT-001 in immune-competent mouse tumor models. The results showed that AdAPT-001 is safe, well-tolerated, and effective as monotherapy and in combination with an immune checkpoint inhibitor. Moreover, the TGF-β trap was produced in large quantities and circulated at high levels over weeks after treatment with AdAPT-001.[4] AdAPT-001 not only increased the entry of cytotoxic T-cells into tumors, but also prevented the development of subsequent tumors on rechallenge with cancer cells and synergized with a PD-L1 checkpoint inhibitor (CI). The latter is especially important as it is well known that only a minority of patients respond to CIs on their own. Hence, the search for a suitable checkpoint inhibitor partner is on.

COLD TO HOT

Despite all the hype and the excitement surrounding them, the reality is that checkpoint inhibitors (CIs) are ineffective against "cold" tumors such as glioblastoma, ovarian, prostate cancer, and pancreatic cancer, in which immune cells are sparse or absent; by contrast, CIs are far more likely to show activity in "hot" tumors with an abundance of immune cells.[5] The rationale for EpicentRx to combine AdAPT-001 with a checkpoint inhibitor is based on the expectation, as shown in preclinical experiments that AdAPT-001 will "heat up" tumors with increased T cell infiltration and cytokine expression and, thereby, overcome resistance to CIs, particularly when mechanisms of immunosuppression predominate, such as TGF-β overexpression, which is usually the case.

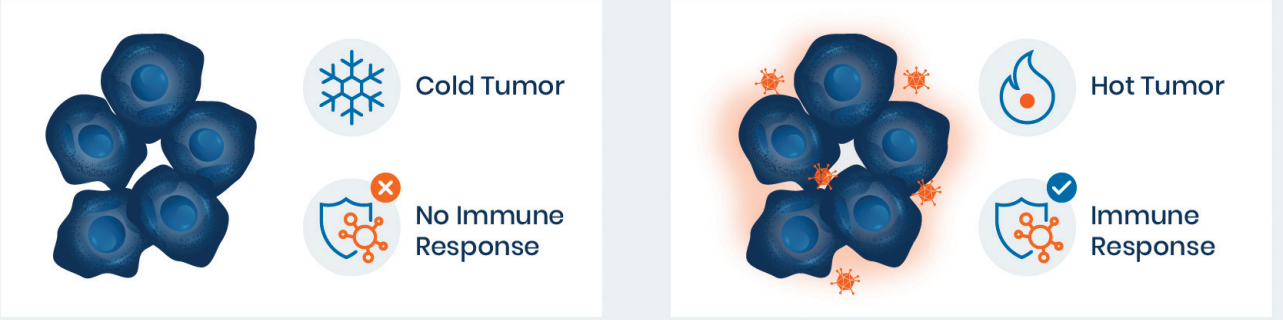
TGF-β & WOUND HEALING

TGF-β is essential for wound healing because decreased inflammation, increased blood flow, and the formation of scar tissue are necessary for repair and resolution. Dr. Reid stated that "tumors are often referred to as 'wounds that do not heal' so it makes sense, in this context, not only that TGF-β is overexpressed but also that this chronic, constant overexpression from the nonhealing tumor wound may contribute, over time, to aggressive cell growth, and metastatic spread through immunosuppressive, fibrotic, and angiogenic mechanisms."

As Dr. Reid explains, "tumors, by and large, manage to hide in plain sight. They are often imageable, of course, with CT or MRI scans but due to several factors, including the overexpression of TGF-β and other immunosuppressive cytokines and the fact that cancer cells derive from and resemble normal cells, the immune system, whose responsibility it is to recognize and eliminate cancer cells, fails to mount a response."

Mechanistically, from the perspective of EpicentRx, the therapeutic potential of AdAPT-001 depends on several factors: first, on preferential lysis of tumor cells, second, on the resultant priming of a systemic anti-tumor immune response from the release of tumor-associated antigens, tumor neoantigens, and danger signals, and third, and perhaps most importantly, on the expression and release of the soluble TGF-β trap, which circulates in the bloodstream for weeks to reverse immunosuppression from TGF-β overexpression in the tumor wound.

FIGURE 2



An oncolytic adenovirus, AdAPT-001, acts to turn cold tumors, where no response to therapy is seen, to hot ones, which are therapy-responsive.

SUMMARY

Incredibly, the history of cancer immunotherapy dates as far back as 2600 BC with the great Egyptian physician, Imhotep, who used a poultice followed by incision to elicit infection at the tumor site.[6] Thousands of years later, at the turn of the 20th century, the equally impressive, Dr. William Coley, who is regarded as the "Father of Immunotherapy," formulated a crude (and, as it turned out, due to issues with quality control, variably unsafe) anticancer vaccine, known as "Coley's toxins," from a heat-killed bacterial cocktail. Checkpoint inhibitors (CI) like pembrolizumab (Keytruda®) and nivolumab (Opdivo®), which "release the brakes" on the immune system, are the culmination of these early, rudimentary efforts. That said, for all the paradigm-shifting hype that surrounds them, CIs are far from universally effective; in fact, only a small subset of patients with certain immunogenic tumor types, such as advanced melanoma, renal cell carcinoma (RCC), and non-small cell lung cancer (NSCLC), benefit from them. Even those patients that initially derive benefit will eventually develop resistance. A marker of non-responsiveness to checkpoint inhibitors is the absence or low presence of T cells in tumors, which are referred to as "cold."[7]

EpicentRx developed AdAPT-001 to be readily manufacturable in-house at large scale, at high titers, and at low cost. Depending on the results from BETA PRIME, which are expected in Q1 of 2023, an immediate hoped-for next step is to approach the FDA for permission to start a Phase 3 trial, prior to a potential approval, in certain immunosuppressed, heavily fibrotic tumor types, like pancreatic cancer, that are known to overexpress TGF-β.

In BETA PRIME, AdAPT-001 is directly injected into tumor masses. Based on preclinical data and potential evidence from the Phase 1/2 BETA PRIME clinical trial, EpicentRx expects to observe responses in non-injected tumors from the generalization of anticancer immune responses established in the injected tumor. In addition to intratumoral administration, AdAPT-001 is also well-suited to subcutaneous and even intravenous administration because the virus can synthesize high levels of TGF-β trap before it is cleared from the dermis or the bloodstream.

Cancer is a systemic disease, the eradication of which heavily depends on immune responses. In our opinion, to overcome impaired immune cell function and, hence, to increase the responsiveness to CIs likely requires a 3-in-1 therapy like AdAPT-001, which 1) eliminates cancer cells and, 2) releases neoantigens and danger signals even as it, 3) turns the cancer cells into "factories" for the synthesis of the TGF-β trap. ◆

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BIOGRAPHY

Dr. Bryan Oronsky serves as EpicentRx Chief Development Officer and combines first-hand clinical experience with 17 years of pharmaceutical development experience. Before joining EpicentRx, he worked as a Medical Officer at Intarcia Therapeutics. He has published more than 100 peer-reviewed scientific articles, reviews, and book chapters. He is also co-inventor of 10 issued patents and more than 50 pending patents in the biomedical and device fields. He was educated at Princeton University, Catholic University in Belgium, and University of Miami Medical School.

DRUG DISCOVERY

Leveraging the Human Gut as a Drug Discovery Tool

By: Bridget Ann Martell MA, MD

INTRODUCTION

A confluence of factors from host genetics, immune dysregulation, environmental triggers, and gut dysbiosis all contribute to a disease developing in an individual. Given certain genetics and environmental factors, some people are susceptible to organisms (or "pathobionts") in the gut that can cause disease, while others are not. Pathobionts are defined as bacteria present in the "normal" human intestine that have the potential to cause or drive disease development, and therefore share features with both commensal symbionts and pathogens.[1] For example, Segmented Filamentous Bacteria (SFB) are common members of the mouse microbiota that exacerbate the development of autoimmunity, and Helicobacter species drive the development of colitis in genetically susceptible mice.[2] SFB and Helicobacter species therefore represent classical pathobionts. In patients susceptible to disease, exposure to pathobionts induces intestinal dysbiosis and triggers an inflammatory cascade that leads to the development and progression of diverse chronic diseases and certain cancers.

Inflammatory bowel disease (IBD) is one example of a disease driven by such factors for which currently available treatments are not a viable solution for all patients. While there have been tremendous advances in IBD therapies, approximately 30% of patients are unresponsive to initial biologics therapy and, even among responsive patients, up to 10% stop responding to treatment annually.

With an initial focus on IBD, that is, Ulcerative Colitis and Crohn's Disease, Artizan Biosciences has an exclusive license to the patented technology, IgA-SEQ™, invented by its founders to identify putative disease-driving bacteria through the examination of fecal samples from patients with IBD. By leveraging this techonology, Artizan uses the human gut as a drug discovery tool. This process has led to a new class of transformative precision therapeutics that disrupt inflammatory disease triggers - gut exclusive microbial metalloprotease inhibitors (GEMMI).

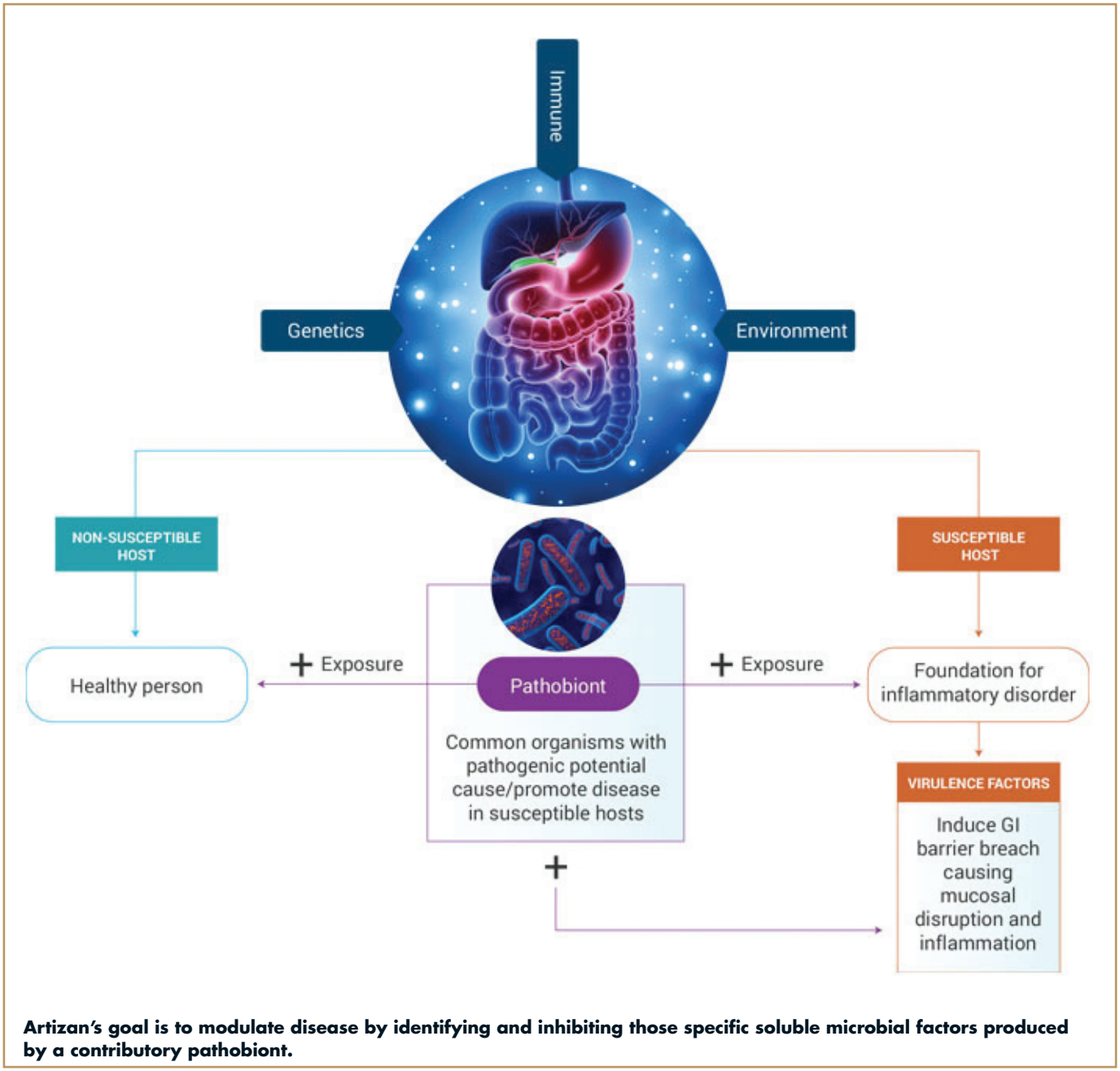
THE MICROBIOME & HOST INTERATIONS

The composition of the intestinal microbiota varies substantially between individuals and has significant effects on host physiology and disease susceptibility.[3-7] A major mechanism by which the microbiota impacts the host is through its interactions with the intestinal immune system. These organisms modulate the intestinal immune system and affect disease risk through chronic stimulation of specific immune responses, of which can be both beneficial and detrimental to the host. In mice, for example, Clostridia species induce the expansion of regulatory T cells and suppress allergic responses and intestinal inflammation, Segmented Filamentous Bacteria (SFB) induce T helper 17 responses, exacerbate the development of arthritis, and protect against the development of diabetes.[8-11] Alterations in the composition of the microbiota, sometimes referred to as "dysbiosis," are known to drive development of both inflammatory and non-inflammatory diseases, including IBD, metabolic diseases, and autoimmunity.[12] IBD is a chronic, relapsing chronic inflammatory disease for which there is no cure. In IBD, it is believed a dysbiotic intestinal

microbiota plays a key role in driving inflammatory responses during disease development and progression.[13-15] In 2020 alone, more than 3 million people in the US and European Union were diagnosed with IBD. Although the exact causes of IBD are unknown, pathobionts are believed to play a pivotal role in disease development.

THE ROLE OF IMMUNOGLOBULIN A

Immunoglobulin A (IgA) is the predominant antibody isotype secreted into the intestinal lumen, where it binds indigenous members of the microbiota and controls microbiota composition.[16-19] IgA is also a critical mediator of intestinal immunity.[20,21] Recognition of enteric pathogens by the intestinal immune system results in the production of high-affinity, T cell-dependent, pathogen-specific IgA, which is transcytosed into the intestinal lumen. In the lumen, these antibodies can bind and "coat" offending pathogens and provide protection against infection through neutralization and exclusion. Indigenous members of the intestinal microbiota also can stimulate IgA production and can become coated with IgA.[22-24] While all intestinal bacteria can induce specific IgA responses, in principle, direct analyses of the proportion of intestinal bacteria that are coated with IgA demonstrated that only a fraction of all intestinal bacteria are



Artizan's goal is to modulate disease by identifying and inhibiting those specific soluble microbial factors produced by a contributory pathobiont.

measurably IgA coated.[25-28] Because little is known about the specificity of the intestinal IgA response in the context of a complex microbiota, whether this fraction is composed of many species or a high percentage of a few species remains unclear. However, while several commensal bacteria have been shown to induce specific IgA responses, pathobionts and pathogens induce higher levels of IgA than "true" commensals.[28] For example, SFB and Helicobacter species are potent inducers of IgA response in the intestine.[29,30]

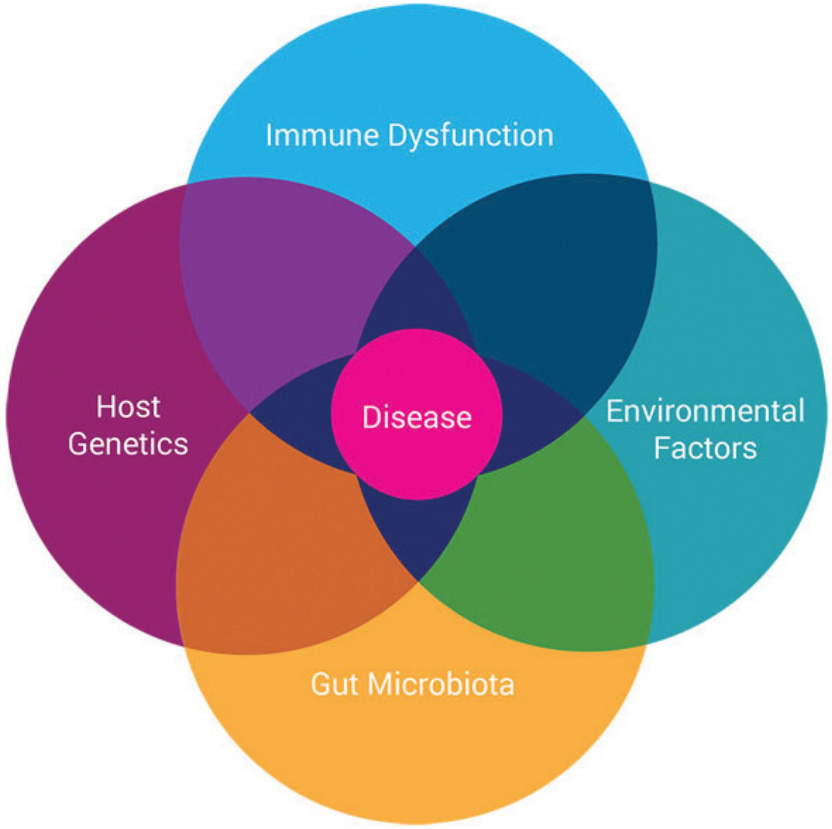
The inflammasome is a critical component of the innate immune system that orchestrates the activation of Caspase-1 and release of the inflammatory cytokines IL-1β and IL-18 in response to infection or damage. Mice lacking components of the inflammasome, such as the signaling adaptor apoptosis-associated speck-like protein containing a CARD (ASC), harbor a dysbiotic microbiota that is colitogenic and can be transmitted to wild type mice through co-housing.[31] In particular, acquisition of bacteria from the family Prevotellaceae has been implicated in colitis development in dysbiotic mice.[32] Despite considerable effort, the identification of specific pathobionts responsible for driving the development of disease in humans has proven difficult due to the complexity and diversity of the microbiota, as well as the influence of host genetics and environment on disease susceptibility.

SUMMARY OF THE IGA-SEQ PATENTED INVENTION

IgA-SEQ capitalizes on the discovery that secretory antibodies can be used to detect and identify organisms present in the microbiota that influence susceptibility to or contribute to the development or progression of diseases or disorders, including chronic inflammatory diseases. However, compared to pathogen-induced IgA, commensal-induced IgA is generally believed to be of relatively low-affinity and specificity.[33,34] Thus, relative levels of bacterial coating with IgA might be predicted to correlate with the magnitude of the inflammatory response triggered by a specific intestinal bacterial species. IgA-SEQ is a method for identifying the target organisms in the microbiota contributing to an inflammatory process and, by default, is on or near any mucosal surface of the patient including: the gastrointestinal, the respiratory, and genitourinary tracts. In addition to IBD, the role of pathobionts and chronic inflammation have been implicated in multiple conditions, including celiac disease, acute diverticulitis, intestinal hyperplasia, metabolic syndrome, obesity, rheumatoid arthritis, liver disease, hepatic steatosis, fatty liver disease, non-alcoholic fatty liver disease, and non-alcoholic steatohepatitis.

FLAGSHIP INFLAMMATORY BOWEL DISEASE PROGRAM UTILIZING IGA-SEQ™

Metagenomic studies comparing the microbiota of diseased and normal individuals have failed to identify disease-causing bacteria for a number of reasons, notwithstanding limited technical methodologies. There is a need in the field to not only identify bacteria in the microbiota that are implicated in the development or progression of certain diseases and disorders, but to determine which are activating the chronic inflammatory pathways and exactly how. When identifying promising microbiome therapeutic approaches for any disease or condition, it is critical to understand the mechanism of disease and disease pathways as well as the role of the microbiome. IgA–SEQ begins that discovery process whereby the human gut now becomes a crucial drug discovery tool. IgA–SEQ was developed at Yale, licensed by Artizan, and utilizes flow cytometry-based bacterial cell sorting and 16S sequencing to characterize taxa-specific coating of the intestinal microbiota with immunoglobulin A. It has been demonstrated that the high IgA–coating uniquely identifies colitogenic intestinal bacteria in a mouse model of microbiota-driven colitis. Proof of principle was shown by leveraging the IgA–SEQ methodology to identify culprit pathobionts and proceed with extensive anaerobic culturing of these organisms from patients with IBD to create personalized disease-associated gut microbiota culture collections with pre-defined levels of IgA coating. Using these collections, it was found that intestinal bacteria selected on the basis of high coating with IgA conferred significant susceptibility to colitis in germ-free mice. Thus, these studies suggested that IgA–coating identifies inflammatory commensals that preferentially drive intestinal disease.[35] Inflammation within the intestine and distal organs can be mediated by innate and adaptive components of the immune response. IgA-SEQ is based on the rationale that certain intestinal bacteria that become coated with IgA are close to the host mucosal surfaces and are activating and promulgating a pro-inflammatory response. Thus, IgA-SEQ is a promising approach for identifying colitogenic bacteria in man. The influence of these gut microbiota/host immune interactions, however, is not limited to the gut. More recently, en-



Artizan identifies and targets disease drivers to develop small molecule and biologic therapeutics to treat the diseases they cause.

richment of IgA-coated microbiota has been demonstrated for Crohn's disease associated spondylarthritis.[36] Thus, IgA-SEQ might be applicable to the identification of microbial strains in the gut microbiota, which, through an inflammatory circuitry, are modulating inflammation and driving disease at distant sites.

The mammalian immune system has evolved in the presence of a complex community of indigenous microorganisms that constitutively colonize all barrier surfaces. This intimate relationship has resulted in the development of a vast array of reciprocal interactions between the microbiota and the host immune system, particularly in the intestine, where the density and diversity of indigenous microbes are greatest. The relationship between the immune system and the microbiota is central to the impact of the microbiota on disease, thus, immunologically important pathobionts are likely to have outsized effects on human disease. By utilizing the novel IgA-SEQ approach, Artizan's team of researchers can take advantage of mucosal antibody responses to the microbiota to identify immunologically relevant microbes that may play causal roles in chronic disease.

PIONEERING TRANSFORMATIVE PRECISION THERAPEUTICS

Artizan utilizes IgA-SEQ and its world-class biobanking program with sophisticated bioinformatics system to enable its research team to examine microbial drivers in many different disease types. IgA-SEQ allows researchers to methodically investigate microbial communities down to individual bacterial strains from healthy and disease-affected samples from its exclusive biobanking program. Once a strain of interest is identified, Artizan applies its mechanistic research expertise to determine the root causes of pathology. Deciphering the precise pathogenic mechanisms allows the company to design transformative disease-modifying therapeutic agents, including novel small molecule and monoclonal antibody treatments. Artizan's unique capabilities identify predictive biomarkers to target precision treatment to the right subset of patients.

To date, this process has allowed Artizan to develop transformative precision therapeutics that target and block the root causes of diverse, serious diseases triggered by intestinal inflammation including gut exclusive microbial metalloprotease inhibitors (GEMMI). These precision therapeutics include ARZC-001, a novel, oral, gut-restricted potent small molecule inhibitor for the treatment of IBD. The company anticipates ARZC-001 will enter the clinic by early 2023. Additionally, Artizan is advancing other candidates into the late preclinical stage for IBD, each distinctly different in chemical composition and the target that it is aiming to inhibit.

Beyond IBD, Artizan is also using IgA-SEQ to identify and characterize microbial drivers of disease within precise patient subsets in other areas, including certain cancers and gastrointestinal, metabolic, autoimmune, and neurodegenerative disease. The company has a Parkinson's Disease therapeutic discovery and development program that is progressing. Artizan also continues to identify partners for therapeutic development in other dis-

ease states as well as concepts that improve the tolerability and viability of currently available treatments in areas including oncology. ◆

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BIOGRAPHY

Dr. Bridget Ann Martell is President and Chief Executive Officer of Artizan Biosciences. She is a seasoned biopharmaceutical executive with high-impact, results-oriented breadth and depth in clinical development, medical affairs, and business development across a range of therapeutic areas from first-in-human through approval and commercialization. She has held leadership and C-suite executive roles at companies, including Kura Oncology, where she led the Menin Inhibitor Program, and at Juniper Pharmaceuticals, where she led the development program for a Bob Langer-created drug/device technology that was out-licensed. She started her pharmaceutical career at Pfizer, where she had roles of increasing responsibility that included Clinical Team Leader for Sutent® GU solid tumors in the Oncology Business Unit and, ultimately, Biosimilars Medical Head. She began her clinical investigation career at Yale with a Career Development Award, where she led a therapeutic cocaine vaccine trial and was a Robert Wood Johnson Clinical Scholar. She was a practicing physician at Yale for 20 years and remains active as an Entrepreneur in Residence at the Yale Innovations Office. She earned her BSc in Microbiology from Cornell University, her MA in Molecular Immunology from Boston University, and her MD from The Chicago Medical School. Dr. Martell is board certified in Internal and Addiction Medicine.

DRUG DELIVERY

Using the IPEG™ Delivery System to Topically Treat Rare Diseases in Dermatology While Limiting Systemic Absorption

By: Zachary Rome, Jessica Raiz, MPH, and Alan M. Mendelsohn, MD

INTRODUCTION

There are many unmet needs in medical dermatology, especially in rare diseases that may not have any approved therapies. In many of these cases, oral therapies are often used off-label, which have demonstrated efficacy but may be associated with systemic toxicity, which then limits their safe chronic use. Recent research has demonstrated that novel topical formulations of these oral therapies may represent safer treatment options that can lead to clinically meaningful outcomes in many rare dermatologic diseases, including congenital ichthyosis. At Timber Pharmaceuticals, we are advancing innovative clinical research that is evaluating high-potential, low-risk treatments for rare dermatologic diseases using unique topical vehicles combined with established medications that enable the targeted delivery of therapies to the epidermis and dermis while minimizing systemic absorption.

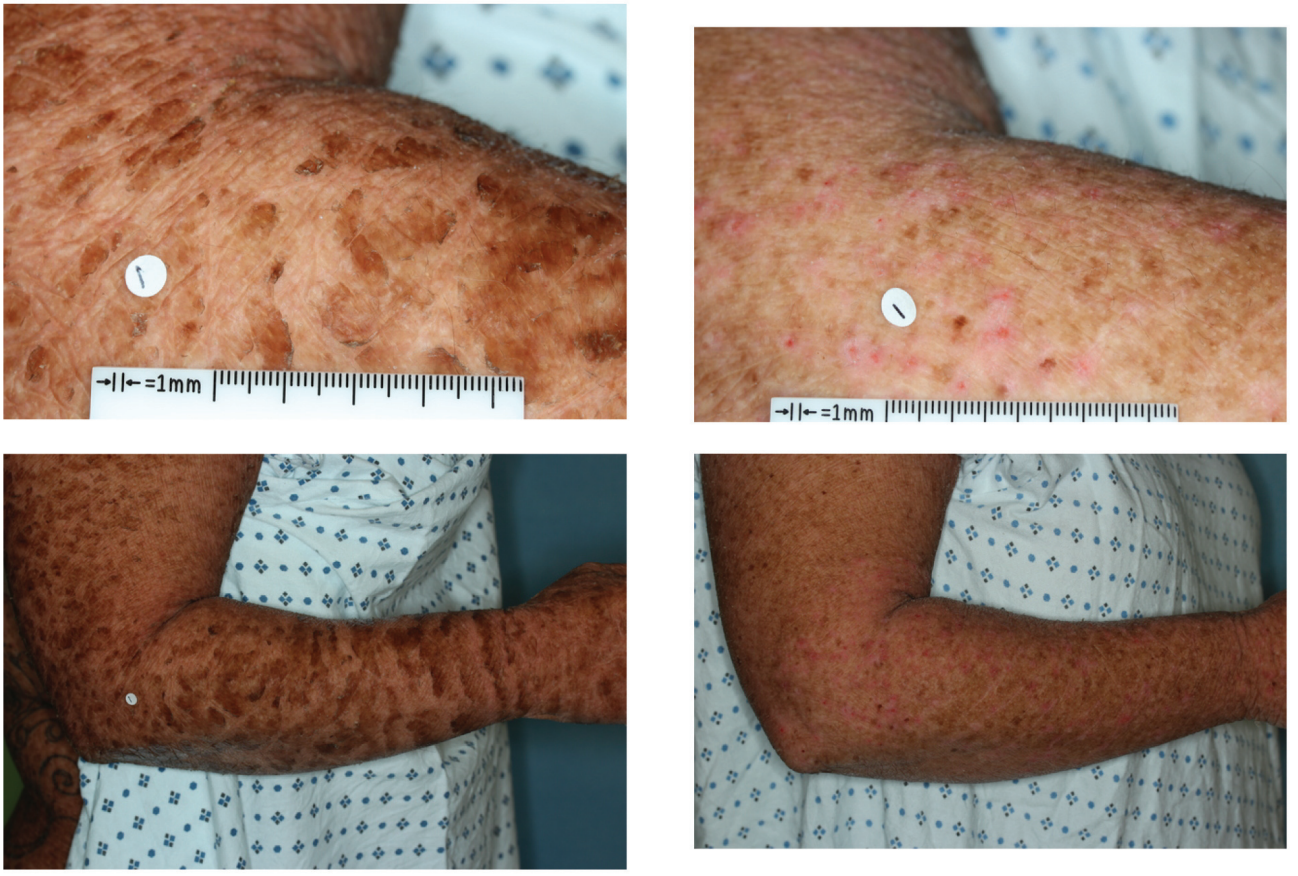
THE IPEG™ SYSTEM & HOW IT WORKS

Timber's patented IPEG™ delivery system is a novel therapeutic approach that uses a proprietary combination of differently sized polyethylene glycol (PEG) molecules combined in a very precise ratio to provide targeted delivery of our active pharmaceutical ingredient (API) – isotretinoin – to pathologic skin layers. This design enables more of our API to be delivered to the epidermis and upper layers of the dermis while minimizing systemic absorption, which could potentially avoid all of the systemic side effects (including teratogenicity) known to occur with some oral drug formulations in dermatology. In addition to providing targeted delivery of our drug to specific skin layers, the IPEG system was developed to stabilize chemically challenging compounds without the need for irritating excipients and solvents, such as ethanol.

While our API in the IPEG system is fully dissolved, the high molecular weight PEG is not soluble in the low molecular weight PEG. This allows our drug formulation to provide a managed release of the isotretinoin from the vehicle system in a way that balances the thermodynamic activity of our drug with its resulting environment. We also believe the sustained humectant properties of the IPEG system may enhance drug delivery across the stratum corneum, the outermost layer of the epidermis.

The IPEG system was applied to the development of TMB-001, an investigational topical formulation of isotretinoin for the treatment of moderate-to-severe subtypes of CI, which is a group of rare genetic keratinization disorders that leads to dry, thickened, and scaling skin. Most dermatologists are familiar with oral isotretinoin, a type of retinoid derived from vitamin A used predominantly for treatment of severe recalcitrant nodular acne, and the rationale for retinoids in CI has been well established in prior clinical research. However, the higher doses of retinoids that must be administered to CI patients (compared to subjects with acne), coupled with the potential need for life-long, chronic treatment in CI, has limited the use of these compounds in real-world practice. Oral isotretinoin has been associated with toxicities, including teratogenicity (ie, may cause birth defects in a developing embryo or fetus), mood changes, mucocutaneous effects (eg, cheilitis, xerosis, eye irritations), and interactions with other an-

FIGURE 1



CI patient in Timber's Phase 2b CONTROL study at baseline (on left) and after treatment with TMB-001 at Week 12 (on right). (Source: Timber Pharmaceuticals)

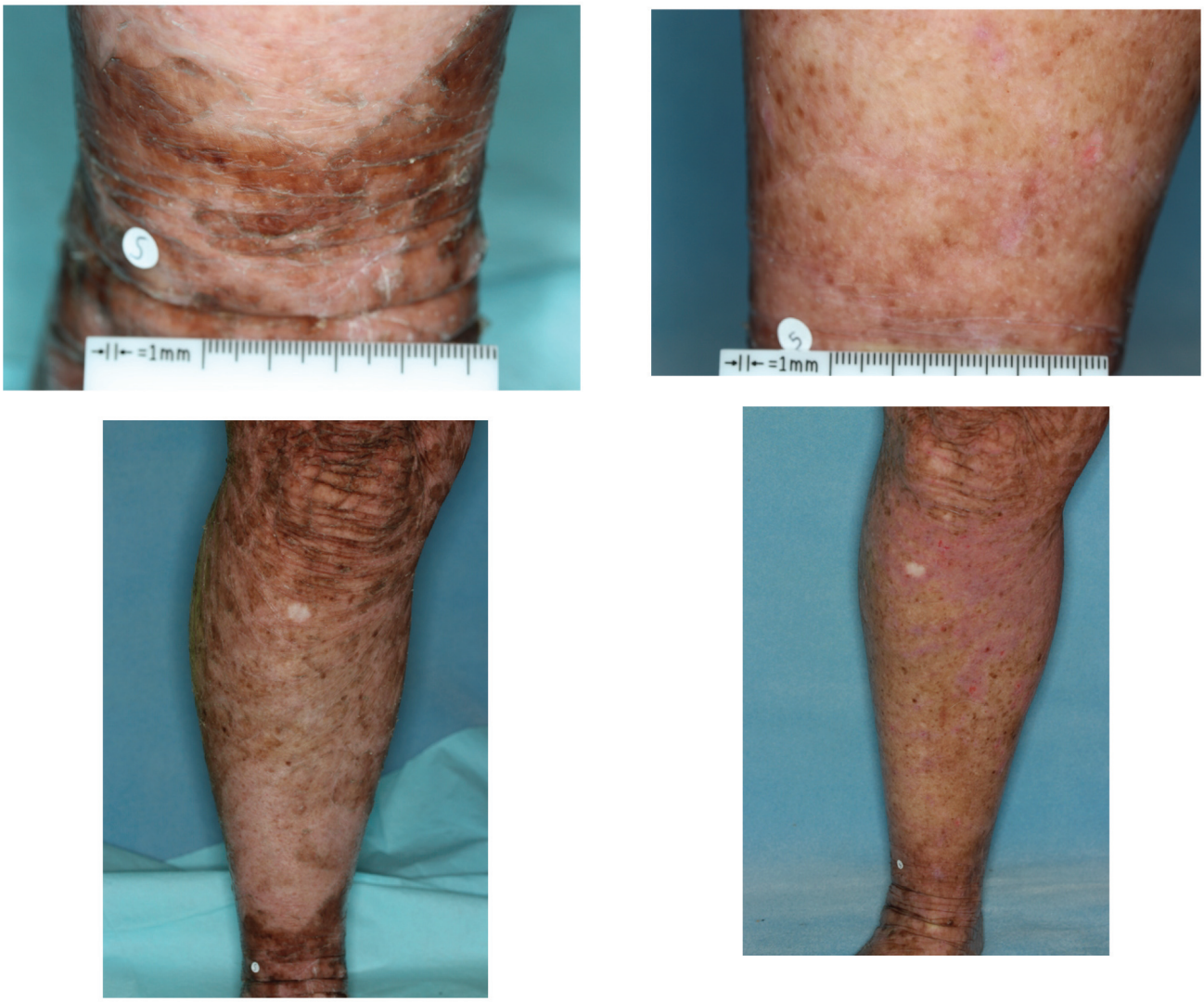
tibiotics (such as doxy- or minocycline). Our innovation was to successfully dissolve isotretinoin, which is a very challenging compound from a formulation standpoint, into a stable topical formulation that reduces systemic absorption, maximizes penetration into the epidermis and upper dermis, is well tolerated in terms of localized skin reactions, and allows for chronic use over larger areas of the body.

With traditional delivery methods of medications for dermatologic diseases, there are often side effects, including burning and localized skin reactions, particularly with alcohol-based formulations. As a result, patient compliance with proper medication application is a major limitation to chronic use. For example, the only other topical isotretinoin formulation ever commercially developed (available in select European countries) used a vehicle system that was more than 95% ethanol, as it is generally known that isotretinoin is soluble in ethanol.[1] However, this vehicle system has proven to be unfavorable in treating large areas of skin, particularly skin that is inherently compromised, as is the case of patients living with CI. It was for this reason we needed to significantly change the vehicle formulation combined with isotretinoin that we would pursue as part of our CI development program, ultimately leading to the TMB-001 formulation. Though ethanol is well known for enhancing skin penetration, in direct comparative studies, the TMB-001 formulation using IPEG technology was found to deliver 2.5 times as much drug to pathologic skin layers compared to the ethanol-based formula.[2] TMB-001 has demonstrated the potential to maximally deliver isotretinoin topically to specific affected areas of skin while minimizing systemic delivery and potentially reducing side effects. This year, the FDA granted Fast Track and Breakthrough designations to TMB-001.

TMB-001: A NOVEL ISOTRETINOIN FORMULATION SHOWS PROMISE

With proof of concept established for TMB-001 and positive results from the Phase 2a and Phase 2b clinical trials, Timber's lead product candidate is currently being assessed for efficacy, pharmacokinetics and safety in the pivotal Phase 3 ASCEND clinical trial. ASCEND will also investigate an optimal dosage strategy for

FIGURE 2



CI patient in Timber's Phase 2b CONTROL study at baseline (on left) and after treatment with TMB-001 at Week 12 (on right). (Source: Timber Pharmaceuticals)

maintenance therapy with TMB-001. In June 2022, Timber announced the first four patients were enrolled in the trial, which is a global (US, Canada, Italy, Germany, and France) randomized, parallel, double-blind, vehicle-controlled study expected to enroll more than 140 participants 6 years of age or older with moderate-to-severe CI, including recessive X-linked ichthyosis (RXLI) and autosomal recessive lamellar ichthyosis (ARCI-LI). These subtypes affect about 80,000 people in the US and nearly 1 million patients globally, and lead to cutaneous manifestations that include large, dark scaling throughout the body. More serious symptoms can include limited range of motion, chronic itching and wounds, an inability to sweat normally (which can lead to heat stroke and death), risk of infections, impaired eyesight or hearing, and countless other comorbidities, which have a significant impact on patients' physical and emotional health and quality of life.

Participants in the ASCEND study are randomized 2:1 to TMB-001 (0.05% isotretinoin) or vehicle control ointment (two participants on TMB-001 for every one participant on vehicle) for 12 weeks, at which point eligible participants in both arms of the study are randomized again to either once-a-day or twice-a-day TMB-001 treatment for an additional 12 weeks to provide valuable information on longer term treatment with the compound. Given their potency, to minimize the initial sensitization period, often seen with treatment with formulations of retinoids, there is a 3-week, once-a-day induction period in the ASCEND study. Patients randomized to receive TMB-001 0.05% are required to also use a standardized bland emollient (Cetaphil™) to add moisture to the skin. After the first 3 weeks, the dosing frequency in the following 9-week treatment

period will increase so participants receive either TMB-001 0.05% or vehicle twice daily, with use of the bland emollient discontinued unless needed for control of localized skin reactions. By reducing the initial sensitization period dosing, we are hopeful that TMB-001 will be better tolerated in most patients, reducing the need for any potential drug discontinuations.

Prior clinical data of TMB-001 demonstrate its promise to fulfill an unmet medical need for CI patients, who are currently limited to off-label use of oral therapies or emollients, creams, lotions, and keratolytics that generally offer little or no benefit in alleviating the biological root cause of their ichthyosis. Data from the Phase 2b CONTROL study support this promise, which the FDA reviewed in a positive end-of-Phase 2 meeting that resulted in a clear path to progress to the pivotal Phase 3 ASCEND study.

The Phase 2b CONTROL study was a randomized, double-blind, vehicle-controlled study designed to assess the efficacy and safety of two concentrations of TMB-001 (0.05% and 0.1% isotretinoin) for the treatment of RXLI and lamellar ichthyosis in 33 patients 9 years of age or older. Participants applied TMB-001 twice daily for 12 weeks.

The primary endpoint of the trial was determined by a reduction in the Visual Index for Ichthyosis Severity (VIIS) scaling score, a novel scale that was validated by researchers at Yale University and which garnered positive attention in the CI community. The primary endpoint was met if there was a 50% or greater reduction from baseline in the VIIS scaling score (or VIIS-50) at Week 12, which was considered a clinically meaningful change. The major secondary endpoint included reduction in overall ichthyosis severity, as measured by a 2-point improvement using the Investigator Global Assessment (IGA) scale (IGA ≥2-grade), a well-known scale in the dermatology community.

Topline results from the CONTROL study announced in October 2021 demonstrated a reduction in targeted and overall severity of CI in patients treated with topical IPEG-based TMB-001. Specifically, in the intent-to-treat (ITT) and per protocol (PP) populations, results reported:

- In the PP population, 100% (nominal p= .04) and 40% (nominal p= ns) of patients treated with TMB-001 0.05% and 0.1%, respectively, achieved VIIS-50 compared to 40% in the vehicle group.
- In the ITT population, 64% (nominal p= 0.17) and 40% (nominal p= ns) of patients treated with TMB-001 0.05% and 0.1%, respectively, achieved VIIS-50 compared to 33% in the vehicle group.
- In the PP population, 100% (nominal p=.002) and 60% (nominal p=ns) of patients treated with TMB-001 0.05% and 0.1%, respectively, achieved a ≥2 point improvement in the IGA at week 12 compared to 10% in the vehicle group.
- In the ITT population, 55% (nominal p=.02) and 40% (nominal p=ns) of patients treated with TMB-001 0.05% and 0.1%, respectively, achieved a ≥2 point improvement in the IGA at week 12 compared to 8% in the vehicle group.
- In terms of safety, TMB-001 was generally well tolerated with a similar incidence of adverse events (AEs) across treatment groups. The most frequent AEs were local adverse effects common for such topical treatments (e.g., burning/stinging), which lessened in severity and frequency beyond the first 2-4 weeks. There were no treatment-related serious adverse events (SAE).[3]

A sub-analysis of the CONTROL study presented at the American Academy of Dermatology (AAD) 2022 Annual Meeting found that TMB-001 0.05% demonstrated a substantially greater proportion of patients achieving VIIS-50 and ≥2-grade IGA improvement compared with vehicle regardless of RXLI or ARCI-LI subtype. Results reported:

- All patients in the PP analysis with RXLI who received TMB-001 0.05% achieved VIIS-50 compared to 75% receiving vehicle and all patients with ARCI-LI who received TMB-001 0.05% achieved VIIS-50 compared to 17% receiving vehicle.
- Improvement of ≥2-grade IGA score was observed in all patients in the PP analysis with RXLI who received TMB-001 0.05% compared to 25% receiving vehicle, and in all patients with ARCI-LI who received TMB-001 0.05% compared to no patients receiving vehicle.
- For patients with RXLI who received TMB-001 0.05%, the median time to achieving VIIS-50 was 28 days compared to 50 days for patients who received vehicle. For patients with ARCI-LI who received TMB-001 0.05%, the median time to achieving VIIS-50 was 32 days compared to 86 days for patients who received vehicle.
- The safety and tolerability profile of TMB-001 remained consistent with the known safety profile of topical retinoids. No significant systemic AEs were identi-

fied. Most AEs reported were application site reactions and were similarly distributed among patients with both RXLI and ARCI-LI who received TMB-001 0.05%.

Based on the clinical success that TMB-001 has shown to date, including results from the completed Phase 2a and CONTROL studies, there is an important opportunity to significantly improve the lives of people living with CI who currently have no FDA-approved treatments and limited standard of care options.

SUMMARY

Every rare disease has its own set of nuances that should be considered on a case-by-case basis, and proper choice of drug, dose, and vehicle for the particular disease is key. Still, the IPEG delivery system upon which TMB-001 is based may be useful in treating many other rare skin conditions in addition to CI. For example, there are other rare disorders of keratinization, such as Darier's disease, for which IPEG-based products could be helpful treatments. Certain blistering conditions, such as epidermolysis bullosa or conditions affecting mucosal surfaces, might benefit from the IPEG delivery system as well. However, it is also likely that many other technologies will be needed to address the tremendous diversity present in rare dermatologic diseases.

There is a significant opportunity for drug developers – it has been estimated that the market for products in the rare dermatology field will see 10-fold growth throughout the next several years.[4] No other field in dermatology – even psoriasis, atopic dermatitis, acne, or skin cancers – is expected to grow at this rapid rate in terms of research and development efforts. There are areas of significant unmet need in the rare dermatology community, and we at Timber are committed to expanding treatment options in this sector to help affected patients, caregivers, and families, starting with our IPEG approach to treatment of CI that has potential additional applications in the years ahead. ◆

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BIOGRAPHIES

Zachary Rome is the Co-founder and former Chief Operating Officer of Timber Pharmaceuticals. He is also a partner at TardiMed Sciences, a life sciences company creation firm. At TardiMed, he has helped to form several life sciences companies that span multiple therapeutic areas and stages of development. He is the Co-founder and President at Patagonia Pharmaceuticals, a privately owned specialty pharmaceutical company developing treatments for rare dermatologic diseases. He was the lead inventor on all of Patagonia's technologies and oversaw their development from concept through Phase 2 studies. He earned his BS in Marine Science and Biology from the University of Miami and his MST in Adolescent Science Biology from Pace University.

Jessica Raiz is Vice President, Program Management and Clinical Operations at Timber Pharmaceuticals. She was previously Director of Clinical Operations at Ferring Pharmaceuticals, Director of Clinical Operations at Champions Oncology, Inc. and Associate Clinical Project Management Director at IQVIA. She also previously held increasing roles of responsibility at Novartis, most recently US Clinical Operations Team Lead. She earned her MPH in Health Law and Bioethics from Boston University School of Medicine and her BA in Biology from Drew University.

Dr. Alan M. Mendelsohn is Chief Medical Officer and Executive Vice President at Timber Pharmaceuticals and is board certified in pediatrics and pediatric cardiology. He was previously Associate Vice President of Dermatology Medical Affairs at Sun Pharma, where he focused on the post-clinical development of tildrakizumab (ILUMYA), an IL-23p19 inhibitor for patients with moderate-to-severe plaque psoriasis. He also has experience as Senior Director, Rheumatology Team Leader, US Medical Affairs at Pfizer and as Senior Director of Immunology R&D at Johnson & Johnson/Janssen. He has authored or co-authored more than 200 peer-reviewed abstracts and manuscripts in the areas of dermatology, rheumatology, and cardiology. He earned his MD from the State University of New York-Downstate Medical Center, then completed a Pediatrics residency at Albert Einstein College of Medicine and then a Pediatric Cardiology fellowship at University of Michigan.

Drug Development
EXECUTIVE

Mike Babics

VP, BD - Parenteral Services

Alcami

Alcami: Unlocking the Potential of Transformative Medicine for 40 Years

Alcami is a contract development and manufacturing organization (CDMO) headquartered in North Carolina with more than 40 years of experience advancing pharmaceuticals through every stage of the development lifecycle. Alcami serves pharmaceutical and biotech companies of all sizes providing customizable and innovative solutions for analytical development, clinical to commercial sterile injectables and oral solid manufacturing, packaging, microbiology, cGMP biostorage, environmental monitoring, and pharmaceutical support services.

Recently, Alcami has been focusing on expanding its sterile manufacturing offerings from a single fill-finish line, which was already manufacturing more than 25 commercial sterile liquid and lyophilized products, to six fill-finish lines, with the addition of five new isolator lines for filling vials, syringes, cartridges, and lyophilized products.

Drug Development & Delivery recently interviewed Mike Babics, Vice President, Parenteral Services at Alcami, to discuss the company's recent expansions in formulation and analytical development, manufacturing, release testing, and biostorage of clinical and commercial drug products for both solid dosage and parenteral products.

Q: Can you provide some background on Alcami for our readers who may not be familiar?

A: Alcami has been providing drug product development, manufacturing, and analytical expertise for more than 43 years. During this time, we have worked with an ever-increasing range of clients and products to provide comprehensive

development and analytical capabilities. We are focused on being the CDMO of choice for drug product development, supply, testing and storage for tablets, capsules, and injectable products.

Q: Alcami works with other companies to bring their medicines from concept to reality. How do those relationships work?

A: Alcami approaches each relationship as a unique partnership. Many of our clients provide presentations to our staff each year, and that is always an incredibly impactful event to be a part of. Our scientists, engineers, and technical staff take enormous pride in knowing their contributions help bring medicines to patients around the world.

Q: What do you believe is the most important factor for success in drug development?

A: Reducing risk in a program is absolutely key. CMC program leaders are looking for CDMO partners that offer experienced formulation and analytical development teams, who can provide processes and methods optimized to be smoothly scaled into non-GMP batches for toxicology material and GMP manufacturing batches for clinical and commercial launch.

Q: How have drug development and manufacturing processes changed throughout the years for Alcami?

A: Alcami was founded in 1979 with a focus on analytical testing of pharmaceuticals, but at the request of our customers, moved into providing clinical development and manufacturing services for tablets and capsules in the 1980s. We continued expanding in the 1990s by adding large molecule analytical testing and commercial manufacturing and expanded into the development and manufacturing of liquid and lyophilized injectable products in 2001. We have recently expanded from the single fill finish line established in 2001 to six parenteral fill finish lines, which now also include pre-filled syringe filling and three new lines for lyophilization..

Q: What are some of the biggest challenges in developing drug products today?

A: Since 2020, a significant percentage of the industry's global resources, including facilities, consumables, raw materials, and operational staff, have been channeled into the pandemic response or impacted by supply chain and clinical staffing challenges. These issues have led to delays for thousands of clinical programs, particularly sterile, injectable medicines.

Q: How is Alcami uniquely qualified and able to address those challenges?

A: Since January 2020, in response to the reduced capacity Alcami's executive leadership was seeing in the injectable drug manufacturing space, Alcami has purchased and installed five new fill finish lines and three state-of-the-art lyophilizers. These investments, combined with recently completed expansions at all three of Alcami's analytical campuses, will enable our clients to meet current and future regulatory requirements, and ensure Alcami can make a significant contribution in fulfilling the growing demand for clinical and commercial injectable products needed for patients around the world.

Q: Are there any notable drug product developments Alcami has been involved in you can discuss?

A: Alcami recently entered into a multi-year agreement with a Civica Rx, a non-profit pharmaceutical company created by consortium of hospital groups and health system partners representing one-third of all US hospital beds. Alcami is incredibly excited to be partnering with Civica toward its goal of helping preventing future drug shortages. Alcami's network of laboratories across the US will support Civica's programs with method establishment, validation, release, and stability for excipients, drug substances, and drug products, in addition to formulation development support.

Q: What do you see are the trends for drug product development and manufacturing in the future?

A: The final version of EU Annex 1 Manufacture of Sterile Medicinal Products was published on August 25, 2022. The

deadline for commencement for the majority of the changes is August 25, 2023. For section 8.123 on freeze-drying and product transfer, the deadline for commencement becomes mandatory on August 25, 2024. In anticipation and based on the draft 2019 Annex, Alcami invested in isolator technology for each new sterile fill finish line and lyophilizers with automated loading and unloading technology.

Q: What do you believe is the next big step in the industry's evolution?

A: An increasing number of clinical trials and R&D investment has been focused on analytical development and testing of biopharma products and that market is anticipated to reach $12.4 billion by 2028.[1]

Bioanalytical testing is experiencing the fastest growth, and Alcami's testing services are designed to support both drug substance and drug product development, validation, and routine analysis. Typical programs include therapeutic proteins, peptides, and therapeutic nucleic acids (DNAs & RNAs). Needed capabilities consist of cell-based assays with associated cell culture workflows, ELISA, electrophoresis, amino acid analysis, HPLC/UPLC with various detection modes, such as UV/PDA, CAD, ELSD, RI, FLD, and MS.

Alcami has invested heavily in expanded capabilities to serve this market, including analytical ultracentrifugation, variable pathlength UV for A260/A280 determinations, and new Tandem Quadrupole and QTOF instruments as part of recently completed expansions in North Carolina. ◆

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- Oral Solid Dose
- Fermentation
- Hot Melt Extrusion
- Potent
- Biologics
- Packaging
- Eye Care
- Topicals

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abbvie | Contract Manufacturing

Vision. Expertise. Success.

Eyecare | Topical | Aseptic Fill-Finish | Hot Melt Extrusion (HME) | Oral Solid Dose
Microbial Fermentation | Biologics | Antibody Drug Conjugate (ADC) | Custom API

AbbVie Contract Manufacturing partners with companies around the globe to develop, scale and manufacture their pharmaceutical products.

With decades of experience, we see the complete picture to deliver your vision and real-world results, while improving people's lives.

Start the journey, at abbviecontractmfg.com

Vision. Expertise. Success.

CMO LEADERSHIP AWARDS2022 CAPABILITIES

CMO LEADERSHIP AWARDS2022 SERVICE

CMO LEADERSHIP AWARDS2022 RELIABILITY

CMO LEADERSHIP AWARDS2022 QUALITY

CMO LEADERSHIP AWARDS2022 EXPERTISE

CMO LEADERSHIP AWARDS2022 COMPATIBILITY

ABITEC CORPORATION
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ABITEC Corporation is dedicated to the advancement of essential **bioavailability enhancement** and formulation development technology. ABITEC develops and manufactures lipid-based excipients to enhance the bioavailability of poorly water-soluble and poorly permeable Active Pharmaceutical Ingredients (APIs) for the pharmaceutical industry. And now with the addition of Larodan, ABITEC has expanded its offerings to include high-purity research grade lipids.

ABITEC has an expansive portfolio of **CAPMUL**® bioavailability enhancers, which are medium-chain mono- and di-glycerides and propylene glycol esters. These functional lipid excipients act as solubilizers and emulsifiers in oral, topical, transdermal, and parenteral drug delivery systems. CAPMUL excipients are recognized as the ideal starting point when formulating BCS Class II & IV (poorly water soluble) and BCS Class III & IV (poorly permeable) molecules. Lipid-based drug delivery systems may be formulated as liquid or semi-solid formulations for oral dosage forms, as well as creams and ointments for topical and transdermal applications.

CAPMUL may be used as a majority component in solubilization/emulsification formulations. Or whenever necessary, CAPMUL-based formulations may be customized with the inclusion of **CAPTEX**® medium-chain triglycerides and/or **ACCONON**® non-ionic surfactants, added for enhanced bioavailability.

ABITEC's **INJECTA**™ parenteral-grade lipid excipients to enable improved solubilization and permeation for injectable APIs. The INJECTA-grade portfolio of products include: CAPTEX medium-chain tri-glycerides, CAPMUL mono-and di-glycerides of glycol esters, and ACCONON non-ionic surfactants, fully analyzed and packaged for parenteral application.

ABITEC manufactures high-quality lipid excipients for drug delivery applications in accordance with strict cGMP and applicable IPEC (International Pharmaceutical Excipient Council) guidelines in ISO-certified facilities. ABITEC's customer-preferred portfolio of pharmaceutical excipients are monograph compliant, supported by drug master files (DMFs), and have precedence of use. For more information about all of ABITEC's invaluable solutions please contact us directly or visit our website at www.abiteccorp.com.

Dosage Forms Include: Oral, Injectable, Topical & Transdermal, Suppositories, Ophthalmic, and Inhaled

Application Include: Solubilization, Emulsification, Lubricating Dry Binder, Permeation Enhancement, Encapsulation, Controlled Release, and Self-Emulsifying Drug Delivery Systems

Future Growth is Our Priority

ABITEC is continuing to look at ways they can expand their capabilities to better serve the pharmaceutical market sectors. The acquisition of Larodan is already bringing new technologies and opportunities to the forefront, but in the coming year there will be even more exciting advancements to share!

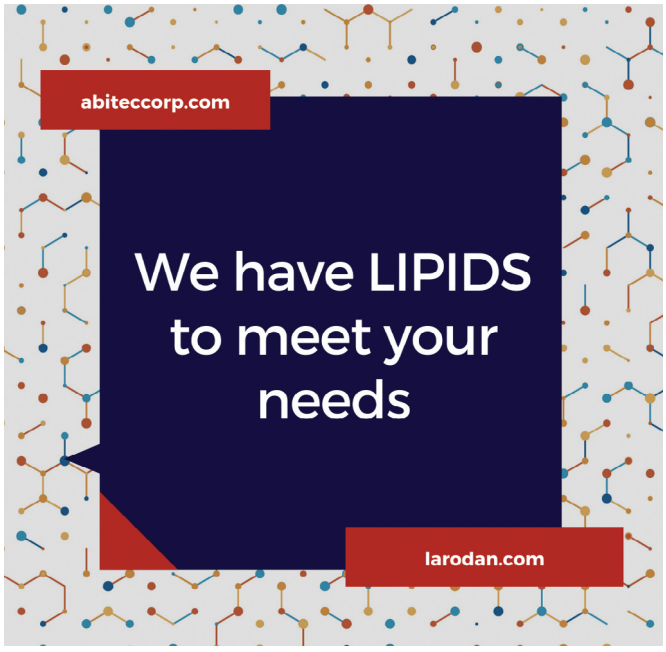
To Request a Sample – visit https://samples.abiteccorp.com/

Social Media Links:

LinkedIn - https://www.linkedin.com/company-beta/1454313/

Twitter - https://twitter.com/abiteccorp

YouTube - https://www.youtube.com/channel/UC9mfJCBOstRuc-i2Asgu4VQ




ABITEC
AN ABF INGREDIENTS COMPANY
Larodan
A part of ABITEC Corporation
Delivering Unique Lipids Today to Address the Research & Therapeutic Challenges of Tomorrow
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About Actylis

Actylis is a leading manufacturer of critical raw materials and performance ingredients serving the Life Sciences industry. Through our hybrid approach we provide combined capabilities in GMP manufacturing and global sourcing of critical raw materials and ingredients, offering unrivaled choice to pharmaceutical & biopharmaceutical companies.

The inherent flexibility in our hybrid approach alleviates common internal customer concerns over time constraints in delivery to market and capacity pressures. We enable customers to consolidate their supply chain with one reliable partner, backed by best-in-class quality and regulatory accreditation, while retaining valuable flexibility.

Global Industry Experts

Actylis has a growing global portfolio of GMP manufacturing sites led by experienced teams. Our production facilities are routinely audited by accreditation bodies and customers, and feature state-of-the-art technology & equipment, industry-leading quality systems, and excellent regulatory performance.

As a global manufacturer and distributor of critical ingredients, Actylis has sector experts worldwide who are always accessible to consult and collaborate with customers' development and manufacturing teams. We are committed to getting to know our customers intimately, understanding their critical ingredient needs and finding the right solution among the flexible manufacturing capabilities we offer, and the hybrid option of manufacturing and global sourcing.

GMP Ingredients

With our hybrid manufacturing / sourcing model, we optimize supply solutions for over 3,000 compounds, including raw materials, cell culture ingredients, excipients, buffers, process solutions, process intermediates, APIs, Water for Injection, amino acids, nucleosides and nucleotides.

Whatever your needs, from regulatory starting material, active ingredients, early or late intermediates, to ingredients for clinical or commercial manufacturing stages, we have the solution for you.

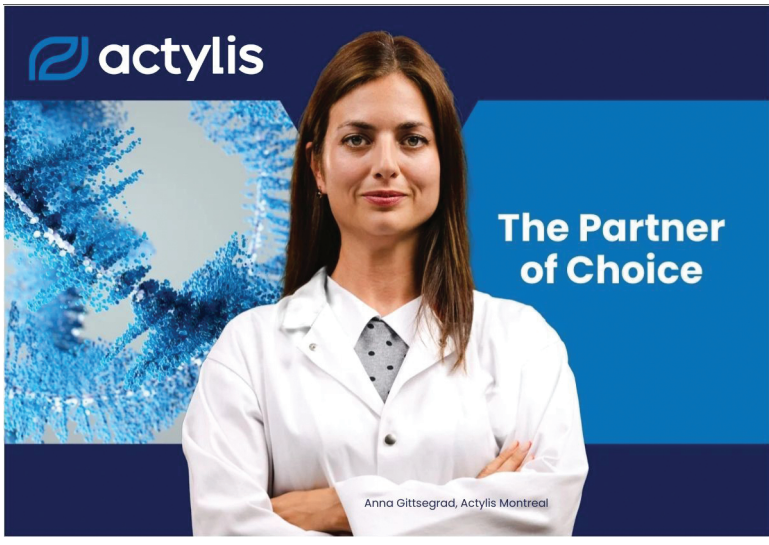
GMP Services

We offer GMP custom manufacturing, ingredient development, custom packaging, R&D and analytical services. Our custom manufacturing offers a valuable, reliable source for niche, difficult-to-find ingredients, providing confidence in secure long-term supply to support drug products. Our expertise begins with process R&D to solve your most complex chemical problems, then it continues with our team of agile scientists during the synthesis stage and concludes with GMP clinical manufacturing.

Quality

Our products are backed by world-class quality, reliable delivery, and a strong regulatory record, which is another key component of the trusted partnerships we build with customers, supporting rapid commercialization and uninterrupted supply of finished products.

Actylis is renowned for our high-quality standards and provides full transparency in the supply chain. Our pharma & biopharma GMP manufacturing facilities hold all the major certifications and applicable licenses from the main accreditation bodies and agencies.



ADARE®
PHARMA SOLUTIONS

COMPANY DESCRIPTION

Adare Pharma Solutions is a global technology-driven CDMO providing end-to-end integrated services, from product development through commercial manufacturing and packaging, with small molecule expertise focusing on oral dosage forms. With a proven history in drug delivery, Adare has developed and manufactures more than 45 products sold by customers worldwide.

SERVICES & CAPABILITIES

Adare provides end-to-end CDMO services, from clinical trial materials and product development to commercial manufacturing and packaging. We can develop and manufacture oral dose products from start to finish, and we can tech transfer pre-established projects into our facilities.

TECHNOLOGIES

Adare's industry-leading experts possess unparalleled experience in the development of unique patient-centric dosage forms that provide taste masking, controlled release, and solubility enhancement capabilities. Our technology platforms address unique formulation challenges to deliver complex and layered solutions for large patient populations with unique needs, including pediatrics, geriatrics, and dysphagic patients.

FACILITIES

Adare operates seven facilities in the US and Europe, staffed by nearly 800 employees. With our global manufacturing network, Adare is capable of serving markets throughout the world. From our state-of-the-art facilities in the US and Europe, we can provide development-scale through commercial-scale production, with a continuum of highly specialized manufacturing services and capabilities to meet any customer's oral solid dose needs.

Commercial Manufacturing Capabilities

Standard Offerings

- Granulation and Mixing
- Roller Compaction
- Fluid bed processing & drying
- Wurster Top Spray
- Oven drying
- Pan coating
- Blending (Bin and Static)
- Tableting
- Tablet Printing & Inspection
- Capsule filling
- Small-scale GMP manufacturing
- Tech Transfer
- Warehousing & distribution

Specialized Offerings

- Microencapsulation of solids and liquids
- Orally disintegrating tablets (ODT)
- Dry syrup/ suspensions
- MMTS™ Minitabs
- DEA Controlled substances:
  - Manufacturing: classes II-V
  - Analytical Labs: classes I-V
- Fixed-dose combination manufacturing
- Liquid filling in hard-shell capsules with banding
- Solvent granulation and coating processes
- Food sprinkle dosage forms
- High Potency: 1 mcg/m^3 and above

Packaging Capabilities

- High-speed bottle filling
  - Low count
  - High count
  - Short run
- Blister packaging
  - Thermo and Cold Forming
- Serialization competent
  - Aggregation capable
- Specialty Packaging
  - Clinical supply services
  - Stick pack and cartoning
  - Powder-in-bottle filling

ADARE PHARMA SOLUTIONS
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A TECHNOLOGY-DRIVEN CDMO DELIVERING END-TO-END PATIENT-CENTRIC SOLUTIONS

TRANSFORMING DRUG DELIVERY. TRANSFORMING LIVES.

Adare Pharma Solutions is a global technology-driven CDMO providing end-to-end integrated services, from product development through commercial manufacturing and packaging, with small molecule expertise focusing on oral dosage forms. Adare's specialized technology platforms provide taste masking, controlled release, solubility enhancement, and patient-centric dosing solutions. With a proven history in drug delivery, Adare has developed and manufactures more than 45 products sold by customers worldwide.

Connect with our experts today: BusDev@adareps.com

ADARE®
PHARMA SOLUTIONS

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LinkedIn: www.linkedin.com/company/ajibio-pharma-services/
Twitter: twitter.com/AjiBioPharma W: www.AjiBio-Pharma.com

Company Description

Ajinomoto Bio-Pharma Services is a fully integrated contract development and manufacturing organization, with sites in Belgium, United States, Japan, and India, providing comprehensive process development services, cGMP manufacturing, and drug product fill finish services for small and large molecule APIs and intermediates.

Ajinomoto Bio-Pharma Services offers a broad range of innovative platforms and capabilities for pre-clinical and pilot programs to commercial quantities, including Corynex® protein expression technology, oligonucleotide synthesis, high potency APIs (HPAPIs), continuous flow manufacturing, and more. Ajinomoto Bio-Pharma Services is dedicated to providing a high level of quality and service to meet our client's needs.

Ajinomoto Bio-Pharma Services is your trusted manufacturing partner providing a broad range of capabilities, regulatory excellence, and extensive experience, helping you navigate production challenges, providing solutions to your development process, and delivering your new therapies to patients who need it most.

MARKETS SERVED

Our integrated global network for large and small molecule development and manufacturing has sites in Europe, North America, and Asia, providing the infrastructure and local support to meet your drug process development and manufacturing needs.

SERVICES & CAPABILITES

Phase-Appropriate Services: Our complete range of process and analytical development capabilities offer the tools to address your needs, whether it is producing small quantities for early testing or in developing robust, reliable, and scalable processes that will enable a strong commercial advantage.

Broad Range of Capabilities: Over 40 years of CDMO experience providing a range of manufacturing capabilities enables us to deliver the flexibility and guidance to meet different drug product needs from emerging therapeutics to life cycle management.

- Drug product aseptic fill finish
- Small molecule manufacturing
- Large molecule manufacturing
- Oligonucleotide and peptide synthesis

Advanced Technologies: Our services are enhanced by a portfolio of innovative and advanced technologies that enable robust, scalable, cost- and time-efficient processes for large and small molecule manufacturing. We are continuously developing new solutions to improve manufacturing processes.

Regulatory Support: With an impressive and successful track record, we are well positioned to advise you on regulatory strategies and navigate hurdles to achieve your program goals. We provide strong, yet flexible quality management to ensure continued program success.

EXPERIENCE THE POWER TO MAKE

We have the capacity and know-how to manage projects from preclinical stage to commercialization successfully, but what truly differentiates us is our dedication to quality and our commitment to fostering trusted partnerships. We're looking forward to hearing from you.

LET'S MAKE A HEALTHY WORLD

WITH AJINOMOTO BIO-PHARMA SERVICES, YOU HAVE THE POWER TO MAKE.

To make your vision a reality. To make your program a success. To make a positive difference in the world.

Your programs deserve the most comprehensive suite of CDMO services available, and Ajinomoto Bio-Pharma Services has the Power to Make your therapeutic vision a reality - from preclinical through commerical production.

CDMO SERVICES:

- Small Molecules
- Large Molecules
- Process Development
- Oligos & Peptides
- Aseptic Fill Finish

WHAT DO YOU WANT TO MAKE?

www.AjiBio-Pharma.com

AJINOMOTO BIO•PHARMA SERVICES | THE POWER TO MAKE®

Alcami and Masy BioServices provide customizable and innovative solutions for analytical development, clinical to commercial sterile and oral solid manufacturing, packaging, microbiology, cGMP biostorage, environmental monitoring, and pharmaceutical support services.

Partnering with Alcami as your contract development and manufacturing organization connects you to a US-based team of dedicated professionals with over 40 years of experience advancing products through every stage of the development lifecycle. Whether you are a virtual start-up or a large organization, you and your patients deserve subject matter experts who take ownership of your program from clinical trials through commercial supply.

- **Analytical Services**
  - Small and large molecules
  - Solid State Chemistry
- **Drug Product Development & Manufacturing**
  - Formulation Development
  - Sterile Fill-Finish
  - Oral Solid Dose
  - Packaging & Labeling
- **cGMP Biostorage**
  - Cryoboxes to pallets
- **Pharma Support Services**
  - Environmental Monitoring
  - Commissioning, Qualification and Validation (CQV) Solutions
  - Metrology & Calibration
  - SenseAnywhere Monitoring
  - Product Rental & Sales

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LinkedIn: https://www.linkedin.com/company/alcami-corporation
W: alcaminow.com

alcami®

Masy BioServices
an Alcami company

SOLUTIONS YOU NEED.
PEOPLE YOU CAN COUNT ON.

Together, Alcami and Masy Bioservices offer world class contract development and manufacturing, analytical services and a full suite of comprehensive pharma support services with over 40 years of experience. Customizable and innovative solutions advance your products through every stage of the development lifecycle.

How can we support your process?

- ANALYTICAL SERVICES
- CGMP BIOSTORAGE
- DRUG PRODUCT DEVELOPMENT & MANUFACTURING
- PHARMA SUPPORT SERVICES

alcaminow.com | masy.com |

Aptar Pharma
W: https://www.aptar.com/pharmaceutical/
E: info.pharma@aptar.com

With over 75 years of proven experience, **Aptar Pharma** is the go-to drug delivery expert, from formulation to patient, for pharma customers worldwide, providing innovative drug delivery systems, components, and active material solutions across the widest range of delivery routes, including nasal, pulmonary, ophthalmic, dermal, and injectables. Aptar Pharma Services provides early-stage to commercialization support to accelerate and de-risk the development journey. With a strong focus on innovation, Aptar Digital Health is a leading provider of integrated digital health solutions to enhance patient experiences across their treatment journey. With a global manufacturing footprint of 14 manufacturing sites, Aptar Pharma provides security of supply and local support to customers. Aptar Pharma is part of AptarGroup, Inc.

End-to-End Support at Every Stage of Your Development Journey

From concepts to initial design, device, and formulation development through the clinical trials phase, analytical testing, regulatory filings, and on to market launch, Aptar Pharma Services can support you at every stage of your product development pathway.

Unparalleled Expertise in Inhalation

Aptar Pharma is the global leader in pulmonary drug delivery solutions, delivering gold-standard devices to manage asthma and COPD, and is leading the way in developing more sustainable pMDIs with end-to-end solutions.

Market-Leading Solutions for Effective Nasal Drug Delivery

We are the global leader in nasal drug delivery solutions with over 280 market references worldwide using our Unidose, Bidose and multidose nasal spray pumps.

Best-in-Class Complete Injectable Solutions

Our best-in-class injectable solutions for Vial, Lyophilization & Pre-Filled Syringes, including Aptar Pharma's PremiumCoat® ETFE-coated solutions, meet the highest quality standards to protect your drug and your patient. Our pure formulations, state-of-the-art manufacturing process and Premium finishing de risk your drug development and accelerate your time to market.

Proven Know-How in Ophthalmic Drug Delivery Devices

Clearly the world leader in preservative-free multi-dose eye care devices, Aptar Pharma's proven OSD platform has over 300 market references worldwide for prescription medications and OTC products.

Meeting the Growing Market Need in Dermal Drug Delivery

We offer a versatile solution platform for dermal drug delivery, serving the pharmaceutical market to enable brand differentiation and meet evolving regulatory needs. Aptar Pharma's Airless+ range offers a clean, hygienic, efficient, and sustainable customer experience, and our Airless+ Extended Support (ES) provides regulatory, analytical and filling support for seamless dermal drug delivery project development.

Building Innovative Digital Device Solutions for Improved Patient Healthcare

Aptar Digital Health creates end-to-end solutions to enhance patient experiences every day, leveraging a holistic ecosystem of digital interventions. Amplified by an industry-leading portfolio of products and solutions, Aptar Digital Health's offerings combine mobile and web apps, connected drug delivery systems, onboarding, training and advanced data analytics services to actively empower patients and create a positive treatment journey.

Our Sustainability Progress

At Aptar, we operate with care for our employees, communities, and the environment by continuously improving our impact and reducing our footprint. We are collaborating with customers, suppliers, industry coalitions and nonprofits to innovate and enable progress towards better outcomes for people and planet. Following the approach to circularity we are helping the industry advance the system-scaled change that will benefit people in the long run by addressing climate change and the waste crisis.

Transforming bright ideas into brilliant opportunities for decades

Aptar Pharma – the go-to drug delivery expert

When pharmaceutical companies around the world want to develop safe, efficient and compliant medicines, they turn to Aptar Pharma for proven drug delivery solutions.

Leveraging our therapeutic insights, over 25+ years of regulatory expertise and the widest portfolio of solutions and services in the industry, we accelerate and derisk our customers' drug development process, helping them transform bright ideas into new market opportunities to improve and save patients' lives.

Let's partner together on your next bright idea. Visit **www.aptar.com/pharmaceutical** to get started.

Delivering solutions, shaping the future.

Aptar pharma

ArtcraftHealth
Demo Device and Training

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Senior Director – Demo & Training Devices
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E: mmason@artcrafthealth.com
W: www.artcrafthealth.com

Demo/Training Devices, Patient Education & Onboarding

Artcraft Health is a leading patient engagement and education agency that takes a holistic approach to demonstration device development and training. Our goal is to elevate and support the entire patient experience through educational onboarding initiatives involving both clinicians and patients. This is how we ensure certainty of use and **long-term success**.

We help patients, caregivers, clinicians, and healthcare providers – who are either counseling patients or adopting new therapies and drug delivery methods–to build the skills, knowledge, and motivation they need for a successful outcome.

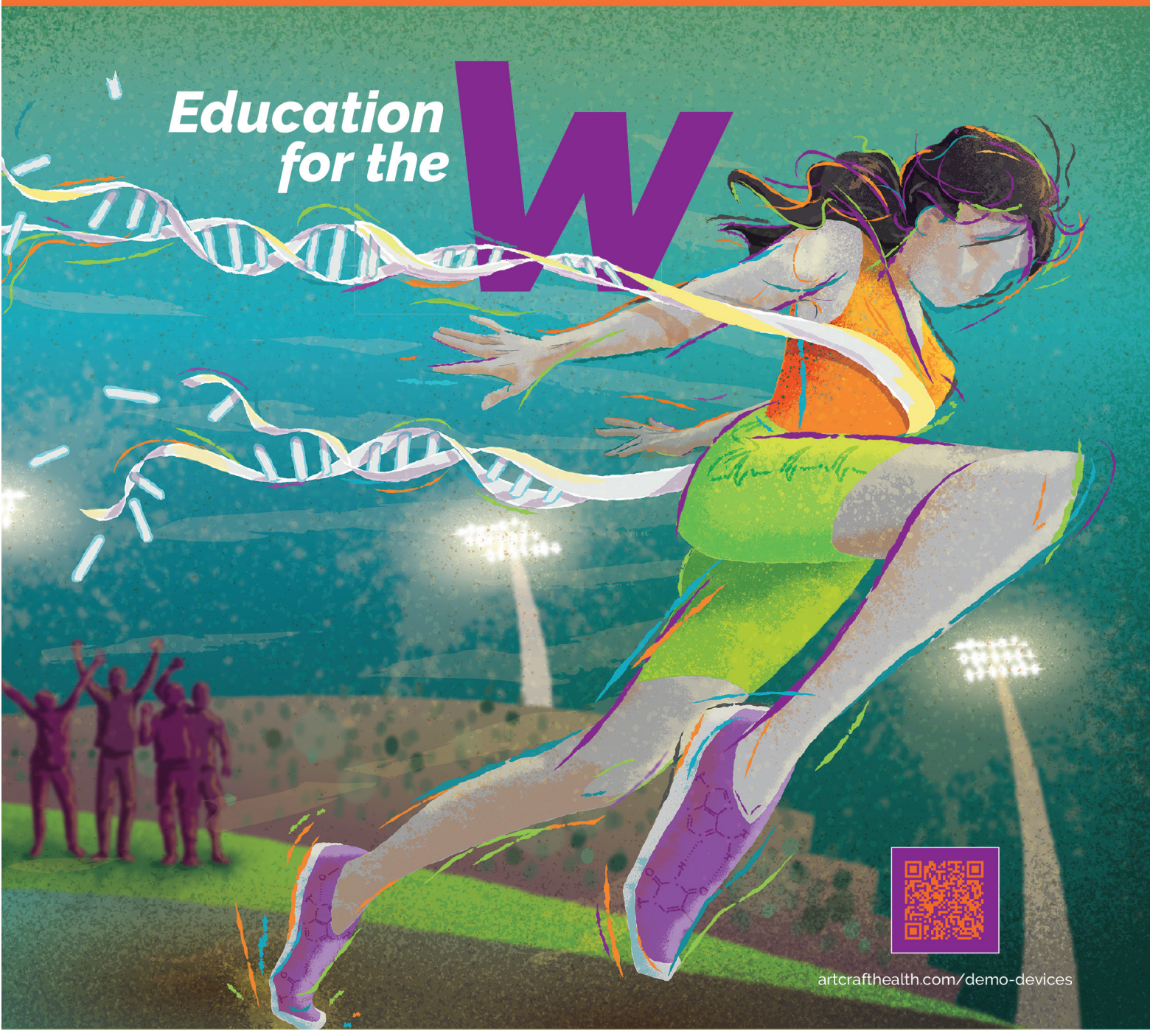
Visit Artcraft Health, www.artcrafthealth.com/demo-devices

Artcraft Health applies educational design, adult learning principles, and a proprietary approach to health literacy during the process. Being a leading health education and engagement agency, the company is dedicated to ensuring a therapy's certainty of use. The focus is to help patients, caregivers, clinicians, and healthcare providers – who are either counseling patients or adopting new therapies and drug delivery methods – to build the skills, knowledge, and motivation they need for a successful outcome.

Artcraft Health excels at simplifying complex delivery methods and packaging them into easy-to-understand educational materials and guides that help patients comply with dosing and administration. Our holistic approach to demonstration device development and training not only provides the highest quality device but also aids in the launch strategy for commercial teams.

Our services include the development of demonstration devices such as prefilled syringes, auto-injectors, and on-body injectors as well as training kits, onboarding initiatives, and educational materials across all media. We also provide the documentation that supports these devices, such as instructions for use, quick reference guides, packaging, cold chain logistic packaging, and training infusion kits. A few of our current clients include AbbVie, Alexion/AZ, Amgen, Fresenius-Kabi, Merck, and Takeda.

Engineering gets you off the blocks, ***but education gets you the WIN.***



Today's novel therapies and delivery devices call for innovatively engineered, cost-effective demonstration devices that support patients' needs. ***But that's just the starting point.***

For a successful start and long-term win, we deliver engaging, educational solutions that support the onboarding experience for patients, caregivers, and healthcare providers. Our proprietary approach to educational design and health literacy ***ensures certainty of use*** across the board—***so everyone gets the W.***

ArtcraftHealth
Demo Device and Training

ASCENDIA PHARMA

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Ascendia Pharmaceuticals is a specialty pharmaceutical CDMO for biologicals and gene deliveries, as well as small molecules. It provides custom sterile and non-sterile enabling formulations, along with analytical methods for new chemical entities, complex dosage forms, and 505(B)(2) product development, as well as OTCs and nutraceuticals.

Ascendia is expanding its people, capabilities, and facilities to meet and exceed customer expectations from early to late state development. This investment allows Ascendia to continue be expert in sophisticated formulations, and well as cGMP sterile and non-sterile clinical trial and commercial manufacturing. Many clients have anointed Ascendia a "Partner of Choice" because of the successes it has achieved for them.

Company Background

Founded in 2012, Ascendia offers a comprehensive suite of pre-formulation, formulation development, cGMP manufacturing, and ICH stability services for all dosage forms using proprietary nano-technologies in nanoemulsion, nanoparticles, and amorphous technology platforms. The company built its foundation of success on its customer-centric culture that exudes its BEST philosophy (Brilliant technology, Excellent service, Superior quality, and Trust).

Markets Served/Facilities

Headquartered in North Brunswick, NJ, Ascendia's 60,000-sq-ft facility has Class 10,000 (ISO 7) and Class 100 (ISO 5) cleanrooms, as well as Class 10,000 (ISO 7) manufacturing suites. Ascendia's expertise in discovering the most effective method of drug delivery for poorly water-soluble molecules and biologics aligns the CDMO with pharmaceutical and biopharmaceutical companies developing new drugs, as well as formulations for existing drugs for new uses.

Products, Services & Capabilities

Ascendia delivers sophisticated formulations to enhance bioavailability and solubility using three proprietary nanotechnologies – NanoSol®, EmulSol®, and AmorSol®. It develops solutions for all dosage forms for small molecules and biologics, including lipid nanoparticles that enable gene therapy. Its facility maintains stability chambers for conducting non-GMP and cGMP stability studies in accordance with ICH guidelines. Ascendia stability studies:

- determine robustness of formulation prototypes during early development
- ascertain chemical and physical integrity of lead formulations before advancement into animal/toxicology studies
- assure final formulations meet stability for clinical trial

Ascendia offers fast, flexible, and small-batch size services for conducting first-in-man study efficiently to stay on schedule and within budget.

Delivering sophisticated formulations.

- Formulation Development for Poorly Soluble Drugs
- cGMP Manufacture for Clinical Materials
- CR, Parenteral & Topical Dosage Forms

ASCENDIA PHARMA

OUR TECHNOLOGIES

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W: http://drugdeliverysystems.bd.com/

BD

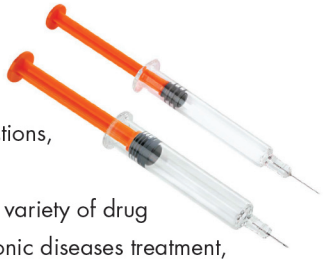
BD Medical - Pharmaceutical Systems

A Partner of Choice for the Pharmaceutical Industry

Founded in 1897, BD is one of the largest global medical technology companies in the world and is advancing the world of health by improving medical discovery, diagnostics, and the delivery of care. BD helps customers enhance outcomes, lower costs, increase efficiencies, improve safety, and expand access to healthcare.

BD Medical - Pharmaceutical Systems Offers Innovative, High-Quality, Clinically Proven & Customized Pre-fillable Parenteral Drug Delivery Systems

BD's drug delivery systems are designed to protect, package, and deliver drug therapies and to maximize healthcare worker and patient safety.



- Pre-fillable Syringes: BD is uniquely positioned to offer pre-fillable syringe systems with expertise in drug container interactions, primary container selection, and container/device integration for a variety of drug therapies, including vaccines, chronic diseases treatment, acute care drugs, anticoagulants, and hyaluronic acid.

- Self-Injection Systems: BD partners with its customers to develop self-injection systems that enable drug administration across a range of volumes and viscosities, leveraging BD primary container technologies and expertise with a focus on reaching the market faster.

- Safety & Shielding Solutions: BD offers a wide range of safety and shielding systems that feature innovative needle shielding system technology for injectable drugs.

BD is a reliable partner that can provide expertise in highly specific fields to support your drug throughout its lifecycle, from development to launch and beyond. The company is committed to building partnerships with pharmaceutical and biotechnology companies and developing product solutions that meet their needs by leveraging our innovative technologies, extensive global manufacturing, and advanced technical, scientific, medical, and regulatory expertise.

BD is Supporting Your Drug Development With a Full Range of services

- Consultative services on drug delivery options
- Regulatory support to optimize time-to-market
- Compatibility testing to mitigate risk
- Global reach and capacity to ensure business continuity
- (Pre)Clinical and Usability assessment Data to support registrations

BD Medical - Pharmaceutical Systems at a Glance

- More than 2.5 million ready-to-administer drug delivery systems manufactured per year
- Products used by more than 500 pharmaceutical and biotechnology companies [1]
- Prefill expertise and consultation at every stage of drug development
- 8 manufacturing plants to meet global production demand
- Worldwide support and regulatory expertise
- Comprehensive cross-functional support and dedicated teams.

[1]SAP Legacy, Tracis, Nodum – January 2018

Committed to Drug Delivery Excellence

At BD, we're committed to providing our pharmaceutical and biotechnology partners with drug delivery systems and solutions that help to derisk development and to shorten timelines. We mobilize our global resources to simplify the technical, medical, regulatory, and manufacturing complexities you face as you bring your combination product to market. Our innovative prefillable syringes, self-injection systems, and safety and shielding devices are designed to improve the lives of patients and care providers—while adapting to the complex requirements for today's combination products. Trust BD experience and expertise to support your success from development to market, and beyond. Learn more at **drugdeliverysystems.bd.com**

BD. Delivering expertise and innovation from development to market

BD

BIODURO-SUNDIA

BioDuro-Sundia is a global Contract Research, Development, and Manufacturing Organization (CRDMO), partnering with pharmaceutical companies to develop and manufacture lifesaving drug products for millions of patients around the world. Our mission is "to be the TRUSTED partner delivering world-class drug discovery, development and manufacturing services" in order to speed our clients to clinic and market.

Our legacy as a pioneer in amorphous solid dispersion (ASD) development and GMP contract manufacturing services extends more than 25 years for oral solid dosage (OSD) forms. Our enabling technologies can screen poorly soluble new chemical entities (NCE's) to increase solubility and enhance bioavailability when only 100 mg of API is available. We use a specialized integrated approach to assess formulation options starting with in-silico evaluation followed by *in-vitro* screening combined with in-vivo PK animal model data. This screening platform, called Solution Engine 2.0, utilizes physical chemistry modeling to screen miscibility coupled with *in-vitro* solubility evaluation of ASD candidates and two rounds of animal PK data to select the best enabled bioavailable prototype for further scale-up and development in less than 8 to 12 weeks.

In 2023, we will have global operations across 7 cities with staff of over 3,000 employees across discovery, drug substance and drug product. We offer clients turnkey solutions from formulation development through regulatory approval including commercial scale manufacturing under cGMP conditions with FDA inspected equipment. Today, we are poised to unlock next-level growth through expanded commercial manufacturing capabilities and integrated services.

Discovery Services

- Chemistry
- Discovery Biology
- Oncology
- Pharmacology
- DMPK
- Hit Identification
- Lead Optimization
- Candidate Selection

Development Services

- Drug Substance
  - Process R&D & Scale-up Synthesis
  - Integrated CMC & IND Filing
- Drug Product
  - Bioavailability Enhancement
  - Controlled Release
  - Formulation, Process & Analytical Development

Manufacturing Services

- Drug Substance
  - Phase I/II GMP
  - Phase II/III & Commercial Coming Soon
  - RSM & Intermediate Production
- Drug Product
  - Phase I/II/III & Commercial
  - Amorphous Solid Dispersion
  - Tablets, Mini Tablets, Capsules, Pellets, Powders & Topical Creams
  - FDA approved Manufacturing facilities – last inspected in October 2019. Zero 483s.

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W: http://www.bioduro-sundia.com
LinkedIn: https://www.linkedin.com/company/biodurosundia/

BIODURO-SUNDIA

Moving You Forward

Why You Should Choose Us?

We are your Trusted Global Contract Research, Development and Manufacturing Outsourcing Solutions Provider (CRDMO)

20+ YEARS OF CTM AND COMMERCIAL MANUFACTURING

PIONEERS IN AMORPHOUS SOLID DISPERSION

UNIQUE MANUFACTURING CAPABILITIES ON THE WEST COAST

15+ YEARS OF RETAINED EMPLOYEES

www.bioduro-sundia.com

BIOVECTRA

WE CARE

We care about making better therapeutics.

BIOVECTRA is a full-service CDMO specializing in the clinical-to-commercial-scale production of high-quality regulated APIs and intermediates, including biologics, synthetic small molecules, pDNA and mRNA, highly potent APIs, and bioreagents. Our teams leverage decades of expertise and a proven track record of excellence to optimize, adapt, and perfect innovative technologies and drug substance development approaches to deliver world-class solutions for pharmaceutical manufacturing.

- Over 50 years of pharmaceutical manufacturing experience
- Flexible, creative systems designed to deliver solutions quickly and efficiently
- Extensive regulatory expertise backed by long standing relationships with major regulatory bodies

Our Facilities

- 5 cGMP facilities in Atlantic Canada
- 270,000+ sq ft manufacturing facility
- 118,000 L of chemical reactor space
- 64,000 L of fermentation bioreactor capacity

Plus… a 36,000 sq ft Biomanufacturing and Vaccine Center (under construction with a planned completion date of Q3, 2023)

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Twitter: https://twitter.com/BIOVECTRA

BIOVECTRA

We care about making better therapeutics

NEW!
BIOVECTRA Expands Manufacturing Capacity With Single-Use Microbial Fermentation Technology

BIOVECTRA is accepting projects at its manufacturing facility in Windsor, Nova Scotia, Canada, for its new, single-use biologics fermentation suite.

Containing 100 L and 1,000 L single-use fermenters, this state-of-the-art process train provides BIOVECTRA customers with several benefits including:

- greater flexibility
- faster turnaround times
- increased capacity utilization
- a decreased risk of contamination
- elimination of costly and time-consuming cleaning and sterilization between batches, which is essential with stainless-steel equipment

BIOVECTRA

BIOVECTRA is a global CDMO with 50+ years of experience supporting clients and their patients from the first clinical trial to commercial launch.


Fermentation: Biologics


Synthesis & Purification, MPEGs, Linkers


pDNA/mRNA


HPAPIs


Bioreagents

We care about making better therapeutics.

www.BIOVECTRA.com

WE CARE

Bora Pharmaceuticals

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LinkedIn: https://www.linkedin.com/company/borapharmaceuticals
Twitter: https://twitter.com/borapharma

Quality with flexibility. Making success more certain.

Bora Pharmaceuticals is a premier international CGMP CDMO specializing in complex oral solid dosage (tablet & capsules), liquids (solutions, suspensions, & nasal sprays) and semi-solids (creams & gels) pharmaceutical Rx and OTC products for late-phase Clinical through Commercial manufacturing and packaging. Bora owns and operates three state-of-the-art CGMP manufacturing facilities (Taiwan and Canada) built to the highest international standards for manufacturing, packaging, R&D, and analytical testing.

We can handle high potency compounds, solvents, flammables, and IR/SR/ER release profile products.

Our Taiwanese facilities are USFDA, MHRA, TFDA, Jordan FDA, and GCC (Gulf Cooperation Council) inspected. Our Mississauga, Our Canada site is approved by all major regulatory agencies including USFDA, Health Canada, ANVISA, EMA, PDMA, and the Japanese Ministry of Health. Our last USFDA audits have had no findings.

Our sites deliver to more than 100 markets around the world including the US/Canada, EU, Southeast Asia, Middle East, and South and Central Americas. All sites are TAA compliant. Our packaging lines are fully serialized. Our sites have over a 98% on-time delivery record!

Bora Pharmaceuticals has an extremely solid financial foundation and experienced management team, with over 20+ years working in the pharmaceutical industry.

Quality

Bora Pharmaceuticals has been dedicated to maintaining the world-class quality standard from its beginning. Advanced quality systems, including QMS, EDMS, and ERP, are effectively utilized to ensure the highest manufacturing quality. At Bora, it is our mission to provide our customers pharmaceuticals with an unparalleled quality they expect.

Bora Biologics

Bora Biologics

Making success more certain

- Flexible solutions for biologics development and cGMP manufacturing
- Broad operational expertise
- Flexible single use manufacturing technologies at an advanced global site
- cGMP, ICH, FDA, EMA, TFDA, PIC/S standards

Discover our end-to-end biologics solutions

landing.boracorpcdmo.com/biologics-manufacturing

CAPTISOL®

A Ligand® TECHNOLOGY

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cdinfo@captisol.com
www.captisol.com

OPTIMIZED DRUG SOLUBILITY AND STABILITY

Captisol is the trade name for Ligand's solvent-free processed modified cyclodextrin preparation. Captisol is a patent-protected mixture of chemically modified cyclodextrins with a modifying structure to optimize drug solubility and stability. Captisol was invented and developed by scientists at the University of Kansas' Higuchi Biosciences Center specifically for drug development and formulation.

Captisol overcomes solubility and stability hurdles faced during each phase of development. Captisol can make a substance more soluble and an agent more stable. Captisol can convert a solid to a liquid or an oil to an aqueous solution. Combinatorial chemistry, high throughput screening (HTS), and molecular genetics have led to an increase in the number of insoluble and unstable molecules, peptides, and proteins being investigated for their therapeutic activity. There are currently more than 50 Captisol-enabled products in clinical development. This unique technology has enabled several FDA-approved products, including Amgen's KYPROLIS®, Baxter International's NEXTERONE®, Gilead's VEKLURY®, Acrotech Biopharma L.L.C.'s and CASI Pharmaceuticals' EVOMELA®, Melinta Therapeutics' BAXDELA™ and Sage Therapeutics' ZULRESSO™. There are many Captisol-enabled products currently in various stages of development.

SEAMLESS TRANSITION TO CLINICAL TRIALS

Captisol may increase systemic exposure for toxicology studies of investigative compounds and has a proven clinical safety record. In early development, Captisol formulation can lead to a seamless transition from nonclinical safety to clinical trials. Captisol has helped more than 10 million patients in over 120 countries.

MULTIPLE ADMINISTRATION ROUTES ENSURE TARGETED DELIVERY

Captisol's chemical structure was designed to create new products by improving solubility, stability, bioavailability, and dosing of active pharmaceutical ingredients. Routes of administration investigated include parenteral, oral, ophthalmic, nasal, topical, and inhalation products. Once inside the body, Captisol releases the drug agent, which then travels to its target. The interaction between Captisol and the agent is not permanent, and Captisol is safely expressed from the kidneys.

PATENTED & VALIDATED MANUFACTURING

Of all modified cyclodextrins, Captisol is an ingredient in the most approved products in the US. Manufactured under cGMP, at multiple locations, using a patented and validated all-aqueous process, annual manufacturing capacity is being increased to 500 MT. Captisol is supplied in ultra-low endotoxin, ultra-low bioburden, low-chloride forms in 100g, 1kg, 5kg and 20kg packages for R&D use. Commercial pack sizes include 1kg, 5kg, and 20kg, with the ability to fill metric-ton orders.

CAPTISOL®

A Ligand® TECHNOLOGY

What sets us apart from other modified cyclodextrins?

A team of experts dedicated to moving your product forward.

- Decades of experience in the pharmaceutical industry developing parenteral, oral, ophthalmic, nasal and inhalation formulations with Captisol and other cyclodextrins
- Recent addition of internal resources and analytical tools will provide greater responsiveness for collaborative feasibility and development programs
- The team can help create your product or assist in your development, safety studies, regulatory or manufacturing
- Our team has successfully completed or assisted with orphan designations and approvals, preclinical, CMC and clinical development for ANDA, 505b2 and traditional NDA programs
- Academic or Industry, the Captisol team is available to discuss your application, evaluate and potentially participate in your research project or developing the concept

Ready? Call 858-550-5632 or email cdinfo@captisol.com

Captisol.com

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Catalent is the global leader in enabling pharmaceutical, biotechnology, and consumer health partners to optimize product development, launch, and full life-cycle supply for patients globally. With broad scale and deep expertise in development sciences, delivery technologies, and multi-modality manufacturing, Catalent is a preferred industry partner for personalized medicines, consumer health brand extensions, and blockbuster drugs. Each year, Catalent helps accelerate over 1,500 partner programs, launches more than 150 new products, and supplies around 80 billion doses of nearly 8,000 products. Catalent's global network comprises over 50 sites and an expert workforce

Technology Highlights

Catalent applies rigorous science, superior technologies, and deep expertise to improve its partners' treatments and bring them through the clinic to patients, faster. Proactive investment and powerful partnerships help transform challenging molecules and new modalities into real treatments.

- **Catalent Cell & Gene Therapy** is a full-service partner for adeno-associated virus (AAV) and lentiviral vectors, as well as plasmid DNA. Catalent's UpTempo Virtuoso™ AAV platform process provides early-stage clients with accelerated timelines for the production of their clinical material. Its comprehensive cell therapy portfolio includes expertise across multiple cell types including CAR-T, autologous and allogeneic cell therapy development and manufacturing, and human induced pluripotent stem cells (iPSCs);
- **Advanced GPEx® cell line expression technology** for biopharmaceutical development, bioanalytics and biomanufacturing;
- **OptiForm® Solution Suite** for rapid, optimized dose form development and bioavailability enhancement technologies, including lipid-based systems, spray drying technology, particle-size engineering, and the OptiMelt® hot melt extrusion (HME) platform;
- **Extensive and unique delivery technologies:** including OptiShell® gelatin-free capsule technology; Zydis® orally disintegrating tablets; oral controlled release including OptiGel® DR; FlexDose℠ stick pack; SMARTag® technology for antibody-drug conjugates; and injectable forms.

Integrated Solutions

Catalent offers integrated development and product supply solutions that can be combined or tailored to enable customers to progress drugs, biologics, and consumer health products from laboratory to market, faster. Post-launch, Catalent provides comprehensive, integrated product supply, from sourcing bulk APIs through to manufacturing and packaging, release testing, and distribution. These flexible, scalable, and creative solutions meet the unique needs of partners of all sizes, from the smallest innovators to the largest pharmaceutical leaders and consumer health companies, advancing thousands of molecules through development towards commercial supply.

Headquartered in Somerset, NJ, the company generated nearly $5 billion in revenue in its 2022 fiscal year.

More products. Better treatments. Reliably supplied.™

DRUG DEVELOPMENT & FORMULATION IS SCIENCE. DOSE DESIGN TO CREATE SUCCESSFUL TREATMENTS IS ART.

Successful treatments are built on drug development science, superior formulation technologies and the art of dose form design that meets the needs of patients, doctors and innovators.

Catalent's NEW OptiDose® Design Solution helps deliver a comprehensive assessment of your Molecule, Patient, and Market. Our scientific advisors will combine expertise across dose forms, thousands of molecules and advanced delivery technologies to deliver optimal dose form, scale-up and manufacturing solutions. We aim to help differentiate your product, improve patient acceptance, and turn your science into commercially successful medicine.

EXPERT OPTIDOSE® DESIGN ASSESSMENT | ADVANCED TECHNOLOGIES | SUPERIOR DOSE FORMS | INTEGRATED SOLUTIONS

Catalent® | *WHERE SCIENCE MEETS ART.*

US + 1 888 SOLUTION (765-8846) **EUR** 00800 8855 6178 catalent.com/optidosedesign

Celanese

The chemistry inside innovation™

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CUSTOMIZED SUPPORT FOR SUSTAINED RELEASE DRUG DELIVERY THERAPIES

From FEASIBILITY to DEVELOPMENT to COMMERCIALIZATION

Celanese works closely with you as a strategic partner to create innovative controlled-release dosage forms for biologics, small molecules, and RNA to meet the goals of patient-centric therapies, improved medicine and better healthcare economics.

Our scientists and engineers are there from concept to commercialization, providing development services, material supply aligned with GMP principles and regulatory support through the Celanese Development & Feasibility Lab. Our objective is to help our customers reduce R&D time and improve the likelihood of successful drug commercialization.

INTRODUCING THE VITALDOSE® PLATFORM

Our VitalDose® Ethylene-Vinyl Acetate (EVA) copolymer drug-delivery platform is an enabling technology for drug-eluting implants, inserts. The platform is flexible and customizable to address formulation challenges and tailor the release rate of your drug.

- Compatible with biologics, RNA, and small molecules
- Provides reliable local or systemic drug administration
- High drug loading capacity (≤ 75%)
- Achieves drug release over >6 months
- Ease of formulation and configurable into a variety of geometries
- An established regulatory path with long clinical use history

VitalDose® EVA has been approved for use in numerous pharmaceutical and medical device applications. We are actively supporting marketed products and development programs in:

- Ophthalmic inserts & intraocular implants
- Oncology
- Women's health
- Central nervous system disorders
- Rare diseases

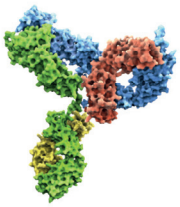
ABOUT CELANESE

Celanese Corporation is a global technology leader in the production of differentiated chemistry solutions and specialty materials used in most major industries and consumer applications. We partner with our customers to solve their most critical business needs and strive to make a positive impact on our communities and the world through our commitment to sustainability and The Celanese Foundation. Based in Dallas, Celanese employs approximately 8,500 employees worldwide and had 2021 net sales of $8.5 billion.

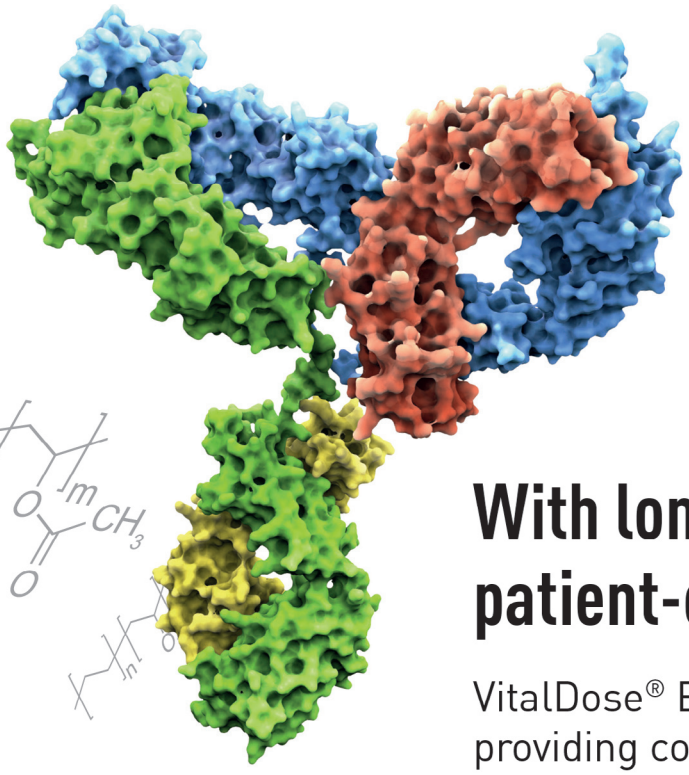
Celanese has supported the demanding requirements of the medical and pharmaceutical markets for over 40 years, expanding possibilities alongside our customers. We're focused on developing new cutting-edge approaches to improve patient care. Our portfolio includes solutions and technologies across applications including drug delivery, medical devices, implantable devices, advanced surgical instruments and connected devices.

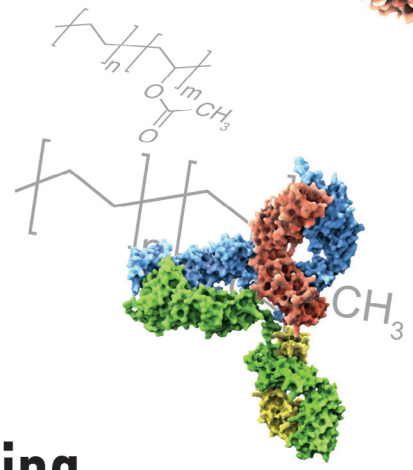
Celanese

VITAL Dose®



Sustained Drug Delivery





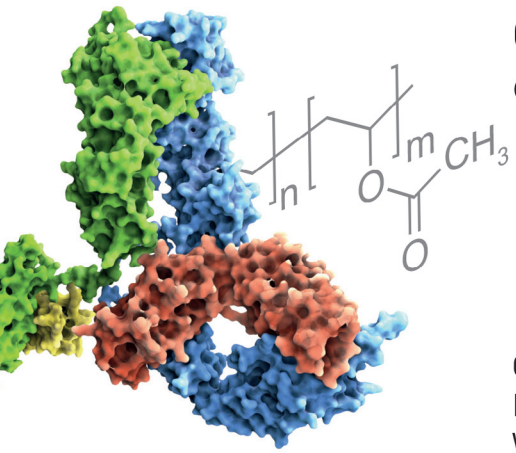
With long-acting, patient-centric therapeutics

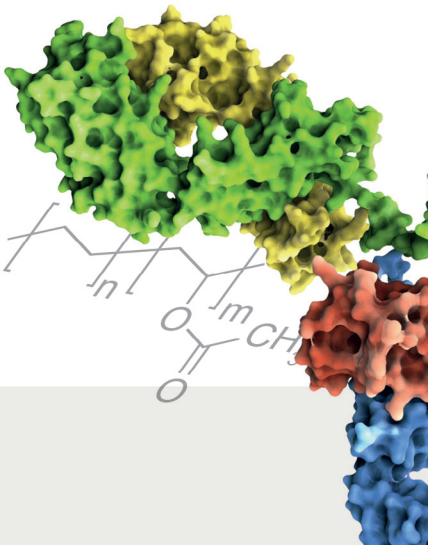
VitalDose® EVA is a copolymer drug-delivery platform providing controlled release through implant and insert dosage forms.

The VitalDose® platform is flexible and customizable with high drug loading capacity (≤75%).

Our scientists and engineers will partner with you to create novel delivery systems for:

- Monoclonal antibodies
- Small molecules
- RNAi





Collaborate with us
Email: Healthcare@Celanese.com
Website: Healthcare.Celanese.com

CREDENCE MEDSYSTEMS

INNOVATION WITHOUT CHANGE

Credence MedSystems, Inc.

Credence MedSystems is setting a new standard in drug delivery, helping you differentiate your products through innovative delivery systems while preserving your trusted processes.

Credence MedSystems is an innovator of drug delivery systems that solve unmet market needs for the pharmaceutical industry. Credence's philosophy of *Innovation Without Change*® allows pharma manufacturers to impress and protect their end users while preserving their existing processes, sourcing strategies and preferred primary package components.

Companion® Product Family

Add end-of-dose cues, automatic needle retraction, and intuitive safeguards to your products while improving the efficiency of your manufacturing processes, maintaining your sourcing strategy and enhancing your sustainability efforts.

Dual Chamber Reconstitution or Sequential Liquid Delivery

Simplify the delivery of your most complex drug products. Maintain separation of components during storage while offering users a safe and friendly experience like that of a liquid-stable drug. Simplified mixing or sequential delivery of two liquids combined with passive needlestick protection minimizes time, complexity and risk of dosing errors and contamination, all while improving safety and usability.

Credence Connect™

Bring digital connectivity to any syringe with real-time monitoring, transmission and storage of injection data… all built into a comfortable reusable finger flange. The Credence Connect can help you enhance chronic disease care and improve clinical trial management.

Micro-Dose™, Multi-Site™ and Force-Assist™

Enable extremely precise micro-dosing, either in a single delivery or in a series of repeat injections, and employ force reduction technology to facilitate delivery of viscous products.

Impress. Provide a better experience for users, consistently, across our entire platform of products.

Preserve. Differentiate without disruption.

Protect. Safeguard healthcare professionals and patients.

Stand out among the competition.

At Credence MedSystems, being innovative means bringing value. Our *Innovation Without Change* approach means we make it easier to meet evolving market demands, with minimal disruption to you.

Contact us to see *Innovation Without Change* in action and explore our portfolio of award-winning, industry-unique drug delivery systems.

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CREDENCE MEDSYSTEMS

INNOVATION WITHOUT CHANGE HAS ARRIVED

THE CREDENCE COMPANION

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This product has not yet been evaluated by FDA

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Facebook: https://www.facebook.com/CuriaCDMO
Twitter: https://twitter.com/CuriaCDMO

Curia is a Contract Development and Manufacturing Organization with over 30 years of experience, an integrated network of 29 global sites and over 3,500 employees partnering with customers to make treatments broadly accessible to patients. Our biologics and small molecule offering spans discovery through commercialization, with integrated regulatory and analytical capabilities. Our scientific and process experts and state-of-the-art facilities deliver best-in-class experience across drug substance and drug product manufacturing. From curiosity to cure, we deliver every step to accelerate and sustain life-changing therapeutics. To learn more visit us at curiaglobal.com

Services & Capabilities

From discovery through commercialization, we leverage deep scientific and process expertise, and state-of-the-art facilities and technologies to ensure every stage of this intricate process advances as quickly and accurately as possible.

SMALL MOLECULES

Our small molecule offering spans IND to commercialization, with a broad service and catalog portfolio. We cover a breadth of modalities in small molecules across:

- Simple and complex APIs
- Steroids & hormones
- Highly potent APIs
- Lipid Nanoparticles (LNPs)
- Fine Chemicals

BIOLOGICS

Our biologics offering spans discovery to clinic and fill-finish services across:

- mRNA
- Monoclonal antibodies
- Proteins
- Vaccines
- Cell lines
- Viral Vectors
- Peptides Oligonucleotides

The journey to breakthrough medicine is never simple. But the right CDMO partner can ease your path with scientific excellence, relentless curiosity and expert, reliable delivery. Our biologics and small molecule offering spans discovery through commercialization, with integrated regulatory and analytical capabilities. For over 30 years, our scientific and process experts and state-of-the-art facilities deliver best-in-class experience across drug substance and drug product manufacturing. From curiosity to cure, we deliver every step to accelerate and sustain life-changing therapeutics.

Learn more at **curiaglobal.com**.

BIOLOGICS SMALL MOLECULES

curia

The World's Only All-Round Cyclodextrin Company

CycloLab Cyclodextrin Research and Development Ltd. is a private SME with the focus on cyclodextrin research and development for over 30 years. CycloLab has four main activities:

1. Cyclolab Ltd. manufactures Dexolve™ (Sulfobutylether Beta-Cyclodextrin: SBECD, https://cyclolab.hu/dexolve/) in multiple ton scale under cGMP conditions based on an FDA-approved Drug Master File. Dexolve is a potent general solubilizer and stabilizer excipient, compatible with any kinds of administration routes and dosage forms. Cyclolab offers free feasibility study (https://cyclolab.hu/feasibility/) with molecules to support cyclodextrin-based formulation development and free samples. Benefits of the application of Dexolve™:

- Significant chemical stability and solubility enhancement (10 to 100,000 fold)
- Increased bioavailability, facilitated delivery
- Reduced aggregation
- Maximized patient safety, complete renal elimination

2. As an R&D company, we develop next generation proprietary cyclodextrins and explore potential applications as well. These are focused in several areas such as evaluating cyclodextrins:

- as excipients in new areas like protein stabilization and non-viral gene delivery, fermentation and enzymatic processes, serum free culture media
- creating selective and targeted drug delivery systems (targeted cancer treatment, BBB permeation, controlled release)
- evaluation of cyclodextrins as API candidates for CNS diseases, infections, antidotes and other conditions
- develop innovative and added-value (505b2) formulations with small molecules

For these activities we seek collaboration, contractual and licensing partners.

3. CycloLab operates as a CRO for cyclodextrin related services including:

- development of products (pharma, veterinary, cosmetic, food, agricultural industries) – formulation development, optimization, characterization, *in vitro* bioequivalence studies
- offering custom synthesis of cyclodextrins, fine-tailored for certain guest molecules or purposes. Cyclolab also has a Grant to support creating cyclodextrin-based NCE development (https://cyclolab.hu/grant/)
- performing cGMP compliant manufacturing of cyclodextrins to be used as APIs or excipients in clinical studies or cyclodextrin enabled formulations for the same purpose that are not available in suitable grades globally
- all analytical tasks related to the above, under GMP (method development, validation, stability studies for formulation ingredients (APIs, cyclodextrins) and final products) as well.

4. CycloLab offers the widest variety of cyclodextrins in various grades (pharma, standard, fine chemical) in our webshop (https://cyclolab.hu/products/) for various purposes (research, analytics, cell cultures, formulation studies, etc). Besides "regular" cyclodextrin derivatives, we are keen on developing novel and special types, like maltooligomers, polymers or fluorescent-tagged products. Within the product list, several Sugammadex related compounds are included.

CycloLab Cyclodextrin Research & Development Ltd.
W: https://cyclolab.hu/ or https://cyclodextrinnews.com/
E: info@cyclolab.hu
LinkedIn: https://www.linkedin.com/company/10040240

DDL

Testing Experts. Service Specialists.

For over 30 years, **DDL** has provided extraordinary service and specialized testing expertise to the medical device and pharmaceutical industries. Our reliable quality, responsive attention, and on-schedule completion for packaging, medical device, and combination products testing secures confidence in performance and safety while achieving regulatory compliance.

Package Testing

DDL's package testing services evaluate the strength and integrity of packaging systems before and after simulating the anticipated distribution and storage conditions that the systems may undergo. Packaging professionals use this combination of simulation and evaluation to validate package compliance with ASTM, ISO, ISTA and other accepted industry standards. DDL offers full service package testing in Eden Prairie, MN and Irvine, CA, and select package testing capabilities in Edison, NJ.

Drug Delivery Device Testing

DDL specializes in mechanical and performance testing for pre-filled syringes (ISO 11040), needle-based injection systems (ISO 11608) and small-bore connectors (ISO 80369). In preparing for regulatory submission or verifying your products conform to the required industry standards, DDL provides reliable test data to document the performance and safety of your drug delivery product.

Container Closure Integrity Testing

Package integrity verification requires careful examination of package leakage given the specific product and its life cycle. DDL's CCI services include both the most recent deterministic capabilities, as well as probabilistic methods, as outlined in USP <1207>. We can provide tailored expertise to design and execute a CCI study based on your system, providing the support you need.

Medical Device Testing

DDL specializes in testing medical devices such as luer fittings, syringes, needles, catheters, guidewires, surgical sutures, cannulae and tracheal tubes. DDL tests to ANSI, ASTM, IEC, ISO, JIS, EN and other industry standards. Vibration, physical shock, thermal shock, friction, flow rate, force to operate, leakage and compression testing are among the many tests provided. Custom test development and protocol creation are also available.

Stability Storage

DDL's testing laboratories contain over 40,000 cubic feet of storage space that have been mapped and calibrated for long- and short-term shelf life studies under various temperature and humidity requirements. DDL has the conditions you need and the capacity to support your tight timelines. Custom storage conditions and reports are available to support your specific procedures.

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F: (732) 346-0295

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LinkedIn: https://www.linkedin.com/showcase/emergent-biosolutions-cdmo

Synchronized to Serious Science. *Yours.*

Emergent CDMO is the contract development and manufacturing (CDMO) arm of Emergent (NYSE: EBS). Emergent CDMO has the scientific and regulatory compliance experience, end-to-end development and manufacturing expertise, and efficient technology transfer capabilities that can harness the urgency, acuity, and scalability required to bring life-saving, life-extending products to market. Even when the world changes around us and new challenges emerge, our mission stays the same — to improve and protect the health of billions of people around the globe by supporting innovative drug makers that make the seemingly impossible possible. We understand that which approach fits you best can be found where science and business strategy intersect, where dynamics like speed, cost, and regulatory approach are balanced in precise harmony. And as an integrated CDMO with the experience of an established biopharmaceutical company, Emergent stands ready to help reach your next clinical or commercial drug product milestone.

Development & Manufacturing Solutions for Biologics

Emergent BioSolutions' mission is to protect and enhance life through innovation. Over the last few decades, Emergent has developed, manufactured, and delivered therapeutics and vaccines throughout the world to tackle the most serious health threats.

Emergent's CDMO business draws on this experience and has supported the development and manufacture of over 40 commercial products approved for distribution in over 70 countries, as well as clinical trial material for a wide range of early to late phase programs. Since 1998, our global manufacturing network has supported over 100 drug product candidates, making Emergent a proven partner for pharmaceutical and biotechnology companies looking for value and reliability through outsourcing.

Technologies & Platforms for Every Strategy

Our CDMO teams have flexible and scalable technology platforms able to support clinical through commercial manufacturing.

Development Services

- Process Development
- Analytical Development
- Formulation Development
- Non-GMP Lab-Scale Manufacturing

Drug Substance Manufacturing

- Upstream & Downstream
- Single-Use Platform (up to 4000L)
- Mammalian Cell Culture
- Process & Analytical Development
- Clinical & Commercial Scale

Drug Product Manufacturing

- Vials and Prefilled Syringes
- Packaging & Labeling
- Viral & Non-Viral Fill/Finish
- Biologics
- Parenteral Formulation Development
- Clinical & Commercial Scale
- Liquid & Lyophilized Products
- Microbiology
- ICH Stability

Wherever you are in your journey, whatever challenges you face, our team of experts and resources are ready to go to work for you.

Let's get started with your next clinical or commercial candidate. Your new formula for success awaits.

EMERGENT® CDMO

Synchronized to Serious Science. **Yours.**

At Emergent CDMO, we like a good challenge. Helping biopharma innovators bring life-saving, life-extending therapeutics to patients around the world is why we are here. Whether your innovation is centered on a global health risk, rare disease, or novel medicine, you'll find us a like-minded and more-than-capable partner.

Learn more at emergentCDMO.com/next-level

DEVELOPMENT
AND MANUFACTURING
SOLUTIONS FOR BIOLOGICS

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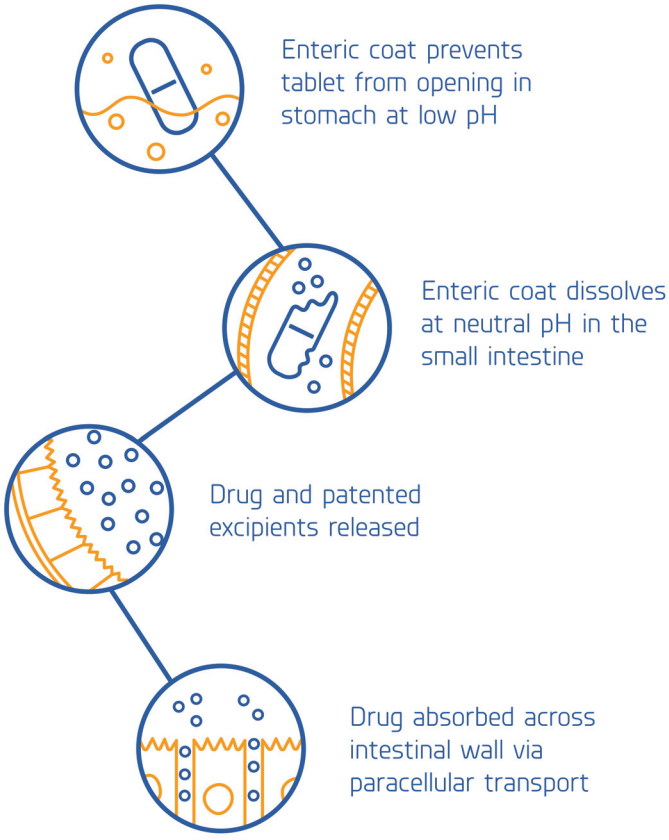
Enteris BioPharma- The Preferred Partner for the Development & Manufacture of Oral BCS III & IV Drug Products

Enteris BioPharma Inc., a wholly owned subsidiary of SWK Holdings Corp. (Nasdaq: SWKH), is a fully integrated development and manufacturing organization offering innovative oral drug delivery solutions. Since its founding in 2013, Enteris has adapted its oral drug delivery technology to advance multiple internal and client programs into the clinic. More recently, Enteris has completed a renovation of its 32,000-sq-ft GMP facility, including HPAPI containment and handling, in Boonton, NJ, enabling long-term partnerships for challenging solid oral drug product development from preclinical through commercial cGMP manufacturing.

Unlike other technologies, Peptelligence® and ProPerma® uniquely address issues with both solubility and permeation in a solid oral dosage form, enabling new and highly scalable treatment opportunities for peptides, peptidomimetics, and small molecules that typically need to be injected. Peptelligence® and ProPerma® utilize an enteric coating surrounding a tablet core containing the API with a synergistic combination of pH-lowering and solubilizing agents that are known to have permeation-enhancing properties.

Enteris' oral drug delivery technologies have been proven safe and effective in more than 15 clinical studies, showing exceptional results in enhancing oral bioavailability of various peptide modalities, including but not limited to GLP-1, GnRH, PTH, DACRA, and KORA analogs. For certain small molecules, the technology has been shown to provide over 20-fold improvement in oral bioavailability. As a true full-service provider of choice, Enteris is uniquely qualified to provide total integrated oral drug product development for the most challenging compounds.



Hovione

The Specialist Integrated CDMO

Hovione offers customized services and innovative solutions from drug substance to drug product with high standards of quality and technical expertise. We provide reliable supply with flexible manufacturing to bring medicines to market faster. Hovione is an integrated supplier to the pharmaceutical industry offering end-to-end solutions in one site.

From Drug Substance to Drug Product

Your partner in custom development and manufacturing of APIs. Bringing together excellence in process chemistry and manufacturing.

The Leader in Commercial Spray Drying

Combining the largest capacity, the best scale-up science, and the most experienced team, Hovione can take projects from development to market. Our particle engineering technologies can address oral bioavailability, lung delivery, modified release, and taste masking. In each technology, we can support from proof-of-concept to commercial manufacturing. We can also handle highly potent compounds. Our Development-by-Design methodology allows our customers to save costly API, to shorten development timelines and get guaranteed results.

The Platform ASD-HIPROS, Hovione's Intelligent Proprietary Screening, is the most advanced and accurate tool to identify Amorphous Solid Dispersion formulations by Spray Drying with maximum performance and stability. In just 6 weeks, this platform maximizes the chance of identifying a successful formulation, accelerating the development towards commercial manufacturing and patient availability.

Continuous Tableting for Drug Product

Hovione is offering a commercial continuous tableting platform prepared to support key control needs and deliver on operational excellence, mechanistic modeling, and appropriate process analytical technology (PAT). Hovione´s quality system has been designed to support the release of continuous tableting products through automated in-process controls, deployment of real time release, and compliant digital infrastructure. This cutting-edge technology offers faster development of simpler processes, agile manufacturing for variable demand, robust control strategies and high process quality standards.

Hovione has a highly experienced multi-disciplinary global team in continuous tableting and upgraded its labs with the tools needed to support the drug product lifecycle, guaranteeing competency and capacity from research & development to production.

Everything for Inhalation

Hovione offers customized high-performance APIs, particle engineering and formulation services along with a full range of highly specialized innovative devices.

The Company

Hovione is an international company with over 60 years of experience as a Contract Development and Manufacturing Organization (CDMO) with a fully integrated offering of services for drug substance, drug product intermediate and drug product. The company has four FDA inspected sites in the USA, Portugal, Ireland and China and development laboratories in Lisbon, Portugal and New Jersey, USA. Hovione´s culture is based on innovation, quality and delivery. Hovione was the first Chemical/ Pharmaceutical Company to become a Certified B Corp, is a member of Rx-360, EFCG and participates actively in industry quality improvement initiatives to lead new global industry standards.

We do well what is difficult, to give our customers what they cannot find elsewhere. Please visit www.hovione.com.

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FORTIS LIFE SCIENCES

nanoComposix

A FORTIS LIFE SCIENCES COMPANY

Fortis Life Sciences offers world-class reagents, tools, materials, and custom services with a best-in-class customer experience for our customers in the biopharma industry. Through our brand nanoComposix, we provide precisely engineered and highly characterized nanomaterials to a global customer base. nanoComposix is an ISO 13485 (2016)-Certified*, FDA-registered developer and contract manufacturer with a nanomaterial product portfolio containing hundreds of variants engineered to address the unique challenges presented by our customers. Our products and CDMO services are backed by technical teams with extensive expertise in nanotechnology, biology, chemistry, physics, and optics.

NANOMATERIALS FOR NANOMEDICINE

At Fortis Life Sciences, we provide solutions for the rapid development and commercialization of medical devices and therapeutic products. There are many nanomaterial companies and many GMP manufacturers but very few that specialize in both.

With our diverse expertise in nanoparticle fabrication to targeted delivery, controlled-release, photothermal therapy, and biofunctionalization, we help partners bring high- impact, nano-enabled products to market.

Find more details and case studies on our website: https://www.fortislife.com/nanomaterials-for-targeted-drug-delivery-and-photothermal-therapy

GMP NANOMATERIAL SYNTHESIS & MANUFACTURING

Fortis Life Sciences specializes in the development and manufacturing of devices and drugs with nanomaterial components. We are experts in the fabrication and scale-up of nanomaterials for use in products that require ISO13485:2016 and cGMP-compliant quality systems.

Tailored GMP Solutions

We work through a multi-stage process with each client to collaboratively develop a GMP Project Plan customized for the target application while maintaining cost efficiency and compliance.

Nanoparticle Manufacturing Expertise

We have been manufacturing nanoparticles for over 16 years. Our lead scientists have 80+ years of collective experience in nanomaterial fabrication, with an emphasis in metals and metal oxides like gold, silver, and silica as well as polymers like PLGA.

GMP Experience & Capabilities

Our facility offers production under the controls of our cGMP compliant / ISO13485 certified Quality Management System and provides scaled nanoparticle manufacturing for medical devices, topical therapeutics, and combination (drug/device) products for preclinical and Phase 1/2 clinical trials.

Find more details and case studies on our website:
https://www.fortislife.com/gmp-nanoparticle-manufacturing

***Specific to 4878 Ronson Ct. Suite J and 4888 Ronson Ct. Suite B**

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FORTIS
LIFE SCIENCES

Custom fabrication and functionalization of nanoparticles for therapeutics

Leverage our unique experience in nanoparticle development and GMP manufacturing to ensure rapid development and commercialization of your nano-enabled products.

We offer solutions from proof of concept to scaled manufacturing of therapeutic systems for:

- Targeted delivery
- Controlled release
- Photothermal therapeutics
- Theranostics
- Gene therapy

Learn more at: fortislife.com/drug-delivery-nanomaterials

nanoComposix

HEALTH SOLUTIONS
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W: flex.com

Partnering with you to create the extraordinary in design and manufacturing of medical products

Vital Statistics

- Flex was founded in 1969
- Number of Employees: 160,000+
- Number of Facilities: 130 sites in 30 countries, 27 medical sites, 14 FDA-registered and 24 ISO 13485:2016-certified sites

Who We Are

- Global design, development and manufacturing provider with over 30 years of medical experience across FDA Class I, II, and III products from simple disposables to smart drug delivery systems and immunoassay diagnostic systems
- Cross-industry experience with innovations in optics, sensors, miniaturization, human machine interface, cybersecurity, and 5G connectivity
- Vertical integration under one roof from "pellet to packout"
- Medical footprint includes multiple plastics tool-making and injection molding facilities
- Global supply chain technology leader with real-time data analysis for speed and agility

Human Factors Engineering

Generative research to identify and meet user needs, formative studies to optimize usability, and summative studies to demonstrate safe and effective use.

Full Design & Development

Accelerate and de-risk design and development and integrate advanced technologies. Engineering and development with manufacturability in mind to ensure an outstanding design can be efficiently manufactured at target cost.

New Product Introduction (NPI)

Expertise in NPI, and collaboration with both design and operations teams results in efficient, validated and scalable production processes that can be easily scaled to high volume manufacturing.

Manufacturing

Our global footprint allows us to match our customers' regional strategies. Tool making, injection molding, PCBA, system integration, full device manufacturing, complex assembly, sterilization and final packaging comprise our full services manufacturing portfolio. The ability to deliver maximum value with disciplined execution ensures Flex produces at the highest level of quality and efficiency.

Supply Chain, Logistics & Distribution

Flex scale drives incredible supply chain strength. Flex Pulse, a sophisticated set of real-time tools enhances speed and impact in supply chain management.

PRODUCT EXPERIENCE

Medical Equipment

Laboratory diagnostic systems, point of care diagnostics, surgical generators, OR and ER equipment, imaging systems, respiratory care equipment, ophthalmic diagnostics, remote patient monitoring, hemodialysis, monitoring, analytical lab equipment.

Medical Devices

Diabetes management, neural stimulators, surgical tools, personal care, personal diagnostics and monitors, wearables, single use disposables, vascular disposables, wound management, neuromodulation disposables.

Drug Delivery

Autoinjectors, on-body injectors, smart injection pens, pumps and infusion systems, wearable pumps.

Precision Plastics

Pipettes, syringes, tubes, IV components and other plastics, high precision molding and tooling.

Providing innovative healthcare solutions from concept and design to manufacturing at scale

Whether your focus is on autoinjectors, smart needles, on-body injectors or other drug delivery systems, Flex helps you mitigate risks and get to market faster to improve lives

Create the extraordinary

healthsolutions@flex.com
flex.com/healthcare

flex

GATTEFOSSÉ

COMPANY

Gattefossé provides innovative excipients and drug delivery solutions to health and personal care industries. With a service and distribution network that spans over 80 affiliates, Gattefossé prides itself for having introduced innovative products that conform to the highest manufacturing and regulatory standards worldwide. Over many decades, Gattefossé has transformed the chemistry of lipid excipients into viable drug delivery systems.

PRODUCTS

Gattefossé excipients are well-known for their efficacy, safety, and quality. They are suitable for the conventional dosage forms as well as modern formulation technologies such as Melt-Extrusion, SMEDDS, and SLN/NLC. Our offer includes tableting excipients like **Compritol®** and **Precirol®**; solubility and bioavailability enhancers like **Labrafil®**, **Labrafac™**, **Capryol™**, **Labrasol®**, **Lauroglycol™**, and **Transcutol®** series; and ready-to-use bases like **Geleol™**, **Geloil™**, **Tefose™**, **Ovucire®** and **Suppocire®** lines. Designed for improved, enhanced, or modified drug release, each product is fully characterized for physical/chemical properties and performance criteria.

CORPORATE & SOCIAL RESPONSIBILITY

Our business practices are intertwined with corporate social responsibility and emphasis on environmental sustainability for a better world. In this and other regards, achieving a competitive edge by innovation is the hallmark of the Gattefossé enterprise since 1880. The commitment to our customers is reflected in our history of service, with focus on problem solving in drug product development. We continue research and development, alongside knowledge sharing with the scientific community in the form of peer reviewed publications, webinars, and seminars.

CAPABILITIES and SERVICES

It is the aim of Gattefossé to simplify formulation decisions that will minimize attrition rates and shorten the drug development path. Through in Americas, Europe, and Asia, we offer complimentary support for solubility screening and formulation design and characterization for various routes of administration. Alongside, we provide guidance for regulatory, safety, and preclinical aspects of our excipients.

www.Gattefosse.com

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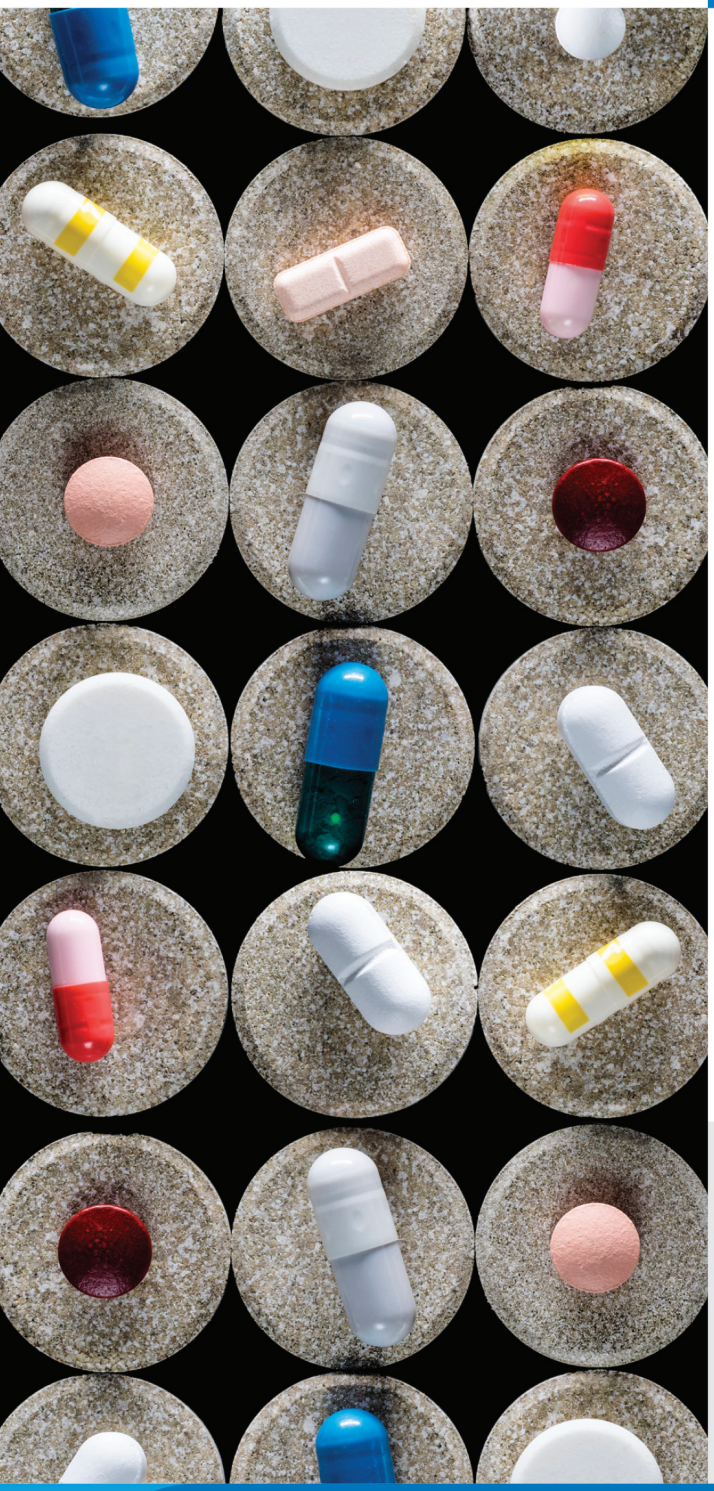
GATTEFOSSÉ

Compritol® 888 ATO



Developed and marketed by Gattefossé

Compritol® (Glyceryl behenate-NF) is a free-flowing, tasteless, odorless powder used in the preparation of a wide array of pharmaceutical, nutraceutical, and veterinary products.

Designed for sensitive applications, its functions include:

- Effective lubricant for capsule and tablet preparations
- Matrix in sustained release tablets and capsules
- Structural component in lipid nanoparticle formulations

Compritol® is referenced in hundreds of globally approved drug product categories:

Prescription Medicines	Over-the-counter Drugs
Antibiotics, antifungals	Analgesics and antipyretics
Antidepressants	Antiobesity treatment
Antiepileptics	Cold and cough remedies
Antihypertensives	Cough suppressants
Antiflammatories	Analgesics and antipyretics
Antivirals	Dietary supplements
Calcium channel blockers	
ACE inhibitors	**Nutraceuticals**
Diabetes	Vitamin & mineral supplements
Diuretics	CoQ10
Gastrointestinal disorders	Glucosamine
Lipid modifying agents	Chondroitin sulfate
Opioids	Methyl-sulfonyl-methane
Vasodilators	Amino acids and Botanical extracts

Other applications include taste masking, protection of sensitive actives like amino acids, minerals, and vitamins when combined.

Key Features

- \+ Inert, tasteless, and easy to use
- \+ Authorized in pediatrics
- \+ Wide range of compatibility and applications
- \+ Global regulatory acceptance
- \+ Immediate, sustained, modified release
- \+ Solid Lipid Nanoparticles (SLN) and nanocarriers

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LinkedIn: https://www.linkedin.com/company/genezen-laboratories/
Twitter: @GenezenLabs https://twitter.com/GenezenLabs

Specializing in lentiviral and retroviral vectors, **Genezen** offers early-phase process development, GMP vector production, analytical testing services and assay development. Leveraging the expansive knowledge and experience of its team, Genezen accelerates cell and gene therapies to commercialization and helps deliver life-changing therapeutics to patients.

Founded in 2014, the company strives to make viral vector production accessible to early-stage, growth-oriented companies and established industry leaders.

Genezen operates out of a 75,000-square-foot, state-of-the-art, cGMP-compliant lentiviral and retroviral vector production facility. Situated in the fast-growing life sciences hub of Indianapolis, the laboratory is the second phase of a larger cGMP-compliant lentiviral and retroviral vector production facility, which will house multiple cGMP production suites with capabilities for host cell expansion and banking and viral vector production.

SERVICES

Process Development

- Transient transfection and plasmid system options
- Producer cell line development
- Plasmid design
- Selection of viral vector platform and cell line for vector production
- Reproducible process design with commercialization approach

Process Optimization

- Upstream and downstream processing
- Proof of concept evaluation runs
- Research cell banks
- Engineering runs at variable scales for further optimization in the process development lab
- Optimized cGMP runs
- cGMP master and working cell bank productions

GMP Vector Production

- Aseptic processing using single-use closed systems from upstream processing to fill and finish
- Adherent cell capability for up to 140L production
- Roller bottles, cell stacks and fixed-bed bioreactor
- Proprietary suspension 293T cell line for up to 200L production
- Single-use/closed systems for virus harvest, purification and concentration
- Access to cGMP compliant master cell banks for common cell lines including HEK293T

Testing

- **Potency:** Biological titers, physical titers (p24), Empty vs Full particle ratio, transduction efficiency
- **Safety:** RCL testing (co-culture and qPCR based), RCR (GALV, ecotropic and direct), endotoxin, mycoplasma, sterility, in-vitro viral assay, PERT
- **Identity:** Vector Copy Number by qPCR, vector insert identity & stability, insertional site analysis, ADA Isoenzyme analysis
- **Stability:** Cell line, viral vector and transgene studies
- **Residual testing:** Benzonase, host cell proteins, host cell DNA, plasmid DNA, E1A qPCR, SV40 qPCR

Cell Manufacturing

- Capabilities across,
  - CAR T, NK, T lymphocytes and other immune cells
  - Hematopoietic progenitors and stem cells, including MSCs
  - Embryonic and induced pluripotent stem cells (iPSCs)
- Enrichment or depletion of specific cell subsets
- Genetic modification (transduction)
- Expansion and differentiation
- Cryopreservation
- Cellular stability studies
- Suspension cell line development
- Producer cell lines

Genezen

Your lentivirus and retrovirus partner

Genezen offers contract process development, GMP viral vector production, transduced cell manufacturing and testing services.

Why Genezen?

Production Capacity

New state-of-the-art, cGMP-compliant multi-vector production facility in Indiana

GMP Vector Manufacturing

Unique expertise in lentivirus and retrovirus production

Process Development

Robust, efficient and scalable processes with in-house assay development

Cell Manufacturing

World-class partnerships to streamline production

Testing

Minimize your time to trial through rapid testing

Solutions to propel your therapies forward.

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gerresheimer

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THE GLOBAL SOLUTION PROVIDER & SYSTEM INTEGRATOR FOR PHARMACEUTICALS & BIOTECH

Gerresheimer is the global partner for pharmaceutics, biotech, healthcare, and cosmetics with a very broad product range for pharmaceutical and cosmetic packaging solutions and drug delivery systems. The company is an innovative solution provider from concept to delivery of the end product. Gerresheimer achieves its ambitious goals through a high level of innovative strength, industrial competence and concentration on quality and customer focus. In developing innovative and sustainable solutions, Gerresheimer relies on a comprehensive international network with numerous innovation and production centers in Europe, America and Asia. Gerresheimer produces close to its customers worldwide with around 11,000 employees and generated annual revenues in 2021 of around EUR 1.5b. With its products and solutions, Gerresheimer plays an essential role in people's health and well-being.

BROADBASED RANGE OF PRODUCTS

The broad range of products and solutions includes pharmaceutical packaging and products for the safe, simple administration of medicines: Insulin pens, inhalers, micro pumps, prefillable syringes, injection vials, ampoules, bottles and containers for liquid and solid medicines with closure and safety systems as well as packaging for the cosmetics industry. The unique and broad range of Gerresheimer products and solutions is found all around the globe, close to the customers, close to the patients. With 37 plants worldwide the company produces in the region, for the region.

DIVISIONS FOR PRIMARY PACKAGING & ADVANCED TECHNOLOGIES

The divisional segmentation of the Gerresheimer Group reflects the specific manufacturing technologies, materials and services used in the divisions' respective products: Plastics & Devices, Primary Packaging Glass and the Advanced Technologies.

Plastics & Devices covers complex, customer-specific products for simple and safe drug delivery and system solutions for liquid and solid medicines and services.

Primary Packaging Glass manufactures glass primary packaging for the pharma and cosmetics industries, as well as specialty glass containers for the food and beverage industry.

Advanced Technologies is the center and hub of innovation for intelligent devices. This division develops smart drug delivery systems for pharma and biotech companies. Its portfolio currently comprises patented micro pumps, which are used to self-administer medication for Parkinson's disease or heart failure, for example. In addition to ongoing evaluation of further projects for the development of smart products, a platform for smart inhalation measurement systems is currently under development.

Gx® Elite Glass Vials

CPHI Frankfurt | November 1–3, 2022 | Frankfurt, Germany | Hall 3, booth 30B21

Improved strength –
minimum 2x–4x standard Type I glass

- Same glass chemistry as Type I
- Cosmetically flawless
- Dimensionally superior

gerresheimer.com

gerresheimer
innovating for a better life

HERMES PHARMA

Get the dose right®

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HERMES PHARMA is the leading expert in developing and manufacturing user-friendly oral dosage forms including effervescent and chewable tablets, instant drinks, lozenges, orally disintegrating granules and HERMES NutriCaps.

ABOUT US

HERMES PHARMA is the leading expert in developing and manufacturing user-friendly oral dosage forms. As a CDMO, we offer customized services along the entire pharmaceutical value chain, from new product development and formulation to manufacturing and regulatory support. For more than 40 years, healthcare companies around the globe have worked with HERMES PHARMA to expand their product lines and grow their brands.

Our sister company HERMES Arzneimittel has a rich portfolio of OTC brands and a long history in pharmaceutical excellence. So, we truly understand the challenges of our customers and can support them on their way to market success.

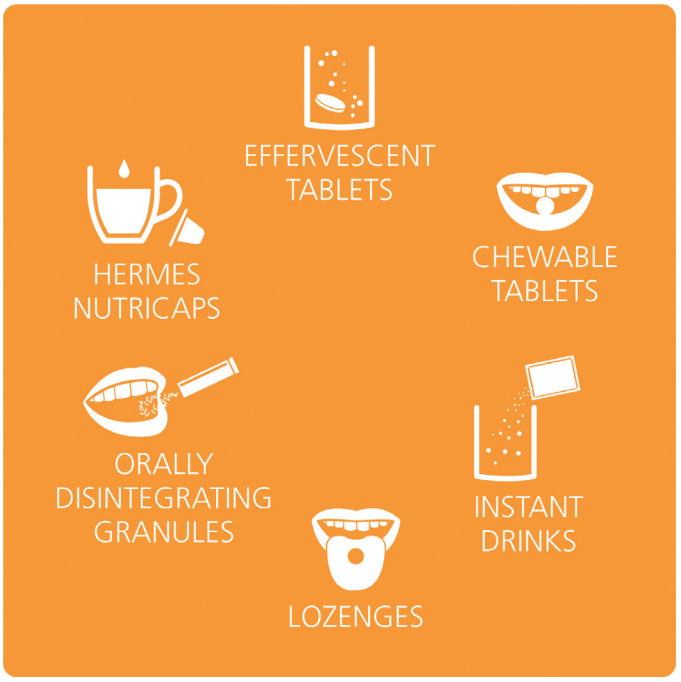
PRODUCTS & SERVICES

We focus exclusively on user-friendly dosage forms and have more than 40 years of experience in this area. The oral route is generally considered a simple and cost-efficient way of drug delivery, primarily using tablets or capsules. However, recent data suggest that difficulties swallowing tablets and capsules are widespread, occurring across all age groups and potentially impacting treatment success. These findings indicate that conventional solid dosage forms may not be the best option for all individuals, and often fail to keep pace with the evolving needs of modern patients.

Our effervescent and chewable tablets, lozenges, instant drinks, orally disintegrating granules and HERMES NutriCaps are user-friendly alternatives to conventional tablets and capsules. They provide an added value to patients and consumers as they:

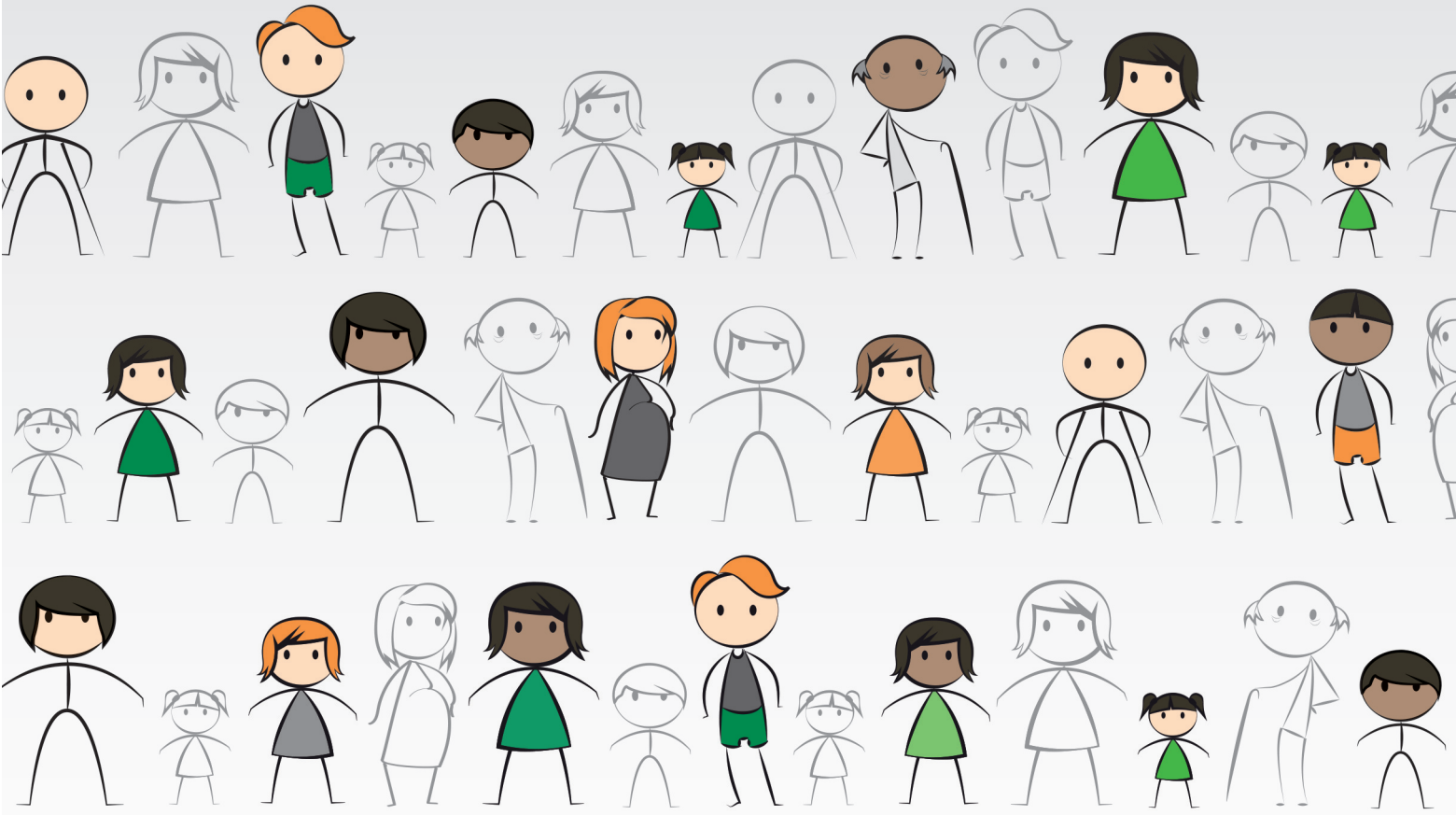
- Are convenient to use and to take.
- Are easy to swallow – even for people with dysphagia.
- Integrate easily into the busy lives of modern patients.
- Can be taken with or without liquids to suit the individual.
- Taste great and offer a variety of choices in terms of flavor.
- Allow greater amounts and different combinations of API to be delivered in a single dose, simplifying treatment regimens.

User-friendly dosage forms help to increase compliance and improve treatment success. Whilst creating a convenient and enjoyable experience for the patient, they also support healthcare companies to revitalize ageing products and boost brand loyalty.



TAKING A PILL IS AS EASY AS PIE?

50% OF YOUR CUSTOMERS WOULD DISAGREE ...



A recent study proves that more than half of the population has problems swallowing tablets and capsules. From breaking and dissolving to not taking them at all, people invent their own strategies to cope with tablets – which may reduce efficacy and treatment success.

At HERMES PHARMA, we have over 40 years of experience in making medicines easier to take – from product design through to manufacturing and packaging. If you need support with developing new products that are specifically designed to meet the needs of modern patients, contact us:
www.hermes-pharma.com

Scan QR-code or visit
www.swallowingtablets.com
to get a free copy of the market study.

HERMES PHARMA

Get the dose right®

LATITUDE: Your Formulation Specialist

LATITUDE Pharmaceuticals is a leading-edge CDMO that provides innovative drug formulation development services and GMP manufacturing for early-phase clinical trials to the human and animal health industries. Founded in 2003, we have completed more than 1,000 client projects and have established a reputation for successfully formulating highly insoluble compounds – the most significant cause of drug development failure.

Formulation Development

LATITUDE's formulation scientists overcome the challenges of difficult compounds, and are the foundation of LATITUDE's reputation for creative approaches, reliability, transparency, rapid turnaround, and client satisfaction. LATITUDE's extensive experience and technical strengths in a wide range of dosage forms are applied to help our clients successfully address even the most difficult formulation challenges including solubility, instability, bioavailability and in vivo adverse reactions. LATITUDE scientists have particular expertise in the formulation of complex injectables including nanoemulsions, liposomes, microspheres and nanoparticles.

LATITUDE has developed the following specialized drug delivery platforms:

- **ClearSol (Solubilization)**
  - A highly effective yet safe way to solubilize a wide range of active pharmaceutical ingredients
  - Successful with a broader range of API than cyclodextrins, and solubilizes to higher concentrations
  - All components are GRAS and FDA-approved for injection
- **PG Depot (Phospholipid Gel Depot)**
  - Allows a customizable sustained-release profile of a subcutaneously administered drug over 1-7 days
  - Injectable through fine (up to 28 G) needles for easy administration
  - Up to 20% drug loading
- **Nano-E (Nanoemulsion)**
  - A versatile solubility-enhancing platform for oral/injectable liquid formulations, also effective to alleviate vein-irritation for injectables
- **ARTSS (Aqueous Room Temperature-Stable Solutions)**
  - Allows the transformation of lyophilized powders or 2-8°C solutions into RT-stable aqueous solutions

GMP Manufacturing

LATITUDE Pharmaceuticals provides GLP- and GMP-compliant manufacturing and analytical testing services – we specialize in rapid customer response and delivery of Phase 1 and Phase 2 clinical trial materials. With a Quality Assurance System managed by experienced and dedicated staff, LATITUDE can GLP or GMP manufacture a variety of dosage forms including sterile injectable or ophthalmic drugs, as well as non-sterile oral or topical formulations, to support GLP toxicology studies or early-stage human clinical trials. LATITUDE is particularly proficient in the manufacture of complex liquid formulations such as nanoemulsions, liposomes, nanoparticles and other controlled-release products.

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Micropore Technologies

COMPANY DESCRIPTION

Micropore Technologies is a global process technology and service provider to the pharmaceutical industry featuring patented crossflow technology for the commercially scalable development of topical and sterile injectable drug products. Originally spun-out of Loughborough University's internationally renowned chemical engineering department, the company's global headquarters and technical center are located at Wilton Center, UK with offices and operations in the USA, India, South Korea & Japan supporting over a hundred clients and strategic partners.

OUR TECHNOLOGY & SERVICES

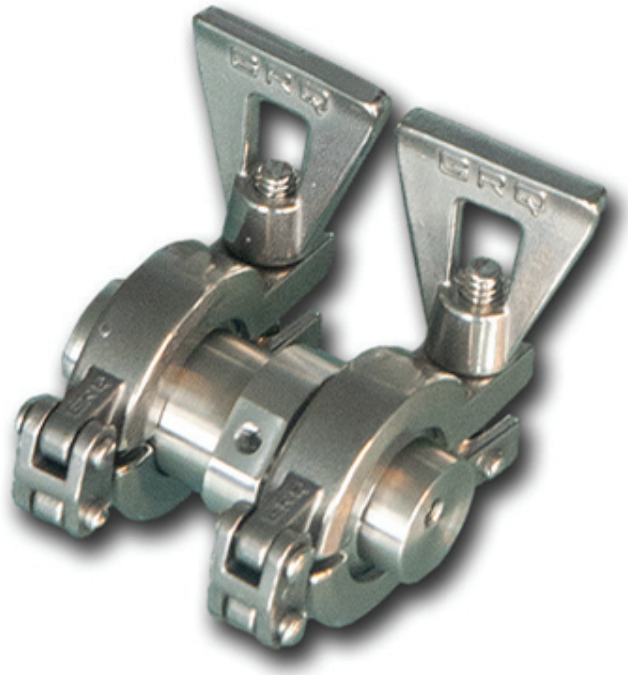
Micropore's technology enables scalable formulation of mono-disperse microspheres, nanoparticles and emulsions. Our array of mixing devices are constructed to operate from early stage high throughput screening on the benchtop to fully integrated GMP manufacturing SKIDs. We offer best in class formulation consultation, in house discovery through preclinical feasibility trials, and process engineering services to supporting the development of commercial manufacturing processes.

Benefits of our gentle mixing approach include:

- Less set-up time, reduced raw materials, and maintenance cost
- Reproducibly uniform drug product
- Reduced use of expensive production additives
- Extremely energy efficient "green" production at all scales
- Higher product yields through less wastage
- No degradation of biologics or primary emulsions

Capabilities

- Early-stage formulation development
- cGMP process consultation and scale-up from lab to commercial
- Pre-clinical batch production
- Aseptic cGMP compliance and validation support
- Particle sizing, shape, and encapsulation efficiency analysis
- Tech transfer of production hardware
- Global technical support and troubleshooting



(Micropore AXF-mini crossflow device).

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Twitter: @microporetech
LinkedIn: linkedin.com/company/micropore-technologies-ltd/

Jubilant HollisterStier is an integrated contract manufacturer of sterile injectables, ophthalmics, otics, and sterile and non-sterile topicals and liquids. Our two facilities in North America provide specialized manufacturing for the pharmaceutical and biopharmaceutical industries. We provide a full-range of support and services to streamline the manufacturing process such as on-site assistance from process qualifications through product release. With over 100 years of manufacturing expertise with a global reach, our team is committed to meeting your project's milestones efficiently.

Our sterile filling lines support:

- Vials (2-100ml)
  - Bulk sizes from 10 l to 2,000 l
  - Lyo capacity from 30 sq ft to 385 sq ft
- Ampoules
- Ophthalmic three piece and preservative free Bottles
- Sterile ointments
- Non-Sterile liquids, ointments, and creams

PARENTERAL MANUFACTURING

Jubilant HollisterStier offers sterile and non-sterile manufacturing services for Phase II through Commercial liquid and lyophilized products. In addition, the Montreal facility offers a wide array of non-sterile manufacturing services for ointments, creams, gels, and liquid products. Our flexible filling lines support packaging into bottles, tubes, and pumps.

NEW

Jubilant HollisterStier announces a $193 million investment at is Spokane, Washington, manufacturing facility, the addition of two new high-speed filling lines with isolator technology along with two lyophilizers per line. The first line will be commercially available starting in early 2024 and the additional line 18 months later.

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Manufacturing & Services
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W: www.jublhs.com

KAHLE AUTOMATION
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KAHLE®
Manufacturer of Automation Equipment
A BBS AUTOMATION COMPANY

KAHLE AUTOMATION S.R.L.
Viale Europa Unita, 57
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E: Kahle@Kahle.it

If you're looking for an automation partner who understands the precision and care required to manufacture the world's finest drug delivery devices, consider **Kahle Automation**, Engineering Excellence since 1920 and now a part of the BBS Automation family.

BBS Automation strengthens MedTech/Life Sciences capabilities with acquisition of Kahle Automation S.r.l.
Federico Ceresetti, CEO Kahle Automation: "Partnering with BBS Automation was the logical next step in Kahle's development." With access to BBS' global reach and market leading reputation, BBS will support Kahle on larger projects and continue its successful growth trajectory by leveraging manufacturing and service capabilities on three continents.

CELEBRATING OVER 100 YEARS. Kahle is the only large-scale automation company in the world that focuses exclusively on custom automated assembly equipment for medical and pharmaceutical devices. For over a century, Kahle has shaped the industry through the use of innovative technologies. Today, we create systems that handle, assemble, inspect, test, and package every medical device imaginable – from syringes, tubing sets and catheters and needle products to diagnostic, pre-filled and combination pharmaceutical devices.

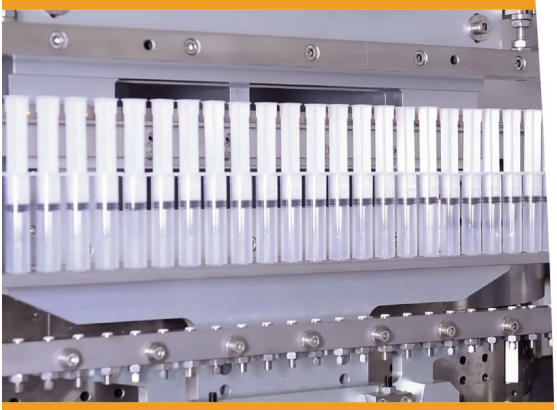
Safety and quality go hand-in-hand with a successful automation project. All of our work is guided by GAMP 5 and ISO 9001 quality standards, and we work with our customers to help them meet FDA 21 CFR Part 820 and Part 11 regulations.

Engineering Excellence requires an automation partner who brings the best technology to your project.
Regardless of whether you're looking for a system that assembles thousands of devices per minute, improves the quality and consistency of your manufacturing process, or whether you're simply trying to maximize the space in your clean room, Kahle has the technical solutions to meet your goals.

Every year, Kahle dedicates over 182,500 man-hours to designing automation systems that manufacture medical devices. This effort has resulted in the largest portfolio of proprietary automation technology in the entire industry. From this portfolio, you can choose from continuous, indexing, and asynchronous motion assembly platforms that feature the latest innovations in mechanical, pneumatic, and robotic assembly with premium inspection and process control operations. This flexibility allows us to create cost efficient, effective systems for projects of every size.

Engineering Excellence requires an automation partner that guarantees performance.
Beyond creating the ideal assembly system for your project, your Kahle team is also focused on getting your machine validated promptly and transitioned efficiently into production. Further, we want to make it easy for your employees to be trained to operate and maintain the equipment. To these ends, your Kahle machine arrives with the best quality and validation documentation in the industry.

Kahle® is dedicated to providing custom automation machinery solutions for the Medical Device, Pharmaceutical, and Healthcare Industries around the world.



Our ideas just got a whole lot brighter

We've merged with BBS Automation

Announcing a partnership in automation equipment that brings a whole new light to medical and pharmaceutical device manufacturing.

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Manufacturer of Automation Equipment
A BBS AUTOMATION COMPANY

Visit www.KahleAutomation.com
or contact Kahle@KahleAutomation.com

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Lonza

Capsules & Health Ingredients

Lonza CHI is a preferred global partner to the pharmaceutical, biotech and nutraceutical markets. Our pioneering Capsugel® capsules and encapsulation technologies help improve speed of development and execution and the match of dosage form performance to ingredients or API application.

Our product portfolio and product services for pharmaceutical partners include:

- Capsules including customizations
- Equipment
- Ingredient/API formulation services

We work to prevent illness and promote a healthier world by enabling our customers to deliver new and innovative medicines that help treat a wide range of diseases. We achieve this by combining technological insight, with world class formulation, manufacturing, scientific expertise and process excellence.

With roots back to Lonza, and InterHealth Nutraceuticals, Lonza CHI has been a health ingredient and capsule manufacturing pioneer and trusted partner for leading global pharmaceutical and nutraceutical companies for more than 100 years.

This experience and expertise have allowed us to become an industry leader in providing innovative and reliable capsules and science-backed ingredients for use in a variety of pharmaceutical and nutraceutical applications around the world.

Our comprehensive products and services offering can be tailored to meet the needs of your development lifecycle by helping you design, optimize and manufacture differentiated dosage form solutions to meet growing and expanding patient and consumer requirements.

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W: www.lonza.com/capsules-health-ingredients

Lonza
Capsules & Health Ingredients

The next generation **enteric capsule** is here.

Discover the Capsugel® Enprotect™ capsule: Bi-layer manufacturing technology.

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- → Targeted enteric drug delivery
- → Acid protection
- → Customizable and scalable

https://go2.lonza.com/enprotect.html

LYOPHILIZATION TECHNOLOGY, INC.
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T: (215) 396-8373 F: (215) 396-8375
E: inquiry@lyo-t.com W: www.lyotechnology.com

WHO WE ARE

Lyophilization Technology, Inc. (LTI) is a Contract Development & Manufacturing Organization (CDMO) focused on all aspects of lyophilization for preparation of health care products.

Clients leverage on our abilities for bringing new products to the clinic and implementing improvements for current products. Capitalize on over 25 years of excellence and our unparalleled capabilities in product development, process engineering, clinical manufacturing, and technical support.

MAJOR MARKETS

Biotechnology and pharmaceutical organizations spanning virtual companies to large multi-national corporations, along with universities and research institutes have engaged our support in successful collaborations for a variety of projects. These projects span initial product and process development for new entities right out of drug discovery through Phase I/II clinical material, to technology transfer to commercial manufacturing with regulatory approval. Gaining a global reputation, LTI has been sought after and completed projects with clients in the European, Middle East, and Asian Pacific regions, as well as North America.

SERVICES OFFERED

Capabilities

- Pre-clinical through Phase II Clinical Materials
- Bulk Lyophilization
- Dedicated/disposable equipment
- Batch sizes: up to 75L
- Vials: 2 to 160 mL
- Dual Chamber cartridges and syringes: 1 to 20 mL
- Novel delivery systems
- Nucleation On-Demand Technology
- DEA license
- US/EU compliant

LTI successfully develops formulations, processes or prepared clinical material for many diverse products, including:

- Biologics (up to BSL-2)
- Oncolytics
- Liposomes
- Anti-Infectives
- Peptides/Polypeptides
- Proteins/mAbs
- Diagnostics
- Nanoparticles/Emulsions
- Vaccines and VLPs
- Controlled Substances
- Highly Potent Compounds
- Antibody Drug Conjugates
- Devices/Delivery Systems
- Small and Large Molecules

Development Sciences

Development Sciences focuses on formulation through finished product characterization. The Process Lab provides capacity for small to medium scale lyophilization. Filtration, filling, stoppering, and loading the qualified pilot-scale lyophilizers are in certified Class A/100 environments, emulating aseptic manufacturing conditions.

- Product Design
- Formulation Development
- Thermal Analysis
- Cycle Design/Refinement
- Product Characterization
- Pilot Plant Scale-up
- Isolation/Containment
- Cartridges

Clinical Manufacturing

US/EU compliant Clinical Manufacturing Area (CMA) for preparation of clinical material enables us to process a wide range of products, including those having unique requirements. The CMA includes an aseptic suite featuring advanced containment/isolation technology using unique disposable negative pressure isolators inspected and approved for handling BSL-2, cytotoxic and highly potent compounds. LTI has also developed the technology that allows us to freeze dry product in both dual chamber cartridges and pre-filled syringes.

- Aseptic compounding
- Pre-clinical through Phase II
- Toxicology Material Processing
- Small to medium batch sizes
- Liquid/diluents
- Dual chamber cartridges/syringes

Technical Services

Technical services are available providing support for all aspects of lyophilization.

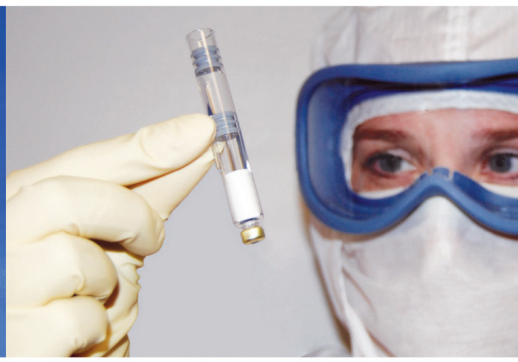
- Customized Training
- Consulting on equipment specifications
- Process requirements
- Guidance on CMC submission
- Support on IQ/OQ and process validation
- Technology transfer
- Process excursions
- Product and process troubleshooting
- Batch record review
- Compliance auditing

Lyophilization TECHNOLOGY Inc.

Integrating Science and Technology

The industry leader with unparalleled capabilites, innovative approaches and effective solutions.





DEVELOPMENT SCIENCES • CLINICAL MANUFACTURING

CONSULTING AND TRAINING

Product Design • Formulation Development • Thermal Analysis • Boundary Studies

Process Engineering • Dual Chamber Processing • Clinical Material Preparation

Quality and Regulatory Support • Technical Services • On-site Training • Consulting

LYOTECHNOLOGY.COM

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Twitter: @MilliporeSigma
Facebook: @MilliporeSigma
LinkedIn: www.linkedin.com/company/milliporesigma/

An Industry-Leading Portfolio of Formulation Products

Our portfolio of formulation products includes excipients for solid, semi-solid and liquid dosage forms for small and large molecules, allowing you to formulate APIs to your exact specifications and requirements. We offer customized manufacturing, formulation services and a standard portfolio of synthetic lipids and functionalized PEGs, biodegradable polymers for sustained release and functional excipients for excellent performance in tableting processes, solubility enhancement and controlled release.

Drug Delivery

Our offering for mRNA synthesis workflow includes products that can be used from generating plasmid DNA to synthesizing mRNA and finally to purifying mRNA as well as integrated CDMO capabilities that include the development and manufacturing of custom mRNAs. Our portfolio of lipids and custom lipid synthesis services help you bring your formulation to scale.

We provide high quality portfolio products as well as customized solutions to meet your specific drug delivery and formulation needs. At every phase of clinical development and commercialization, we have the resources and expertise to support your critical development milestones. We offer regulatory expertise and support to help you meet today's complex regulatory challenges.

Liquid Formulation

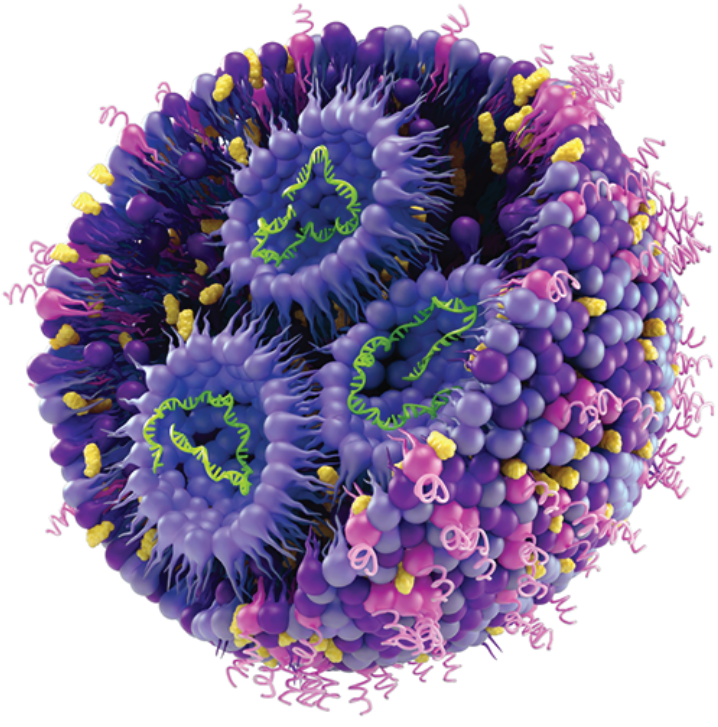
Our broad portfolio of high-quality excipients for both small molecule and large molecule formulations allows you to target different administration routes such as ophthalmics, nasal, parenteral, oral, and otic preparations. Specifically developed for high-risk biopharmaceutical applications, we offer a wide range of buffers, salts and stabilizers low in bioburden and endotoxins as well as our Viscosity Reduction Platform to enable subcutaneous formulation of highly concentrated protein biologics, bringing together increased concentrations and improved downstream processing. And to help you minimize regulatory and quality-associated risks, all of our excipients are supported by extensive documentation via the industry-leading Emprove® Program. Explore our portfolio of excipients for liquid formulation on our website.

Solid Formulation

Our high-quality raw materials and functionalized excipients form a comprehensive portfolio that addresses all your most pressing challenges in solid formulation manufacturing, with products that include: antioxidants and preservatives, binders and fillers, coatings and supporting material, disintegrants, lubricants and glidants, pH adjusters, surfactants and stabilizers, and taste modifiers.

Our particle optimized Parteck® functional excipients, for example, are specifically developed to address formulation challenges in solid dose, featuring unique particle properties and outstanding individual functionalities. The result is excellent tableting behavior and simplified formulation design, so you can speed your product to market.

In addition, you can rely on our industry-leading Emprove® Program to meet today's complex regulatory challenges with a superior combination of comprehensive documentation and transparency. Our high-quality raw materials, regulatory expertise, and dedicated support provide everything you need to simplify supplier qualification, speed up processes, and reduce your total cost of ownership.



MilliporeSigma

Unique solutions for complex formulation challenges

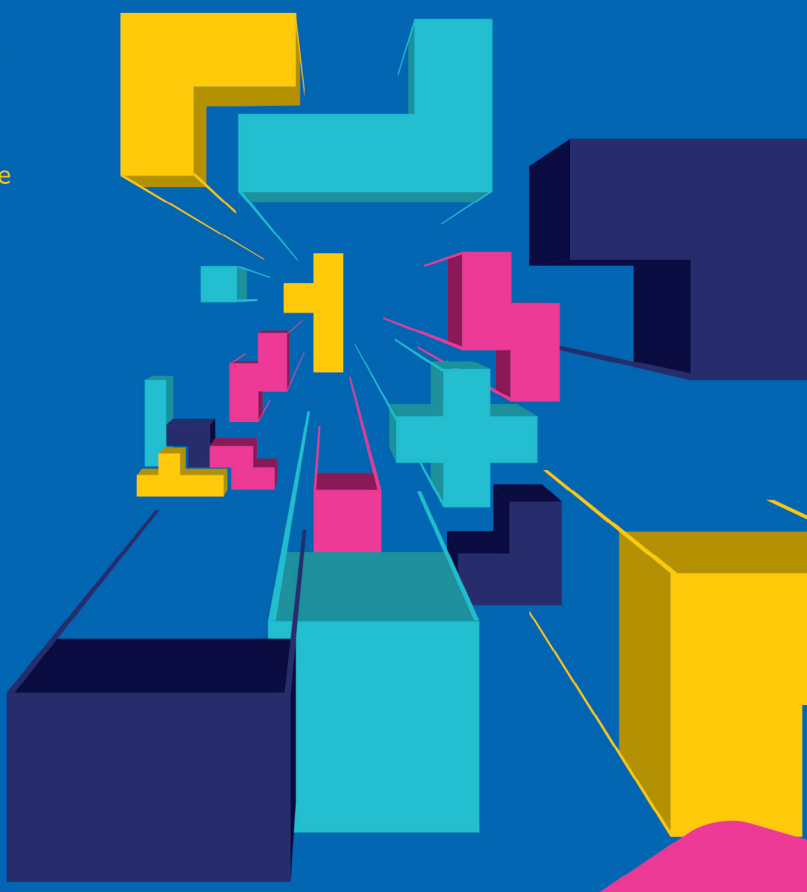
Don't block in. Break through.

Novel modalities, preferred routes of administration to ensure patient compliance, and improved release kinetics are changing the playing field. And these new challenges call for new formulation solutions.

With a proactive excipient partner, you are not alone on your journey, and you will know which variables to change and which to keep the same.

Gain greater control in your formulation game:

- Global application labs and consultative services
- Specialized excipients for controlled release and solubility enhancement
- Customized solutions for advanced drug delivery



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Pharma & Biopharma Raw Material Solutions

MITSUBISHI GAS CHEMICAL

Mitsubishi Gas Chemical (MGC) is a leading company in the field of oxygen barrier and absorbing polymers. Based on these technologies and experiences, MGC launched new multilayer plastic vial named OXYCAPT™ in 2019. It has achieved excellent oxygen and ultraviolet (UV) barrier, high water vapor barrier, very low extractables, high pH stability, low protein adsorption, high transparency, high break resistance, easier disposability, lighter weight, etc.

Products

OXYCAPT™ consists of three layers. The drug contact layer and the outer layer are made of cyclo-olefin polymer (COP), and the oxygen barrier layer is made of MGC's novel polyester.

The oxygen barrier of OXYCAPT-P vial is about 20 times better than that of COP monolayer vial. OXYCAPT™ also provides an excellent UV barrier. While about 70% of 300-nm UV light transmits through glass and COP, only 1.7% transmits through OXYCAPT™. The OXYCAPT™ vial is produced by co-injection blow-molding technology. MGC has also developed inspection methods for testing the oxygen barrier layer. All of the containers are fully inspected by state-of-the-art inspection machinery. MGC can offer bulk and ready-to-use (RTU) vials. The RTU vials are provided in ISO-based nest and tub formats. The nest and tub are mainly sterilized using gamma rays. There are 2-, 6-, 10-, and 20-mL variants for vials. MGC is pleased to consider customizing the shape and size if there is a request from customers.

In addition to the advantages of COP, such as a strong water vapor barrier, high break resistance, very low extractables, and low protein adsorption, OXYCAPT™ also provides strong oxygen and UV light barrier. MGC believes OXYCAPT™ offers a lot of benefits to the rapidly growing field of biologics and gene/cell therapies.

MITSUBISHI GAS CHEMICAL COMPANY, INC.
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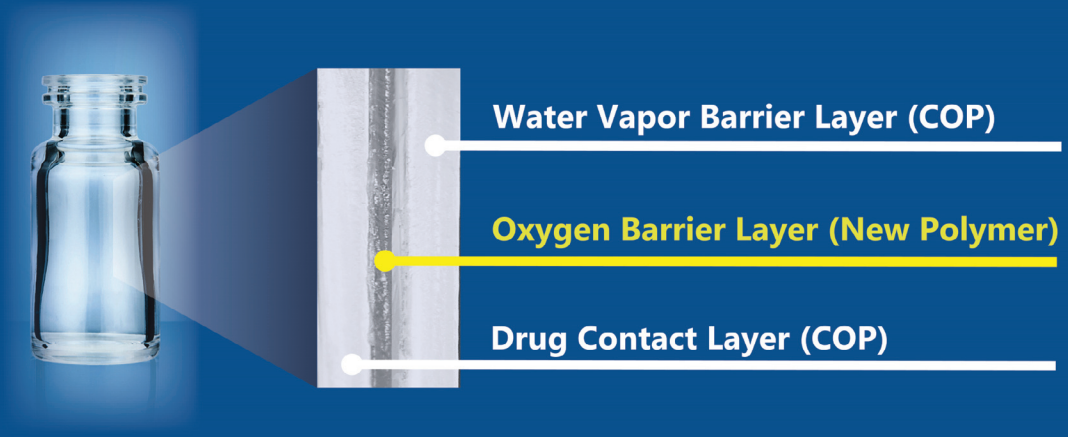
W: https://www.mgc.co.jp/eng/products/abd/oxycapt.html

OXYCAPT™ Multilayer Plastic Vial

Multilayer Structure



- Excellent Oxygen Barrier
- High Water Vapor Barrier
- Very Low Extractables
- Low Protein Adsorption
- Excellent Ultraviolet Barrier
- High Break Resistance
- High pH Stability
- Gamma-sterilized Vial
- For Biologics & Regenerative Medicine
- Customizable

2, 6, 10, 20mL Vial

Nest & Tub for Vial

MITSUBISHI GAS CHEMICAL

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Mitsubishi Gas Chemical America, Inc.
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Mitsubishi Gas Chemical Europe GmbH
https://www.mgc-europe.de

NEMERA
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E: information@nemera.net W: www.nemera.net

As a world-leading drug delivery device solutions provider, Nemera's goal of putting patients first enables it to design and manufacture devices that maximize treatment efficacy. **Nemera** is a holistic partner and helps its customers succeed in the sprint to market with its combination products. From early device strategy to state-of-the-art manufacturing, Nemera is committed to the highest quality standards. Agile and open-minded, the company works with its customers as colleagues. Together, they go the extra mile to fulfil its mission.

NEMERA IS YOUR HOLISTIC PARTNER FOR THE COMBINATION PRODUCT JOURNEY

From device selection through product lifecycle management, Nemera is your single partner for the whole of the combination product journey. By focusing on solutions that make patients' lives easier and safer, Nemera has built a strong portfolio of innovative products and technologies. To complement the products portfolio, **Nemera also offers end-to-end services and expertise in device development, device consulting, and contract manufacturing** to help you through every step of the journey. Nemera applies this know-how and its singular focus on healthcare to realize its vision of becoming the most patient centric drug – device company in partnership with our customers.

OPHTHALMIC: A CLEAR VISION FOR EYE CARE

One of the main criticalities of self-administered eye care treatments today is poor patient adherence, especially with chronic diseases. We strive to improve patient experience by providing safe and effective multidose eyedroppers for preservative-free solutions, used all over the world: **Novelia®** is a preservative-free multidose eye dropper delivering consistent drops for better patient compliance.

NASAL, BUCCAL, AURICULAR: MAKE EVERY SPRAY COUNT

The number of drugs delivered through the ear, nose and throat is expanding. We provide a comprehensive range of pumps, compatible with a wide choice of actuators for each delivery route (ear, nose and throat), suitable for regulated and low regulated markets: **multidose pump systems (SP270+, SP370+, SP27, SP37, In-vitro Bioequivalence for nasal sprays, Child-resistant solutions), unidose systems (UniSpray), Retronose®, and electronic technologies (Safe'n'Spray™ and Electronic Nasal device)**. We guarantee precision and dose consistency to maximize treatment efficacy and improve patients' outcomes.

DERMAL: CONVENIENT FOR PATIENTS, PROTECTIVE FOR FORMULATIONS

The dermal application is a convenient non-invasive way to administer liquid sprays, lotions, gels, or creams to the skin for dermatological, anti-inflammatory or systemic treatments. Our airless and atmospheric delivery devices are suitable for RX and OTC formulations and have all the documentation needed to be registered on regulated markets: Sof'Bag®+, Sof'Airless, Spray pumps for vicous formulations and Child Resistant Closure systems.

PARENTERAL: COMPLEX DEVICES, SIMPLE PATIENT CARE

The growing prevalence of chronic diseases, along with the evolution of self-administration at home, is driving new ways of administrating parenteral drugs. As injecting a drug means increased risks of use errors and needlestick injuries, self-administration at home translates into a need for safer, easy-to-use and ergonomic devices. We are committed to ensure adherence and user well-being for patients and healthcare professionals providing a comprehensive parenteral product range that matches their need: **Passive Safety Systems (Safe'n'Sound® 1ml and 2.25ml), Reusable and Disposable Pen platforms, Implanters, and Body injectors (Symbioze®).**

INHALATION: A BREATH OF EXPERTISE

From the concept idea to large scale manufacturing, we're the utmost holistic partner to develop your inhalers. We help our customers succeed in the sprint to market with their formulations targeting the inhalation treatments. We also are an active contributor to the scientific community and we strive to consider in our research evolving trends in inhalation and in patient needs, as well as increasing interest to digital and sustainability related factors.

OVR (ORAL, VAGINAL, RECTAL)

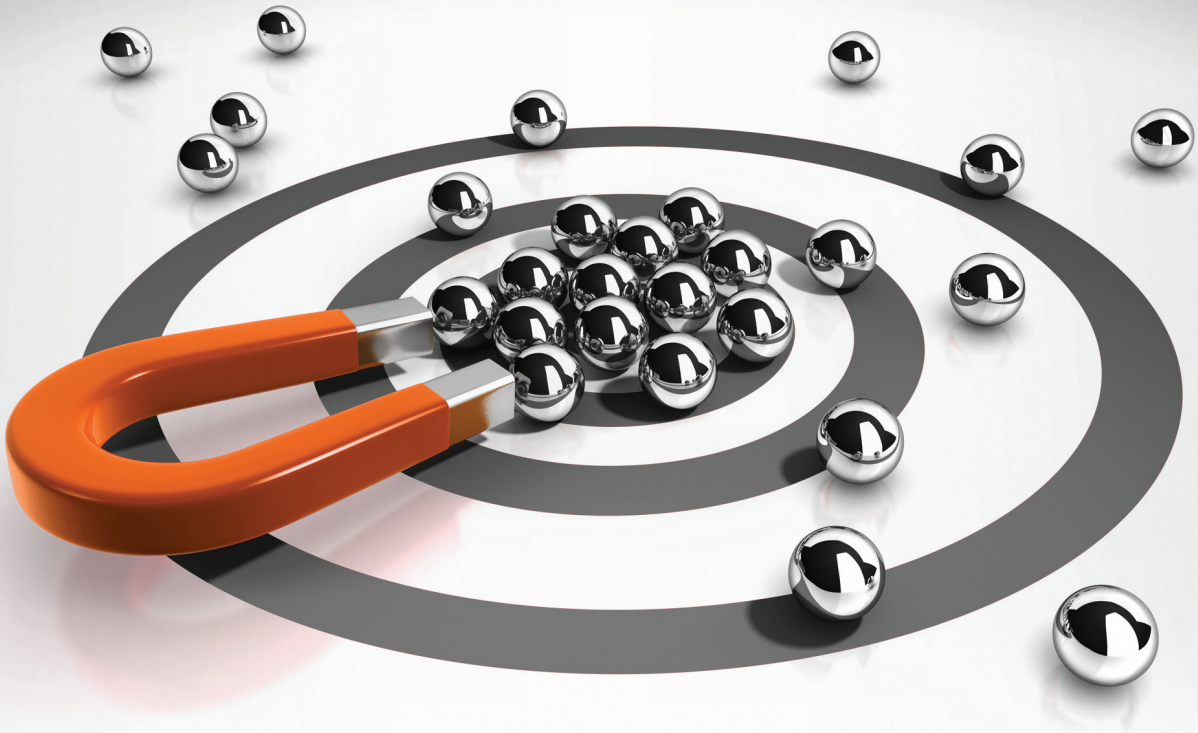
We offer millimeter solutions in medicine applicators and dispensers, being today a global reference for quality and precision in this segment. Our systems aim to be used for oral, vaginal and rectal treatments, such as Oral infections, Vaginal infections, and Rectal diseases.

Nemera

we put patients first

Your Drug Delivery Device Solutions Partner

SMART MARKETING
ATTRACTS THE RIGHT REACTION



Your go-to-market strategy deserves a strong marketing plan.
Element Six can help you hit your mark.

Effective marketing strategies start with **insight, analysis, and expertise—** this leads to methodically formulated creative solutions.

Element Six (e6) specializes in telling your story, developing marketing tools and content that draws the response your business needs.

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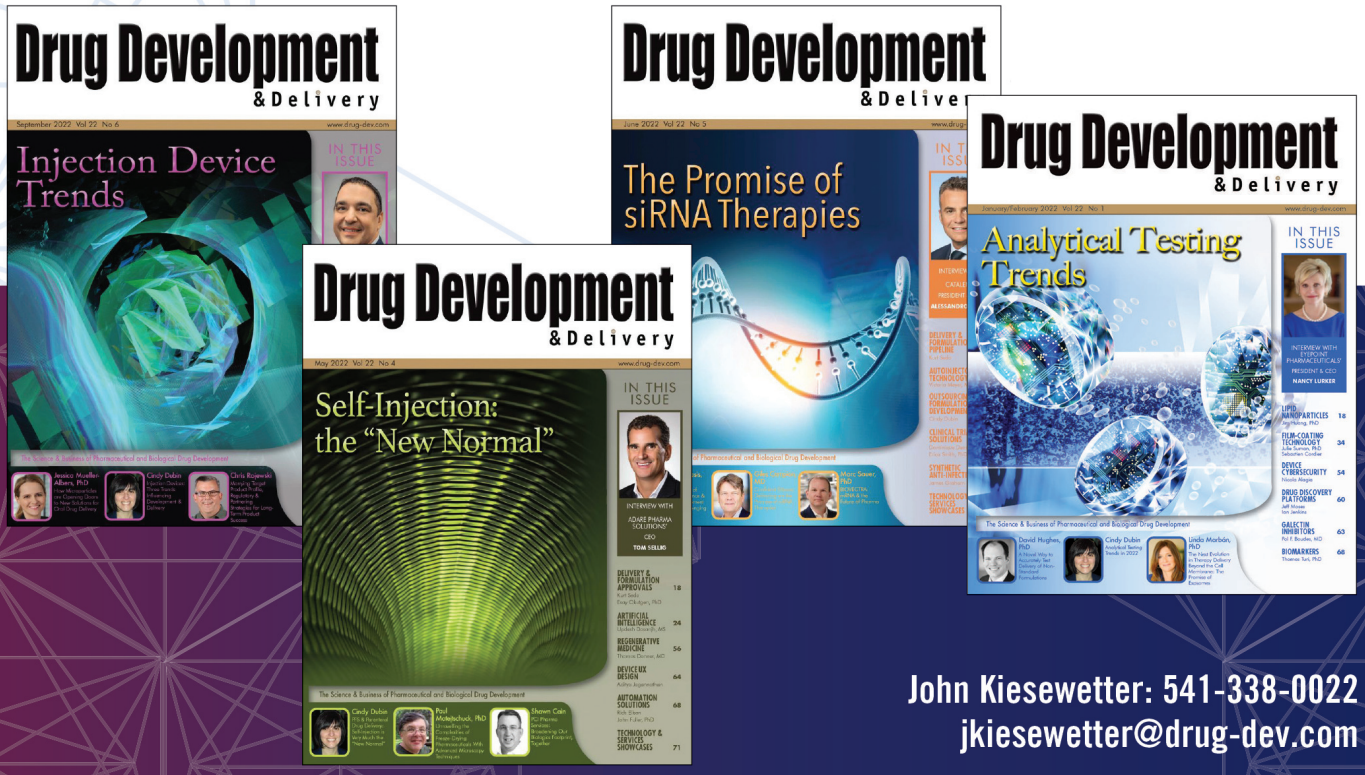

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Design & Manufacturing Group

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W: oneworlddmg.com
Linkedin: https://www.linkedin.com/company/one-world-design-manufacturing-group/

Injection Training Pioneers

One World DMG is a leading designer and manufacturer of injection trainers and patient onboarding materials for the pharmaceutical and biopharmaceutical industries. For 25 years we've pioneered the development of injection training tools that provide the most authentic injection experience possible. Our trainers have proven effective both in the medical setting and in patients' homes, where comfort with self-injection is crucial to adherence and better health outcomes.

Why Partner with One World DMG?

Our award-winning team has become synonymous with expertise and innovation. Our clients have come to trust our design and engineering solutions to optimize their injection training programs by providing tools that will support the success of their brands. That trust has culminated in the injection trainers we've created for 50 brands – across all platforms including autoinjectors, pen injectors, pre-filled syringes, wearables, transdermal patches, and respiratory devices.

At the core of the company is its people. Since 1984, our employees have been selected from among the very best in their respective fields. Finely tuned as a team, they are unparalleled in design, engineering, project management and creative excellence.

One World's in-house team includes:

- Principal Mechanical Engineers
- Project Managers with Med Device Backgrounds
- Senior Industrial Designers
- Graphic Designers & Animators
- Board Certified Medical Illustrators

Offerings

Projects are supported from initial design concept to manufacturing and distribution and at every step in between. Along with design and manufacturing, One World DMG offers services for design verification, human factors support, mechanical design engineering, prototyping, validation, automated assembly, and supply chain management.

Patient Onboarding

The importance of helping patients as they begin their self-injection treatment is widely understood by the healthcare community. Successful training programs support the patient with tools that educate by providing the whys and hows of treatment and help build confidence and reduce fears.

In addition to our injection trainers, One World DMG's onboarding offerings include:

- Patient Starter Kits
- HCP Injection Demonstration Kits
- Injection Trainer Packaging
- Instructions For Use/Quick Reference Guides
- Training Videos & Animations
- Injection Demonstration Models

One World DMG has been designing powerful patient education and training materials since 1984, offering IFUs that are thoughtfully written and produced. We believe the real value of a well-executed user-friendly IFU can't be underestimated. Teaching patients and healthcare providers how to easily understand and use your product is not only critical to compliance and better health outcomes, but to the user experience in general – and ultimately the perception of your brand.

WE PIONEERED INJECTION TRAINING AND CONTINUE TO LEAD THE WAY.

injection trainers

Design & Engineering • Project Management

25 years of experience making injection trainers coupled with our expertise developing patient onboarding materials is what sets One World DMG apart. Clients trust our design and engineering solutions will provide the best patient experience possible in the medical setting and more importantly... at home where it's needed most.

We've created injection trainers for 50 brands across all platforms. Let us put our innovation to work for you. Contact info@oneworlddmg or visit us at oneworlddmg.com.

one world™
Design & Manufacturing Group

Owen Mumford

Pharmaceutical Services

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E: pharmaservices@owenmumford.com
W: www.ompharmaservices.com

With more than 70 years' experience in medical devices, **Owen Mumford Pharmaceutical Services** is a division of Owen Mumford, with the Head Office located in Woodstock, UK. Our global presence extends from manufacturing facilities in the UK and Malaysia to subsidiaries in the US, Germany, and France.

Owen Mumford Pharmaceutical Services specialises in the design, development, and manufacture of injectable drug delivery systems for the pharmaceutical, biotech, and generics industries. Our trusted devices are used daily in the delivery of various medications for a multitude of conditions across the globe.

Our product portfolio includes single- and multi-dose reusable and disposable auto-injectors, pens, and syringes for subcutaneous and intramuscular administration. Our flagship products include the UniSafe® platform, a spring-free, passive safety device for 1ml and 2.25ml pre-filled syringes. The platform also includes UniSafe® 1mL Auto-injector, a reusable, mechanical, companion auto-injector for UniSafe® 1mL safety syringe available with optional connectivity, currently in development. UniSafe 1ml has regulatory approval as a combination product in Asia and Europe, where it is also in patient use.

Our most recent innovation is the two-step single-use auto-injector Aidaptus®. Aidaptus can be used for both 1ml and 2.25ml syringes in the same base device. It can also readily adapt to different fill volumes using auto-adjust plunger technology, providing a solution for formulation changes during development and lifecycle management.

Aidaptus has an innovative, patient-centric design with automatic needle insertion that provides a simple and consistent user experience. The stopper sensing technology, coupled with the independent, two-phase needle insertion and drug delivery, significantly reduces any impact forces on the syringe, mitigating the risk of syringe breakages during use. With a needle that is shielded before, during, and after use, Aidaptus provides reassurance to users who are new to auto-injectors, as well as those who experience needle phobia. It can also give users confidence that the injection has been successfully completed with an audible notification at the start and end of the procedure.

Owen Mumford Pharmaceutical Services has an exclusive agreement with Stevanato Group, a global provider of drug containment, drug delivery, and diagnostic solutions. Stevanato Group is our manufacturing partner for the Aidaptus auto-injector, moulding the components for the device and also providing final and sub-assembly equipment. Our collaboration aims to reduce supply chain complexity and reduce risk in combination product development for our pharmaceutical partners.

Owen Mumford Pharmaceutical Services also has an alliance with Noble International, providing patient-focused training devices for both UniSafe and Aidaptus.

Our products are supported by our services, and we work with our pharmaceutical partners every step of the way, assisting them throughout their combination product development.

Aidaptus®

2-step single-use auto-injector platform

Available now

Versatile design

intuitive delivery

Your fill volume may change, with Aidaptus® **auto-adjust plunger technology** your auto-injector doesn't need to

Accommodates both 1mL and 2.25mL glass syringes in the same device

See our auto-adjust plunger technology in action

Find out more by scanning the QR code or visiting **ompharmaservices.com/dd&d-dec2022**

Now in collaboration with Stevanato Group

*In addition to an air bubble and overfill

OMPS/ad/dd&d/ob/1022/7

Owen Mumford Pharmaceutical Services

1952–2022 INTO THE FUTURE... WITH CONFIDENCE AND CONSCIENCE

PACE® LIFE SCIENCES –
PEOPLE ADVANCING SCIENCE
HQ: 1311 Helmo Avenue North
Oakdale, MN 55128
T: 612-656-1175
W: www.pacelifesciences.com

ADDITIONAL CDMO/CRO NETWORK SITE LOCATIONS:
Boston, MA
Salem, NH
San Diego, CA
Norristown, PA
Ann Arbor, MI
South New Berlin, NY
San German, PR

PHARMACEUTICAL CMC DEVELOPMENT (CDMO)

PEOPLE ADVANCING SCIENCE

Pace® Life Sciences provides a full suite of contract CMC development, CTM manufacturing, regulatory compliance, consulting, and facility support services to the pharmaceutical, biopharmaceutical, and gene therapy industries. Pace® Life Sciences operates from a network of CDMO sites, GMP analytical testing laboratories, and manufacturing support service centers across the United States. Our experienced, highly trained industry experts, and our investment in state-of-the-art development and manufacturing facilities emphasizes our commitment to efficiently advancing client programs through the clinic to commercialization. We are dedicated to delivering the best and most reliable services with positive customer experiences across all channels of our business.

Our Pharmaceutical Development laboratories in Boston, MA, Salem, NH, San Diego, CA, Philadelphia, PA, and Ann Arbor, MI, provide IND-enabling services to help new therapies progress through the pre-clinical stages, to include: Characterization of new synthetic small molecules, biologics such as proteins, peptides, antibodies, antibody drug conjugates, and gene therapies such as oligonucleotides. Early phase development services include lyophilization process development, spray-drying, phase-appropriate analytical development, Test Article preparation, and Clinical Trial Materials (CTM) manufacturing and packaging services.

Technology transfer to our state-of-the art GMP testing facilities enables our clients to seamlessly and confidently advance their programs from preclinical and clinical studies to commercialization in a manner compliant with regulations and industry standards. Strategic partnering with Pace® is a key accelerator for getting your products to market on time and on budget. We provide a real and tangible difference to your customer experience by combining all essential service elements:

Comprehensive Scope of Services: A broad scope of services to support you from early characterization and Pharmaceutical Development through marketed product support.

PHARMACEUTICAL DEVELOPMENT

- Characterization of Novel Molecules & Biologics
- Solid State and API Characterization
- Formulation Development
  - Long-Acting Injectables
  - Lyophilization
  - Hot-Melt Extrusion
  - Spray Drying
- Clinical Supplies Manufacture (Sterile & Non-Sterile Capabilities)
  - Sterile Aqueous Products
  - Ophthalmic
  - Tablets/Capsules
  - Solutions, Suspensions, Ointments, Creams Clinical Packaging

ANALYTICAL METHOD DEVELOPMENT

GMP Laboratory Testing

- Raw Materials Clearance Programs
- Methods Development & Validation
- In-process & Finished Product Testing
- ICH Stability Programs
- Reference Standards Programs
- Extractables/Leachables
- Elemental Impurities
- Physical-functional Testing
- Microbiology Testing Services
- Commercial Product Support

Facility Services

- Facility Commissioning & Qualification
- Critical Utility Qualification
- Equipment Services
- Laboratory Relocations

Consulting Services

- Regulatory Strategy & Agency Support
- Quality & Compliance Consulting

Capacity: Pace® is committed to providing services to all clients, large or small. Our flexible response to demand provides various service models to include fee-for-services, dedicated resource programs, full-time equivalent (FTE) model on-site at Pace®, and/or FTE programs at the client site, which allow for economical options to meet business demands.

Quality: Our facilities have long histories of successful regulatory agency, client, and third-party audits. High-quality data and information provides the confidence you need to advance your products quickly.

Reliability: Our integrated services ensure critical path demands stay on schedule.

Pace®

LIFE SCIENCES

People Advancing Science™

We advance the science of our pharmaceutical and biopharmaceutical customers through the drug development process; from early-phase R&D through clinical trials and GMP commercial product support. For customers with in-house manufacturing and labs, Pace® provides professional services to support their operations.

- Characterization of Novel Compounds
- Formulation Development
- Process Development
- GMP Clinical Trial Material Manufacturing
- Spray Drying
- Lyophilization
- Commercial Product Support
- GMP Central Laboratory Testing
- Facility Commissioning & Qualification
- Critical Utility Qualification
- Equipment Services
- Laboratory Relocations
- Regulatory Strategy & Agency Support
- Quality & Compliance Consulting

See how Pace® can be the best solution for your projects.

www.pacelifesciences.com

PCI Pharma Services

PCI is as a leading global CDMO, truly spanning the cycle, connecting development and commercialization, de-risking the supply chain providing clients with integrated end-to-end drug development, manufacturing and packaging capabilities that increase their products' speed to market and opportunities for commercial success.

PCI brings the proven experience that comes with more than 90 successful product launches each year and over five decades in the healthcare services business. Leading technology and continued investment enable us to address global outsourcing needs throughout the product lifecycle.

PCIs offers a global network of innovative centers of excellence for the development, manufacturing, packaging, storage and distribution of life-changing therapies. Our specialist contained manufacturing and packaging facilities dedicated to processing highly potent drug products combined with our renowned lyophilization and sterile manufacturing capabilities are complemented by a global network of packaging sites. Our aim is simple, to accelerate your product from development to commercialization as efficiently and cost-effectively as possible.

Drug Development & Manufacturing Solutions

PCI offers full service formulation development including analytical development/characterization of sterile and non-sterile dosage forms. Our scalable development and manufacturing capabilities for tablets, capsules, gels, ointments, liquids, sterile and lyophilized drug products, aid delivery of life-changing therapies to patients from early phase clinical trials through to commercialization.

Clinical Trial Services

PCI provides a global service with localized focus, delivering over 200 protocols a year in over 100 countries, utilizing best-in-class technologies combined with our experienced and dedicated teams. Providing a seamless clinical service PCI supports the global supply of investigational medicines with pharmaceutical development, clinical drug product manufacturing, packaging, labeling, storage and distribution.

Commercial Packaging Technology

With true customer focus and flexibility at the core of commercial packaging, we are able to support the unique requirements of each product type and global market supplied. Utilizing state-of-the-art packaging technologies we provide advanced primary, secondary and tertiary packaging solutions for a diverse portfolio of conventional dosage forms including oral solids, powders, liquids, creams and gels, as well as specialist injectable and parenteral delivery forms including vials, cartridges, prefilled syringes and auto-injectors.

PCI speedsolutions™

As PCI continues to grow and evolve to meet our client's needs, we are proud to introduce *speed***solutions**™. Speed-solutions combine value-added services and expertise, delivering an integrated approach to every client project, de-risking the supply chain by eliminating the need to transfer to alternative suppliers. Irrespective of where you enter the PCI world of speed-solutions, your unique journey towards commercialization is tailored to your specific needs providing ultimate solution flexibility and complete customer-centricity with truly integrated speed-solutions from development to commercialization.

PCI Pharma Services
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E: talkfuture@pci.com - W: www.pci.com


pci
PHARMA SERVICES
Introducing speedsolutions™
Accelerating your product through development to commercialization and beyond
PH I
PH II
speedtostudy™
speedtopatient™
speedtoapproval™
speedtolaunch™
PH III
COMMERCIALIZATION
Harnessing decades of global drug product development and commercialization, you can rely on our integrated speed solutions to simplify your supply chain, spanning the cycle from study to launch.
Development & Manufacturing | Clinical Trial Services | Commercial Packaging
Let's talk future™
talkfuture@pci.com | pci.com
Your bridge between life-changing therapies and patients

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Pfanstiehl is a global leader in the manufacture of cGMP high purity, low endotoxin, low metal injectable-grade excipients and biopharmaceutical components for upstream bioprocessing, downstream formulation, and specialty applications. In addition, Pfanstiehl is a leading contract development and manufacturing organization (CDMO) specializing in the isolation, purification, custom synthesis, and scale-up development of small molecule Active Pharmaceutical Ingredients (APIs), in gram to multi-ton commercial quantities. While most ingredient manufacturers or resellers focus on other industries, such as food, cosmetics, agriculture, and/or nutritional supplements, offering only a subset of 'pharma- grade' ingredients, Pfanstiehl is Pharma Grade through and through. It's all we do. Pfanstiehl's ICH Q7-compliant manufacturing facility is centrally located just north of Chicago, and only 35 minutes by car from O'Hare International Airport.

Pfanstiehl's tried and true, platform-enabling protein and cell membrane stabilizers include Trehalose, Sucrose, Arginine, and Maltose. Parenteral-grade, multi-compendial Mannitol and Sodium Succinate are also offered as key tools for formulation optimization. We are continuing to expand this portfolio to include other key excipients based on feedback from our clients who want real cGMP manufacturing from a company that understands and supports their requirements. Many clients are not simply looking for a high-quality source of consistent ingredients, but seek a partner who can adapt to the ever-evolving regulatory landscape and address emerging formulation challenges collaboratively.

For upstream applications, Pfanstiehl manufactures high purity, low endotoxin, low metal galactose for reduction of lactate and ammonia production. Overall cell culture performance improvements can be achieved with optimized titration of galactose in lieu of other carbon sources. Pfanstiehl offers multiple types of galactose, including a non-animal- derived product. Mannose is also offered as a high purity cell culture supplement to improve native glycosylation and improve consistency in product quality attributes, particularly in high titer processes. Trehalose can be utilized in upstream bioprocessing and cell therapy applications to reduce protein aggregation and improve cell robustness.

Pfanstiehl was founded in 1919 and is celebrating its 100-year anniversary as a leader in carbohydrate and process chemistry. Pfanstiehl's customers include most of the world's leading biopharmaceutical and pharmaceutical companies. Our products are utilized in market-leading drugs that treat life-threatening and debilitating diseases, including cancer, rheumatoid arthritis, STDs, and diabetes. Increasing regulatory and quality requirements are benefiting high integrity biopharmaceutical and pharmaceutical suppliers like Pfanstiehl with high purity, strong cGMP controls and a strong reputation with FDA and other regulatory agencies. In everything we do, Pfanstiehl is motivated by a concern for both product quality and environmental/worker safety. We design and equip our plant, write our procedures and train our people to meet or exceed US FDA, cGMP, OSHA and international regulatory and multi-compendial standards.

Delivering on the Promise of Purity

PharmaCircle™

The Difference is in the Details

PharmaCircle is a leading provider of authoritative information, global insight, and expert analysis on the pharmaceutical, biotech, drug delivery technology and device, and animal health industries.

PharmaCircle's premier database tracks drugs, biologics and combination products in all stages of development, connecting pipeline and product information with formulation and component details. The database delivers seamless integration of scientific, clinical, safety, regulatory, manufacturing and commercial information, and detailed analyses on over 8,000 drug delivery technologies and delivery devices.

PharmaCircle provides the broad and deep global coverage, and powerful search and analysis tools needed to answer challenging questions so you can uncover new opportunities and make informed decisions.

Key content and capabilities include:

- Pipeline & Products Intelligence
- Drug Delivery Technology Analyses
- Company Capabilities Profiles
- Business Prospecting Tools
- Trial Landscape Insights
- Formulation & Excipient Details
- Strategic Deals Analyzer
- API & Finished Dosage Form Manufacturers Finder
- Global Regulatory Compendium
- Physical Chemical & Pharmacokinetic Data
- Venture Capital Investment Tracking
- Service Provider Comparisons
- Patent Exclusivity Tracking
- Drug Label Comparisons
- Key Product Sales & Forecasts
- Epidemiology Data

To learn more about how PharmaCircle can help your company, please visit our website www.pharmacircle.com.

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Phillips Medisize

a molex company

From Concept to Care

Product realization is inherently unpredictable, especially in regulated industries — we can help you succeed. Launch your product with our integrated, end-to-end design, development, and manufacturing capabilities including a laser focus on quality and risk management.

As a contract development and manufacturing organization, Phillips-Medisize, a Molex company, has deep roots. For more than 60 years, customers have trusted us to help them scale quickly and get to market faster.

Our portfolio of design, development, and manufacturing solutions is built on a solid foundation of specialized capabilities:

- End-to-end Services — contract design, development, and manufacturing services for all stages of a product's lifecycle
- Connectivity Enablement — hardware and software solutions that improve patient adherence and disease management
- Technology Accelerators — platform technologies for accelerated time to market, lower costs, and reduced risk

Phillips-Medisize o¬ffers a global presence that helps our customers create innovative products to help people around the world live healthier, more productive lives.

Phillips-Medisize Brings Possibilities to Life

When leading healthcare and life science companies work with Phillips-Medisize, a Molex company, they get access to over 60 years of innovation. Phillips-Medisize brings decades of experience in advanced electronics, connectivity, and sensor technologies to help develop transformative medical and pharmaceutical solutions that help people live healthier, more productive lives:

- 7.5k+ Employees Worldwide
- 11 Countries
- 32 Global Locations
- 30 Innovation Centers

Medical Technology for Next Generation Innovations

In the last year, we have helped:

- 10 Million patients manage diabetes
- Perform 1.4 million cardiovascular surgeries
- Supply 150,000 AEDS for use in emergencies

In the last year, we have helped:

- Pharma drug delivery
- In-vitro diagnostics
- MedTech
- Automotive
- Defense
- Specialty consumer

Get started with us today
www.phillipsmedisize.com

Pii

Pharmaceutics International, Inc

Challenges Frame Opportunities

PHARMACEUTICS INTERNATIONAL, INC. (PII)
10819 Gilroy Road
Hunt Valley, MD 21031
T: (410) 584-0001
E: bd@pharm-int.com or pdupont@pharm-int.com
W: www.pharm-int.com

Year Founded: 1994
Number of Employees: 250
Key Personnel: John Fowler, President & CEO
Business Development Team: Christian Ahlmark, Vice President of Business Development; Gerri Mirkin, Director of Business Development, East Coast; Cindy Koonce, Director of Business Development, Mid Atlantic; and Brad Arnold, Director of Business Development, West Coast
Human Resources: George Sanders, Vice President of Human Resources
R&D: Sundeep Sethia, Head of R&D
Quality: Thomas Pamukcoglu, Vice President of Quality
Quality Control: Cathy Sioma, Director of QC Analytical Services
Supply Chain: David Fidler, Senior Director of Supply Chain
Operations: Alan Saidel, Head of Operations
Project Management: Devan Patel, Senior Director of Business Development; Stephanie Taylor, Senior Project, Project Development; and Tobie McQueen, Project Coordinator
Marketing: Devan Patel, Senior Director of Business Development, and Paul Dupont, Head of Digital Marketing

Concept to Clinic to Commercialization

At Pharmaceutics International, Inc. (Pii), our motto is "challenges frame opportunities." We are a US-based contract development and manufacturing organization (CDMO) that has a passion for solving problems efficiently with the highest quality standards. Emphasizing a collaborative relationship with our clients, Pii's experts embrace the art and science of drug development and manufacturing. Our outcome is to deliver better results faster for our clients and their patients.

Pii's Hunt Valley, Maryland campus includes four cGMP and FDA certified facilities, 70 manufacturing suites with all the necessary analytical testing capabilities on site, and four integrated aseptic filling suites delivering quality, safety, and efficiency.

Experienced with small and large molecule compounds, we have special expertise in developing and manufacturing complex parenteral drugs, vaccines, extended-release formulations, and non-aqueous injectable drug products. We can also overcome stability challenges with precision lyophilization cycle development and production.

Services

- Formulation & Process Development
- Oral Drug Development
- Parenteral Drug Development
- Bioavailability Enhancements
- Method Development & Validation
- Stability Testing
- Clinical Trial Manufacturing
- Commercial Manufacturing
- Highly Potent Drug Manufacturing
- Analytical Services
- Quality Systems Development

Capabilities

- Development & Commercial Technology Transfer
- Vaccine Fill/Finish
- Sterile — vials, syringes, cartridges
- Lyophilization
- Highly Potent Compounds — hormones, cytotoxins
- Parenterals — aqueous, non-aqueous
- Oral Solids — soft gels, tablets, capsules
- Oral Liquids — suspensions, syrups, solutions
- Solid dispersions
- Topicals
- Controlled release formulations
- Fluid-bed processing
- Micro & nanotechnologies
- Coating
- Packaging Serialization
- Enhanced Project Management

plas-tech engineering

EXCELLENCE IN MEDICAL MANUFACTURING

PLAS-TECH ENGINEERING
EQUINOX MEDICAL LLC
875 Geneva Parkway, N.
Lake Geneva, WI 53147
T: (262) 248-2379
E: info@plastechengineering.com
W: www.plastechengineering.com

About Us - Plas-Tech is a full-service medical device manufacturing company. To better support the drug delivery and biotech markets, we created Equinox Medical as a subsidiary of Plas-Tech Engineering. Together they provide value at every step of the way that enables our customers to benefit from higher quality products with leading edge design for manufacturing, assembly, tooling engineering and polymer materials expertise.

With over 30 years of expertise in medical manufacturing our capabilities have proven to be advantageous for our customers in the medical device industry as well as other related industries that require difficult to manufacture products.

Engineering & Product Development: Concept to Distribution
Our customers count on us for invaluable assistance with early-stage involvement in the form of engineering, design, and commercialization support. From feasibility analysis and product design suggestions to having us create tooling for efficient high-speed production runs.
Engineering strengths include:

- Early-stage development
- Design for Manufacturing (DFM)
- Design for Assembly
- 3D Solid Modeling
- SolidWorks®
- Integration and robotic automation design

Prototyping
Prototyping is an essential part of the Go-To-Market process and can serve multiple purposes. It can demonstrate feasibility of a component or function in pre-production testing.

Plastic Injection Molding
Our strategically located manufacturing facility delivers low-medium volume, high-mix manufacturing solutions with speed-to-market objectives and minimized procurement, materials management, and manufacturing costs.

Assembly, Shipping & Distribution
In addition to prototype, low-volume, and production molding, we also offer product assembly, secondary operations, pad printing and sterile packaging for our customers. If your project requires shipping and distribution, we offer options to manage this for your company.

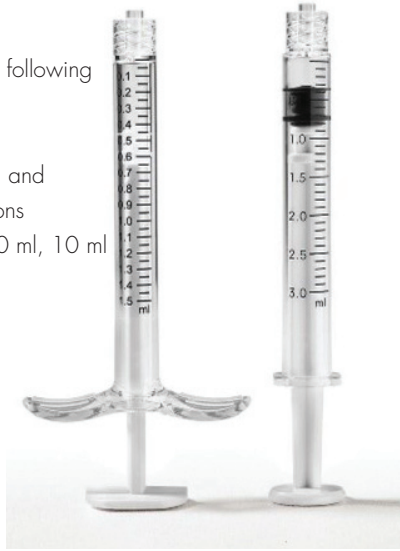
- Cleanroom Injection Molding is a value add at Plas-Tech Engineering. We offer scientific molding process and controls along with full molding process validations.
- Prototypes to high-capacity production molds.
- Antistatic, Static Dissipative, Conductive & Static Shield Molding
- Glass Alternative or Replacement Molding.
- In-Mold Labeling & In-Mold Decoration (IML / IMD)
- ISO Class 6 and 7 cleanrooms (1000) Clean Room post processing
- Micro-Molding
- Over molding /Insert Molding

equinox MEDICAL, LLC

Equinox Prefillable Syringes & SmarTUB ISO Nested Syringes
With recent advancements in pharmaceuticals, the syringe market has experienced significant changes. Traditional glass syringes have limitations that make them incapable of serving the entire market, allowing Plas-Tech engineers to develop plastic syringes as an alternative. Our COP & COC glass replacement plastic syringes are the answer, with improved accuracy and performance advantages over traditional glass syringes.

Fully customizable and available in the following resins, styles, and sizes
COC, COP, CBC, PC, cPET, PP
Colors: Natural/Clear, Amber, Printed and non-Printed, Custom Graduations
Sizes: 0.5 ml thin, 1.0 ml, 1.5 ml, 3.0 ml, 10 ml

- Equinox Comfort-Grip
- ISO Modified Flange



SmarTUB®
by Plas-Tech Engineering

Fully customizable and available in the following resins, styles, and sizes
COC, COP, CBC, PC, cPET, PP
Colors: Natural/Clear, Amber, Printed and non-Printed, Custom Graduations
Sizes: 1.0 ml, 2.25 ml 3.0 ml

- Traditional ISO Luer Lock
- Modified Luer Lock with Suspension Tip

plas-tech engineering

EXCELLENCE IN MEDICAL MANUFACTURING

Medical Device | Diagnostics| Design
Product Development | Cleanroom Manufacturing

Plas-Tech Engineering is integrating drug delivery technology with novel Biotech and Pharmaceutical applications. From the development of prototype devices to full commercialization, we provide fresh ideas and manufacturing to challenging applications. Whether it's injection molding, tooling or assembly, we bring disruptive ideas and technologies to the market.

- Equinox prefillable syringes
- Equinox SmarTUB® customizable nested syringes
- Full service medical manufacturing and device assembly
- Full process validation and sterilization services
- In-house mold making and plastic injection molding
- Cleanroom assembly and automation
- Regulatory filing and support

Plas-Tech Engineering, Inc. / Equinox Medical LLC
875 Geneva Parkway N., Lake Geneva, Wisconsin 53147
Tel: 262-248-2379
Email: info@plastechengineering.com
Web: www.plastechengineering.com

SmarTUB® by Plas-Tech Engineering

equinox MEDICAL, LLC

INVENTIVE **COLLABORATVE** **DISRUPTIVE**

PROVERIS SCIENTIFIC CORPORATION
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W: www.proveris.com

Testing True Product Performance

Leader in spray and aerosol product testing and contract services

Proveris® Scientific's focus is helping its customers unlock the complex relationships between formulation, device, and human usage — knowledge that's essential for timely and effective OINDP development and commercialization. Our industry standard instruments offer rapid insight into critical spray and aerosol parameters, and our team of scientists provide expert consultation and contract test services, taking into account key regulatory and operational nuances of orally inhaled and nasal drug products. As key partners to our clients we help to:

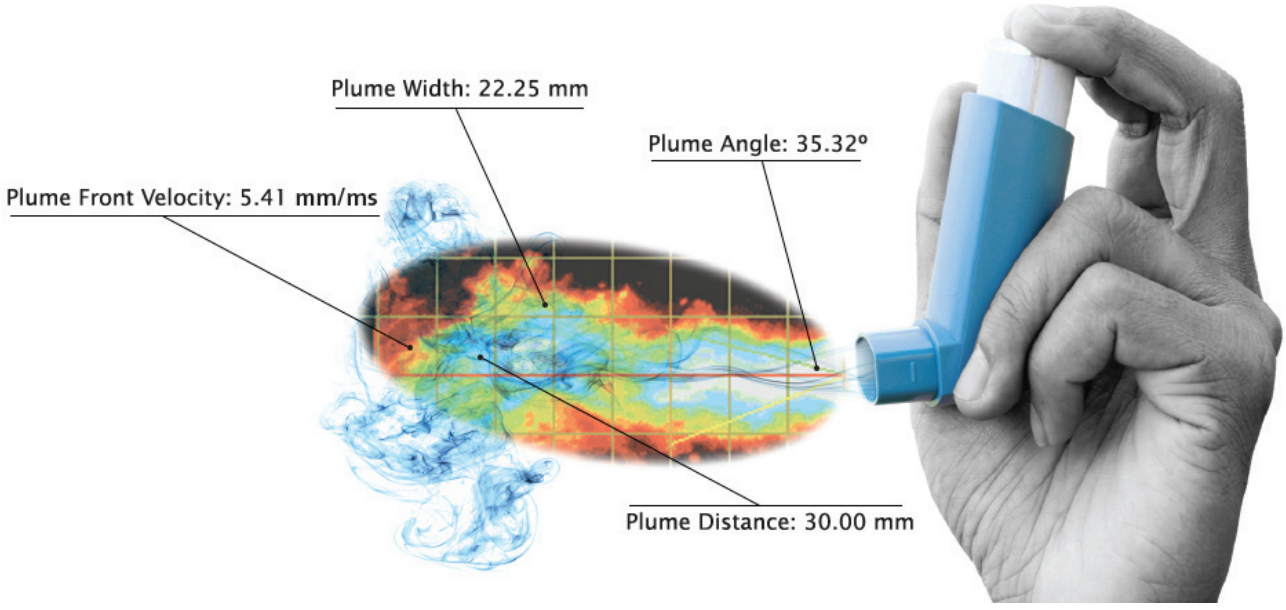
- accelerate successful product development and prevent late-stage development failures
- realize significant savings in time and resources by streamlining testing workflows
- evaluate the suitability of various OINDP delivery devices and optimize device parameters for maximum efficacy
- optimize testing variables to maintain batch-to-batch reproducibility, simplifying regulatory submissions

Proveris Instrumentation

Proveris Scientific manufactures a range of analytical instruments for spray and aerosol characterization, precision automated actuation for through-life testing, automated nasal spray collection systems for spraying, weighing and sample collection, automated shaking and actuation for wasting of pMDIs, as well as powerful software to preserve audit trail and manage your data efficiently.

Contract Services

Proveris Laboratories contract test service offerings include custom packaged studies for method development, formulation and device screening/optimization, human-usage parameters, CMC analytical drug product characterization, device robustness, stability studies, IVIVC studies, and measuring regional drug deposition using physiologically relevant models.



viota®

Software by Proveris

DATA INTEGRITY FOR OINDP RESEARCH, DEVELOPMENT, AND MANUFACTURING

Viota provides the tools you need to achieve 21 CFR Part 11 compliance. It lets you manage your data securely and efficiently all while offering easy intuitive instrument control across all SprayVIEW®, Vereo®, and Indizo® Systems.

- Designed for Orally Inhaled and Nasal Drug Product (OINDP) applications
- Performs common *in vitro* tests including spray pattern, plume geometry, force-to-actuate, auto-actuation of devices for pump delivery, and sample collection
- The latest Viota 9 release includes the ability to perform Plume Front Velocity and Spray Duration measurements for pMDIs and SMIs
- A central database allows methods and data storage across all Proveris systems
- Robust reporting functionality—auto generation of submission-ready data for ANDA applications, quality audits, and other regulatory submissions
- Full audit trail and security levels with eSignatures assures Part 11 compliance

NEW! Version 9 allows for Plume Front Velocity and Spray Duration Measurements on your SprayVIEW System!

LEARN MORE:

www.proveris.com
contactus@proveris.com
+1 508 460-8822

proveris SCIENTIFIC

Quotient Sciences

Molecule to cure. Fast.™

Molecule to cure. Fast.

Quotient Sciences is a drug development and manufacturing accelerator providing integrated programs and tailored services across the entire development pathway. Cutting through silos across a range of drug development capabilities, we save precious time and money in getting drugs to patients. Everything we do for our customers is driven by an unswerving belief that ideas need to become solutions, molecules need to become cures, fast. Because humanity needs solutions, fast.

Integrated drug development programs

We offer fully integrated development, manufacturing, and clinical testing services for small molecules and peptides at all stages of development.

- **Candidate development** – support when selecting the right molecules for development, offering expertise that shortens timelines to the clinic
- **Early development** – fast and effective support to accelerate molecules from first-in-human (FIH) through to proof of concept (POC)
- **Late development** – scaling up molecules for registration/validation and commercial launch, at no expense to speed or quality

Translational Pharmaceutics®: Our flagship platform for fully integrated drug development

For over 15 years and over 1,000 molecules, Quotient Sciences' Translational Pharmaceutics® platform for drug development has helped global pharma and biotechs accelerate their molecule to market. By integrating drug substance, drug product, and clinical testing activities under a single provider, Translational Pharmaceutics® has been proven to shorten development times by an average of 12 months or more, minimize risk and significantly reduce R&D costs.

Our expertise in understanding dependencies between drug substance properties, formulation design, and clinical outcomes enables us to enhance development efficiency. Having both drug substance and drug product manufacturing activities under one organization allows us to deliver integrated chemistry, manufacturing, and controls (CMC) development activities for both pre-clinical and clinical studies in parallel, simplifying the supply chain and improving the likelihood of downstream clinical and commercial success.

Tailored services

- **Drug substance synthesis and manufacturing** – customized and tailored to each program, building a deep knowledge of molecule developability.
- **Formulation development** – experts in complex formulation development for modified release, solubility enhancement and pediatrics
- **Clinical trial manufacturing** – a streamlined, flexible approach to drug product supply that reflects your clinical study design and timeline
- **Clinical pharmacology** – rapid study startup and recruitment through our clinical units in Miami, FL, US and Nottingham, UK
- **Data sciences** – fast access to reliable data is critical for decision making during a study
- **Commercial manufacturing** – trusted, global services for reliable commercial supply, including support for high-potency compounds
- **Bioanalysis** – world-class expertise, delivering rapid bioanalytical data to support drug development milestones
- **Drug development consulting** – expertise at all stages of development, from candidate development through commercial launch

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Twitter: https://twitter.com/Quotient_Sci
Facebook: https://www.facebook.com/quotientsciences
Instagram: https://www.instagram.com/quotient_sci
Youtube: https://www.youtube.com/@quotientsciences

Quotient Sciences

Molecule to cure. Fast.™

Accelerate Timelines. Reduce Costs. Minimize Risks.

Quotient Sciences is a drug development and manufacturing accelerator that is cutting through silos across the entire development pathway. With a full offering of tailored services and integrated programs for small molecule and peptide drug programs, our goal is to help you reduce costs and risks to get new medicines to patients, fast.

Integrated Programs

Candidate Development
Selecting the right molecules for development

Early Development
Accelerating molecules through to proof-of-concept

Late Development
Accelerating products through to commercial manufacture

Tailored Services

- Drug Substance
- Formulation Development
- Clinical Trial Manufacturing
- Commercial Manufacturing
- Clinical Pharmacology
- Bioanalytical Services
- Data Sciences
- Drug Development Consulting

→ quotientsciences.com/accelerate-timelines

Recipharm
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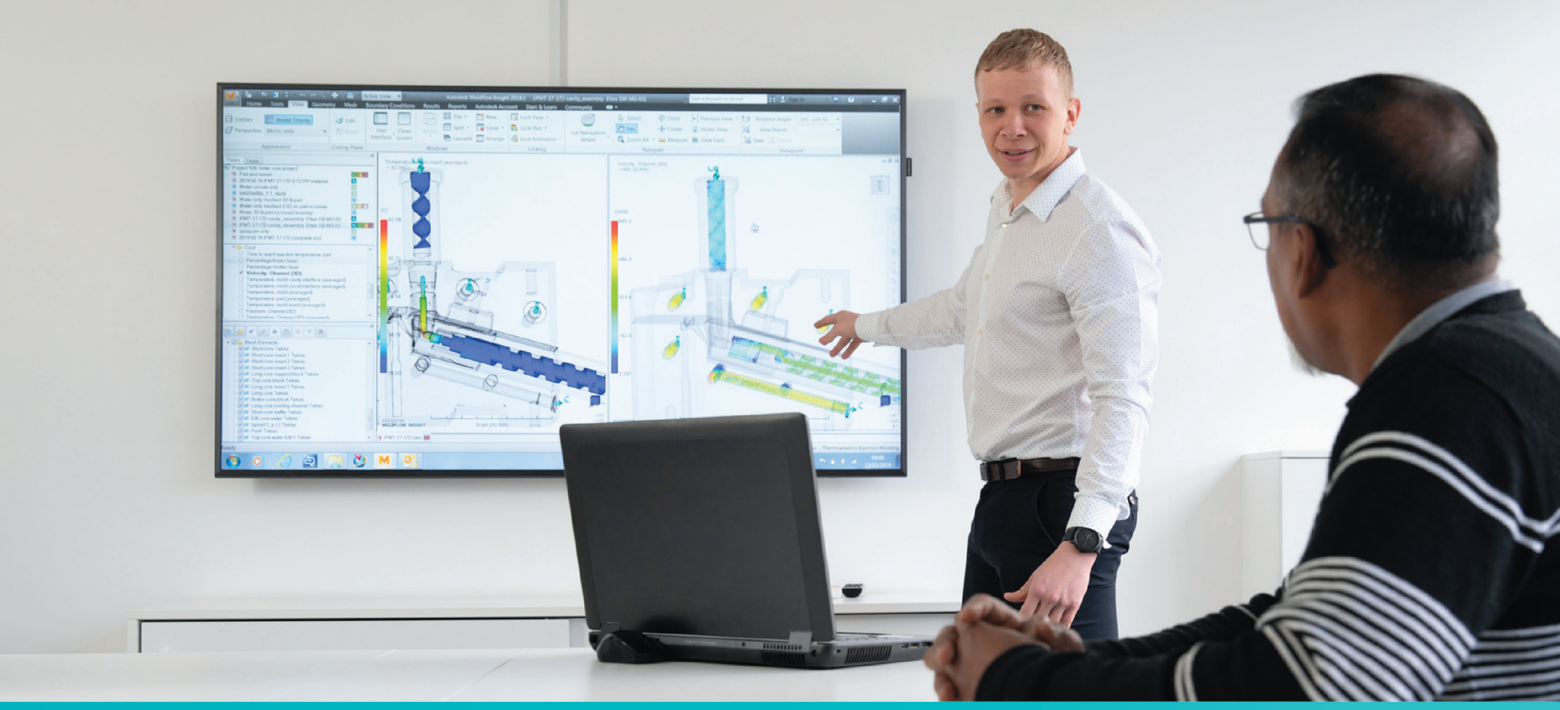
E: info@recipharm.com - W: https://www.recipharm.com/

As a top five CDMO, **Recipharm** delivers exceptional quality services and products through the entire drug/device combination development and manufacturing journey.

We are at the forefront of drug delivery device innovation, thanks to the heritage of Bespak by Recipharm, which has over 60 years' experience. We partner with pharma and biotech companies to deliver life-changing medicines, by providing design, development, and manufacture capabilities of innovative drug delivery devices.

Recipharm offers a fully integrated, combination drug product service for developing and manufacturing novel inhalation and intranasal drug delivery, including pressurized metered dose inhalers (pMDIs), soft mist inhalers (SMIs), dry powder inhalers (DPIs), and nasal spray devices. We also deliver market-leading design, development, and manufacture of injectable drug delivery devices, offering a range of auto-injectors utilizing our proprietary VapourSoft® technology.

Our teams have extensive experience across the whole lifecycle of drug development through to commercial manufacture, building innovations that have the potential to create new treatments and opportunities globally, as well as accelerating routes to market. Working with our customers, we mitigate project risk and work toward successful outcomes that will benefit the healthcare industry and patients. Recipharm, your one partner for integrated device platform offerings.



Your partner for innovative drug delivery

We provide our expertise in drug product formulation and device development, supply for clinical trials, as well as commercial manufacturing capabilities for a wide range of devices such as inhalers, nasal technologies, and injectable devices.

Discover how Recipharm can take your product from concept to commercial.

Speak to us today.

Analytical & formulation development

Drug product characterisation

Device design & development

Clinical supply

Industrialisation & manufacture

Commercial supply

Scan the QR code to learn more.

recipharm.com

Recipharm

SINGOTA SOLUTIONS
4320 W. Zenith Drive
Bloomington, IN 47404
T: 812-961-1700
E: solutions@singota.com
W: www.singota.com

Singota Solutions is a contract development and manufacturing organization (CDMO) focused on getting products to patients faster by being agile, accountable, and transparent. Founded in 2006, and headquartered in Bloomington, Indiana, Singota provides responsive, quality driven outsourcing services.

Aseptic Manufacturing – Singota fills parenterals into ready-to-use vials, syringes, or cartridges utilizing our gloveless, robotic, SA25 aseptic filling workcell for pre-clinical, clinical, and small commercial therapies. Our manufacturing process ensures freedom from in-process human intervention by not only removing the impact of operators from the initial aseptic environment but also by removing operator variability from the filling process. Some features include:

- Precise, automated, robotic filling allowing repeatability and reduced line loss
- Small volume runs for vials, syringes, or cartridges
- Use of pre-sterilized, nested containers, and pre-sterilized, single use product contact materials
- Customized finishing services, specializing in small-volume clinical batches

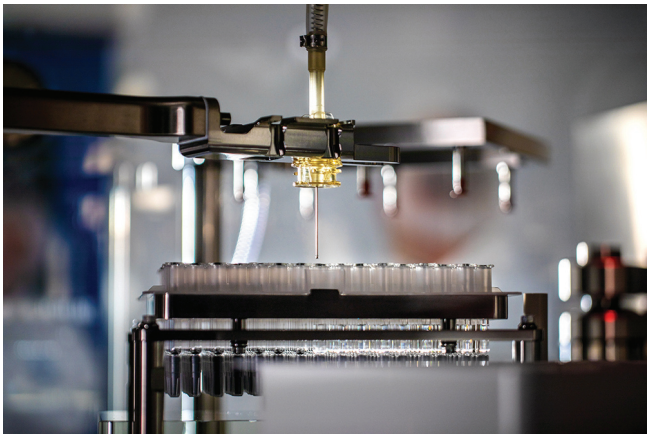
Quality Control & Development Laboratory – Our laboratory services include formulation development, process development, and analytical testing. We work with clients in the early phases of development to post-manufacturing support. Our on-site lab saves valuable time on client projects by working seamlessly with our comprehensive services to ensure client milestones are met. Services include:

- Technology/method transfer
- Method qualification
- Thermal characterization
- Lyophilization
- Microbiology challenge studies
- Raw material testing — compendial and other QC release test methods for identity and CoAs
- Release and stability testing (ICH)
- Transport simulation testing, thermal cycling, and thermal excursion studies
- Material compatibility
- Forced degradation studies
- Regulatory support for IND submissions
- Solubility and stability formulation enhancements

Supply Chain Management & Warehousing – Singota manages a diversified group of materials from APIs and excipients to finished products in our secure cGMP warehouse. We have the capability to handle toxic, potent, flammable, and hazardous materials. Service features include:

- Controlled room temperature (15°C-25°C), cool (2°C-8°C), and frozen (-20°C, and -80°C) storage conditions available
- Clinical trial support and material distribution
- Expertise in temperature-controlled materials management and distribution practices
- Sampling and dispensing capabilities for bulk material forms (liquids, powders, tablets)
- Client accessible material management software
- International supply chain assistance including importer of record services and European storage

Contact us at solutions@singota.com or (812) 961-1700 to speak with a Business Development representative to see how we can accelerate your project.



singota®
solutions

Your CDMO

Focused on Faster

We focus on agility and speed while never compromising quality. Our goal is to help you clear your drug development hurdles and meet your pre-clinical and clinical milestones *faster.*

Contact us today

singota.com solutions@singota.com 1.812.961.1700

Stevanato Group

Founded in 1949, Stevanato Group is a leading global provider of drug containment, drug delivery, and diagnostic solutions to the pharmaceutical, biotechnology, and life sciences industries. The Group delivers an integrated, end-to-end portfolio of products, processes, and services that address customer needs across the entire drug life cycle at each of the development, clinical, and commercial stages. Stevanato Group's core capabilities in scientific research and development, its commitment to technical innovation, and its engineering excellence are central to its ability to offer value added solutions to clients.

Global Presence, Local Capabilities

Today, Stevanato Group counts more than 4,700 people in 16 sites in 9 countries and has an annual turnover of more than 800 billion Euros. The global growth enabled Stevanato Group to serve customers with consistent and high-quality products and services close to their operations.

Advanced Drug Containment Solutions & Analytical Services

Stevanato Group boasts unique expertise in providing advanced pharmaceutical containers from glass tubing. Its comprehensive portfolio covers every customer need, from those related to small molecules to highly sensitive drugs. Stevanato Group produces vials, syringes, and cartridges for different applications, such as vaccines, diabetes care, anesthetics, hormones, anticoagulants, and biologics. Glass containers are available both in bulk with Stevanato Group EZ-fill®, the market-recognized ready-to-fill configuration. Stevanato Group can also provide container closure and device characterization analytical services through its Technology Excellence Centers.

Your Specialist in Contract Manufacturing

Stevanato Group offers a broad range of manufacturing services and capabilities to produce high-quality devices, including pen-injectors, auto-injectors, wearables, and inhalers. As a one-stop solution provider and manufacturer, it can cover all parts of the process, harmonizing them from product development to delivery of the final product, packaged and sterilized as needed.

Vision Inspection, Assembly & Packaging Technologies: A Modular & Flexible Approach

Stevanato Group capabilities range from modular assembly platforms and packaging lines to advanced vision inspection machines, including manual, semi-automatic, and automatic. Stevanato Group equipment can inspect a wide range of liquid, emulsions, viscous, gel-like, powder, and lyophilized drugs, catering to the needs of both small firms or big pharma companies producing blockbuster drugs.

STEVANATO GROUP
Via Molinella, 17 35017 Piombino Dese, Padua, ITALY
W: www.stevanatogroup.com

MANAGING COMPLEXITY, DELIVERING VALUE

Creating a reliable ecosystem to empower our partners and their ability to produce safe, easy-to-use and cost-effective treatments to improve patients' lives.

Stevanato Group

stevanatogroup.com

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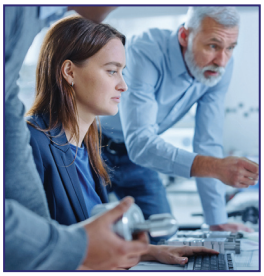
E: infoUS@vetter-pharma.com





YOUR PARTNER IN ASEPTIC FILLING AND PACKAGING

Vetter is a leading contract development and manufacturing organization (CDMO) that specializes in the aseptic filling of syringes, cartridges and vials. Vetter holds numerous patents and has extensive experience with biologics and other complex compounds, including monoclonal antibodies, peptides, interferons, and vaccines. More than 80% of Vetter's active projects are biologics.

Collaborating with biotechnology and pharmaceutical companies both large and small, Vetter supports products from preclinical development through global market supply. Through its US and European facilities, Vetter Development Service provides state-of-the-art support for early stage products, with transfer at Phase III to Vetter Commercial Manufacturing for large-scale production. We offer state-of-the-art technology and innovative processes to promote product quality and maximize API yield.

VETTER AT A GLANCE

- Headquarters in Ravensburg, Germany
- Additional clinical development facility in Chicago, US and Rankweil, Austria
- Sales offices for Asia Pacific in Singapore, Japan, South Korea and China
- Approximately 5,700 employees
- Worldwide specialist in the aseptic production of prefilled drug delivery systems
- Global experience and expertise with regulatory authorities including FDA, EMA, PMDA (Japan), and RP (Germany)
- Lyophilization (freeze-drying) and siliconization specialist

CONTACT US

Visit www.vetter-pharma.com or contact us at info@vetter-pharma.com, infoUS@vetter-pharma.com, or infoAsiaPacific@vetter-pharma.com for more information

Comprehensive support for your injectables

For over 40 years, Vetter has been a trusted partner in injectables manufacturing for pharmaceutical and biotech companies around the world. Our deep expertise enables us to integrate with your team to design and implement a personalized plan for success in a shifting global marketplace. Our strategic partnership includes:

- Customized clinical and commercial manufacturing services for your product throughout its lifecycle
- Deep and comprehensive technical, analytical, and regulatory subject matter expertise
- Proven manufacturing processes that are flexible, efficient, and scalable
- Filling and packaging capabilities that utilize the latest technology to meet international market demands

CMO LEADERSHIP AWARDS 2022

GERMANY BEST MANAGED COMPANIES

KOREA BIOPROCESSING EXCELLENCE AWARDS

Inquiries

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Asia Pacific: infoAsiaPacific@vetter-pharma.com
EU/international: info@vetter-pharma.com

www.vetter-pharma.com

VETTER
Answers that work

Contract Manufacturing

AbbVie Contract Manufacturing partners with companies across the globe to develop, scale and manufacture pharmaceutical products and bring them successfully to market. Drawing on more than four decades of success as the manufacturing division of AbbVie, we have the depth of experience and the technical knowledge to navigate issues and deliver the innovative solutions customers need. We are much more than a CMO – we are your partner for success. With foresight, scientific expertise and passion we anticipate the technical and compliance challenges along the entire pharmaceutical development journey through to commercialization. We see the complete picture to deliver our customer's vision. With full access to global state-of the-art facilities and world-class talent, our customers have come to depend on our service and quality to deliver real-world results. For more information, visit AbbVie Contract Manufacturing at **www.abbviecontractmfg.com.**

Lipid-Based Excipients

ABITEC Corporation is dedicated to the advancement of essential bioavailability enhancement and formulation development technology. ABITEC develops and manufactures lipid-based excipients to enhance the bioavailability of poorly water-soluble and poorly permeable Active Pharmaceutical Ingredients (APIs) for the pharmaceutical industry. ABITEC has an expansive portfolio of CAPMUL® bioavailability enhancers, which are medium-chain mono- and di-glycerides and propylene glycol esters. These functional lipid excipients act as solubilizers and emulsifiers in oral, topical, transdermal, and parenteral drug delivery systems. For more information, visit ABITEC at **www.abiteccorp.com.**

Hybrid Supplier

Actylis is a leading global manufacturer of critical raw materials and performance ingredients serving the Life Sciences industry. Through our hybrid approach we provide combined capabilities in GMP manufacturing and global sourcing of raw materials and ingredients, offering flexibility and unrivaled choice to pharmaceutical and biopharmaceutical companies. Thanks to our hybrid manufacturing/sourcing model we can supply solutions for over 3,000 compounds, including excipients, cell culture ingredients, buffers, process solutions, PIs, APIs, Water for Injection, amino acids, nucleosides and nucleotides. We also offer GMP custom manufacturing, ingredient development, custom packaging, R&D and analytical services. All our products are backed by world-class quality, reliable delivery, and a strong regulatory record. Discover Actylis and explore our raw materials and ingredients portfolio. For more information, visit Actylis at **www.actylis.com.**

Specialty CDMO

Adare Pharma Solutions is a global technology-driven CDMO providing end-to-end integrated services, from product development through commercial manufacturing and packaging, with expertise in complex oral formulations. Adare's specialized technology platforms provide taste masking, controlled release, solubility enhancement, and patient-centric dosing solutions. With a proven history in drug delivery, Adare has developed and manufactures more than 45 products sold by customers worldwide. For more information, visit Adare Pharma Solutions at **www.adarepharmasolutions.com.**

CDMO Services

Ajinomoto Bio-Pharma Services is a fully integrated contract development and manufacturing organization, with sites in Belgium, United States, Japan, and India, providing comprehensive process development services, cGMP manufacturing and drug product fill finish services of small molecule and large molecule APIs and intermediates. Ajinomoto Bio-Pharma Services offers a broad range of innovative platforms and capabilities to rapidly scale from clinical and pilot programs to commercial quantities, including: Corynex technologies, oligonucleotide synthesis, high potency APIs (HPAPI), biocatalysis, continuous flow manufacturing, and more. Ajinomoto Bio-Pharma Services is dedicated to providing a high level of quality and service to meet our clients' needs. For more information, contact Ajinomoto Bio-Pharma Services at **www.AjiBio-Pharma.com.**

CDMO Services

Alcami is a contract development, manufacturing, and testing organization headquartered in North Carolina with over 40 years of experience advancing products through every stage of the development lifecycle. Approximately 700 Alcami employees across four campuses in the United States serve biologics and pharmaceutical companies of all sizes, helping to deliver breakthrough therapies to patients faster. Alcami provides customizable and innovative solutions for formulation development, analytical development and testing services, clinical and commercial finished dosage form manufacturing (oral solid dose and parenteral), packaging, and stability services. For more information, visit Alcami at **www.alcaminow.com.**

Primary Packaging & Closure Solutions

Aptar pharma

With the global rise of chronic diseases and the COVID19 outbreak, increasingly complex drug products are being tested and launched on the market. Choosing the right primary packaging and closure solution is essential to facilitating regulatory approval and fast time-to-market. Building on 70 years' experience in the development and manufacturing of drug packaging solutions, Aptar Pharma offers end-to-end services, accelerating and de-risking the choice of closure component. Our PremiumCoat® Service packages address key customer challenges at different stages of their drug development. Leveraging our state-of-the-art PremiumCoat® technology, internal capabilities, expertise, and knowledge of the drug development journey, Aptar Pharma offers three packages to support the validation of PremiumCoat® with your glass container (Platform Package) or your specific drug (E&L Package). The Development Package accompanies our customers through their validation process, to ensure their success. For more information, visit Aptar Pharma at **www.aptar.com/pharmaceutical/.**

Demo/Training Devices

ArtcraftHealth
Demo Device and Training

Artcraft Health is a leading patient engagement and education agency that takes a holistic approach to demonstration device development and training. Our goal is to elevate and support the entire patient experience through educational onboarding initiatives involving both clinicians and patients. This is how we ensure certainty of use and long-term success. We help patients, caregivers, clinicians, and healthcare providers – who are either counseling patients or adopting new therapies and drug delivery methods – build the skills, knowledge, and motivation they need for a successful outcome. We excel at simplifying complex delivery methods and packaging them into easy-to-understand educational materials that help patients comply with dosing and administration. So we not only provide the highest quality device, but also aid in the launch strategy for commercial teams. For more information, visit Artcraft Health at **www.artcrafthealth.com/demo-devices.**

Formulation Development

Ascendia Pharma

Ascendia Pharmaceuticals is a speciality CDMO dedicated to developing enhanced formulations of existing drug products, and enabling formulations for pre-clinical and clinical-stage drug candidates. We specialize in developing formulation solutions for poorly water-soluble molecules and other challenging development projects. Combining our extensive knowledge and experience of formulation capabilities with our suite of nano-particle technologies, we can assess the feasibility of a broad array of robust formulation options to improve a drug's bioavailability. Thusly decreasing the amount of drug and the number of injections and greatly reducing in some cases the daily pill-burden from 20 to 4. Ascendia's expertise spans across (IV, SC, or IM), injection, ophthalmic, transdermal, nasal delivery, along with immediate- and controlled-release products for oral administration and complex generics. For more information, visit Ascendia at **www.ascendiapharma.com.**

Specialized Sterile Injectables

Baxter

Backed by over 90 years of experience in parenterals, Baxter's BioPharma Solutions (BPS) business collaborates with pharmaceutical companies to support commercialization objectives for their molecules. BPS is a premier CMO with a focus on injectable pharmaceutical manufacturing designed to meet complex and traditional sterile manufacturing challenges with confidence of delivery, service and integrity. BPS can support your pharmaceutical needs with a broad portfolio of sterile fill/finish production capabilities, and our reputation is built on the high-quality products we manufacture for our clients in a cGMP environment. Our delivery systems include: prefilled syringes, liquid/lyophilized vials, diluents for reconstitution, powder-filled vials and sterile crystallization. For more information, visit Baxter BioPharma Solutions at **www.biopharmasolutions.baxter.com.**

Parenteral Delivery Devices

BD

FOR BETTER TREATMENT OF CHRONIC DISEASES. Across the healthcare continuum, BD is the industry leader in parenteral delivery devices that help health systems treat chronic diseases. We not only continually advance clinically proven, prefillable drug delivery systems, we do so with a vision to help healthcare providers gain better understanding of how patients self-inject their chronic disease therapies outside the healthcare setting. This is why we partner with leading pharmaceutical and biotech companies worldwide to develop digitally-connected self-injection devices — including wearable injectors and autoinjectors — to capture valuable data that can be shared with caregivers. Discover how BD brings new ideas and solutions to customers, and new ways to help patients be healthy and safe. For more information, visit BD Medical – Pharmaceutical Systems at **bd.com/Discover-BD1.**

CRDMO

BIODURO-SUNDIA

BioDuro-Sundia, an Advent International portfolio company, is a trusted, leading contract research development, and manufacturing organization (CRDMO) for over 27 years. We provide our biotech and pharmaceutical partners with fully integrated services to support their efforts from target identification to commercial drug product manufacturing. The company is based in the US and China with more than 3,000 employees and 10 global sites across 7 cities. Core expertise includes small and large molecule discovery, development and scale-up, support for IND submission, unique technology platforms, such as bioavailability enhancement of insoluble compounds, and clinical as well as commercial manufacturing. We help biotech and pharma partners across the globe to significantly accelerate discovery and de-risk development to create higher-value outcomes. For more information about BioDuro-Sundia, visit **www.bioduro-sundia.com.**

Global CDMO

BIOVECTRA is a full-service CDMO specializing in the clinical-to-commercial-scale production of high-quality regulated APIs and intermediates, including biologics, synthetic small molecules, pDNA and mRNA, highly potent APIs, and bioreagents. Our teams leverage decades of expertise and a proven track record of excellence to optimize, adapt, and perfect innovative technologies and drug substance development approaches to deliver world-class solutions for pharmaceutical manufacturing. We offer: over 50 years of pharmaceutical manufacturing experience, flexible, creative systems designed to deliver solutions quickly and efficiently, and extensive regulatory expertise backed by long-standing relationships with major regulatory bodies For more information, visit BIOVECTRA at **www.BIOVECTRA.com.**

International CGMP CDMO

Bora Pharmaceuticals is a premier international CGMP CDMO specializing in complex oral solid dosage (tablet & capsules), liquids (solutions, suspensions, & nasal sprays) and semi-solids (creams & gels) pharmaceutical Rx and OTC products for late-phase Clinical through Commercial manufacturing and packaging. Bora owns and operates three state-of-the-art CGMP manufacturing facilities (Taiwan and Canada) built to the highest international standards for manufacturing, packaging, R&D, and analytical testing. For more information, visit Bora Pharmaceuticals at **https://www.boracorpcdmo.com/.**

Platform Technology

Captisol is a patent-protected, chemically modified cyclodextrin with a structure designed to optimize the solubility and stability of drugs. Captisol was invented and initially developed by scientists in the laboratories of Dr. Valentino Stella at the University of Kansas' Higuchi Biosciences Center for specific use in drug development and formulation. This unique technology has enabled 11 FDA-approved products, including Onyx Pharmaceuticals' Kyprolis®, Baxter International's Nexterone®, and Merck's NOXAFIL IV. There are more than 30 Captisol-enabled products currently in clinical development. For more information, visit Captisol at **www.captisol.com.**

OptiForm® Solution Suite

The path to first-in-human trials needs to be as fast and efficient as possible, but improper candidate selection, poor formulations, and gaps in clinical dose strategy can lead to inadequate preclinical and clinical data; often extending timelines and increasing cost. To overcome these challenges, Catalent developed OptiForm® Solution Suite, a comprehensive program that seamlessly integrates candidate selection, optimal dosage form assessment, bioavailability enhancement, and CGMP clinical materials delivery. OptiForm Solution Suite is fast, flexible, and fact-based, delivering data to allow the right decisions to be made at each stage of development and accelerate molecules to Phase 1. It combines a comprehensive range of screening tools, ADME considerations, and in silico DMPK modeling, plus bioavailability enhancing tools, providing materials for CGLP toxicological on to first-in-human studies. For more information, contact Catalent Pharma Solutions at (888) SOLUTION or visit **www.catalent.com.**

Drug Delivery Platform

The chemistry inside innovation™

Celanese Corporation a global chemical leader in the production of differentiated chemistry solutions and specialty materials used in most major industries and consumer applications. With decades of experience in medical and pharmaceutical applications, our customers trust us to provide unrivaled service, world-class expertise, and quality that improve product development, enhance manufacturability, and elevate patient experiences. Our VitalDose® technology is a drug delivery platform providing controlled release through implant and insert dosage forms. Based in Dallas, Celanese employs approximately 8,500 employees worldwide and had 2021 net sales of $8.5 billion. For more information about solutions for the VitalDose sustained drug delivery platform, visit **vitaldose.com.**

Differentiated Injectable Delivery

Credence MedSystems is an innovator in drug delivery devices. Credence's philosophy of *Innovation Without Change* results in products that impress and protect end-users while preserving pharma's existing processes, sourcing strategies and preferred primary package components. The Companion® family of syringe systems includes proprietary integrated needle-retraction technology, reuse prevention, critical safety & usability features as well as sustainability advantages. The Dual Chamber platform offers simplified delivery for drugs requiring reconstitution or sequential injection at the time of delivery. The Credence Connect™ Auto-Sensing Injection System incorporates automatic real-time monitoring of critical injection data into a reusable ergonomic finger grip. Credence's Metered Dosing product line allows precise delivery of small volumes and a force advantage when viscosities are high. For more information, call +1 844-263-3797 (+1-844-CMEDSYS), email info@credencemed.com, or visit **www.CredenceMed.com.**

CDMO Experts

At **Curia**, we pair a comprehensive site of R&D services with deep experience in discovery, drug substance development and drug product formulation. We deliver hit-to-lead-to-candidate selection through comprehensive discovery biology, synthetic and medicinal chemistry, DMPK and bioanalytical services from our integrated drug discovery centers of excellence. With more than 350 drug discovery programs delivered, 564 patents issued, and over 95 preclinical and clinical candidates developed, we understand how to reduce costs, shorten timelines and help guide you to better outcomes. A partnership with Curia ensures your compound is in the capable hands of an experienced team that knows what it takes to successfully navigate the drug discovery and development continuum. For more information, visit Curia at **https://curiaglobal.com/research-development/.**

Betadex Sulfobutyl Ether Sodium

CycloLab Cyclodextrin R&D Laboratory Ltd, Hungary has been operating in various fields of cyclodextrin-based research as well as pharma-grade cyclodextrin manufacturing for over 40 years. Our dedicated manufacturing facility produces betadex sulfobutyl ether sodium (SBECD under brand name Dexolve®) in multiple ton scale annually under cGMP conditions based on an FDA-approved Drug Master File. Dexolve is a potent API solubilizer and stabilizer excipient, already approved for various administration forms and marketed in 13 human and one veterinary formulation. Betadex sulfobutyl ether sodium has outstanding, favorable safety profile compared to non-complex forming solubilizing inactive ingredients such as surfactants. For more information, visit CycloLab Ltd. at **www.cyclolab.hu.**

Testing Services

DDL

Testing Experts. Service Specialists.

DDL is an independent third-party ISO 17025 accredited testing laboratory that provides packaging, device, and materials testing. For over 30 years, DDL has provided extraordinary service and specialized testing expertise to the medical device and pharmaceutical industries. We employ a team of engineers, technical, and quality experts devoted to helping our customers bring medical device and drug delivery products to market. Our single source, totally integrated approach enables organizations of all sizes from start-ups to globally recognized corporations maximize product performance, reliability, and safety while seamlessly achieving regulatory compliance. We work hard to build strong partnerships with our clients and have an unwavering commitment to assist in getting products to market on time. For more information, visit DDL at **www.DDLTesting.com.**

Development & Manufacturing Solutions

EMERGENT® CDMO

Emergent CDMO is dedicated to helping pharma and biotech innovators bring lifesaving therapies to patients from around the world. Our integrated development and manufacturing network can support early to late-stage production of biotherapeutics and vaccines. Whether you're looking for initial process development support, small volumes of material for clinical trials, or large-scale production for a global commercial therapy, our experienced CDMO team is ready to serve as your trusted guide from molecule to market. We support a broad portfolio of preclinical through commercial programs with experience in a wide range of platforms and technologies including mammalian, viral, and plasma proteins. For more information, visit Emergent CDMO at **www.emergentcdmo.com.**

FULL-SERVICE CDMO

VETTER

Vetter is a leading contract development and manufacturing organization (CDMO) that specializes in the aseptic filling and packaging of syringes, cartridges, and vials. The company has extensive experience with biologics and other complex compounds. Collaborating with pharma/biotech clients worldwide, Vetter supports products from preclinical development through global market supply. Through its US and European facilities, Vetter Development Service provides state-of-the-art support for early stage products, with transfer at Phase 3 to Vetter Commercial Manufacturing for large-scale production. For more information, visit Vetter at **www.vetter-pharma.com.**

Formulation Solutions

enteris BIOPHARMA
Intelligent Solutions for Oral Drug Delivery℠

Enteris BioPharma is a clinical-stage biopharmaceutical company offering innovative formulation solutions built around its proprietary oral drug delivery technologies. In addition to its formulation development expertise, Enteris BioPharma has a 32,000-sq-ft GMP facility in Boonton, NJ, offering an expanding range of manufacturing and development services for solid oral dosage forms, including handling and processing of highly potent APIs. The Peptelligence® and ProPerma® technologies provide oral bioavailability enhancement of challenging BCS-III and BCS-IV compounds by uniquely improving both permeation and solubility through a smart combination of pH-lowering, charge dispersal, membrane wetting, and solubilizing agents in a highly scalable solid oral dosage form. The technology has robust IP protection and extensive clinical validation. Enteris is the preferred partner for the oral delivery and development of peptides and small molecules. For more information, visit Enteris BioPharma at **www.enterisbiopharma.com.**

Delivery Design, Development & Manufacturing

Flex helps a diverse customer base design and build products that improve the world. Through the collective strength of a global workforce across 30 countries and responsible, sustainable operations, Flex delivers technology innovation, supply chain, and manufacturing solutions to diverse industries and end markets. Flex's health solutions business focuses on medical device and drug delivery design, development, and manufacturing solutions for pharmaceutical and medtech companies. From pens and autoinjectors to wearable pumps and inhalers, Flex helps pharma companies by providing solutions wherever they are in the product lifecycle. Our approach is supported by FDA-registered and ISO 13485-compliant and ISO 11608-1-accredited facilities, with a world-class single quality system across sites. For more information, visit Flex at **www.flex.com.**

CDMO & Manufacturing Services

Fortis Life Sciences offers world-class reagents, tools, materials, and custom services with a best-in-class customer experience for our customers in the biopharma industry. Through our brand nanoComposix, we provide precisely engineered and highly characterized nanomaterials to a global customer base. nanoComposix is an ISO 13485 (2016)-Certified*, FDA-registered developer and contract manufacturer with a nanomaterial product portfolio containing hundreds of variants engineered to address the unique challenges presented by our customers. Our products and CDMO services are backed by technical teams with extensive expertise in nanotechnology, biology, chemistry, physics, and optics. *Specific to 4878 Ronson Ct. Suite J and 4888 Ronson Ct. Suite B. For more information, visit Fortis Life Sciences at **https://www.fortislife.com/gmp-nanoparticle-manufacturing.**

Hands-On Formulation Support

With application and R&D Centers in the United States, France, India, and China, the **Gattefossé group** is providing formulation support for oral, topical, transdermal, and other routes of administration. Equipped with state-of-the-art analytical and processing instruments, we stand to assist with your projects at all stages of development, from solubility screening to late-stage formulation and "proof-of-concept" studies. Moreover, we provide extensive regulatory support, sharing toxicological and safety data, and analytical/characterization methods. For more information, visit Gattefossé at **www.gattefosse.com.**

Lentiviral & Retroviral Vectors

We're specialists in lentiviral and retroviral vectors, accelerating your therapy to commercialization and helping you deliver life-changing therapeutics to patients. Whether you have a defined process or need guidance to identify the best path forward, our experts have the flexibility to support you wherever you are in your journey. **Genezen** offers contract process development, GMP viral vector production, transduced cell manufacturing, testing services and assay development. Keeping growth front of mind, we tailor our solutions to your needs and ensure your therapy progresses as quickly and safely as possible. Our new state-of-the-art, cGMP-compliant facility has recently opened in the fast-growing life sciences hub of Indianapolis, providing our partners with the capacity and technologies for the aseptic manufacture of lentiviral and retroviral vectors. For more information, visit Genezen at **https://genezen.com/.**

On-Body Drug Delivery

SensAIR is a platform for on-body drug delivery that can deliver drugs of higher viscosity, such as monoclonal antibodies. The aim is to provide patients with the best possible support in the subcutaneous delivery of large-volume biologics. The ready-to-use SensAIR On-Body Delivery Device is easy to use and enables patients to start medication in a self-determined manner in familiar surroundings. The SensAIR On-Body Delivery Device can be adapted to medications of different viscosities and with different requirements. This applies to the size of the medical device as well as to the needle used, variable cartridge sizes and possible connectivity, for example to the patient's smartphone. Together with Gerresheimer's One-Stop-Shop quality promise, which includes a solution from the cartridge to the drug delivery device from a single source, SensAIR enables optimized delivery of biologics. For more information, visit Gerresheimer at **www.gerresheimer.com.**

User-Friendly Oral Dosage Forms

HERMES PHARMA is the leading expert in developing and manufacturing user-friendly oral dosage forms, including effervescent and chewable tablets, instant drinks, lozenges, orally disintegrating granules, and the newly developed HERMES NutriCaps. As a CDMO, we offer customized services along the entire pharmaceutical value chain, from new product development and formulation to manufacturing and regulatory support. For more than 40 years, leading healthcare companies around the globe have worked with HERMES PHARMA to extend their pharmaceutical and nutraceutical product lines as well as to grow their brands. Our sister company HERMES ARZNEIMITTEL has a rich portfolio of successful OTC brands and a history of more than a hundred years in pharmaceutical excellence. This heritage makes HERMES PHARMA a reliable and experienced partner who truly understands the challenges of its customers. For more information, visit HERMES PHARMA at **www.hermes-pharma.com.**

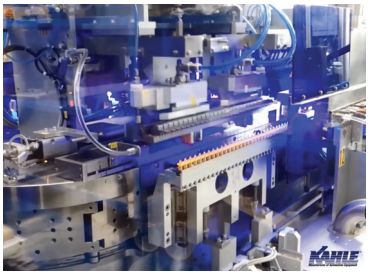
Contract Development & Manufacturing

Hovione is an international company with over 58 years of experience as a Contract Development and Manufacturing Organization (CDMO) and is currently a fully integrated supplier offering services for drug substance, drug product intermediate, and drug product. With four FDA-inspected sites in the US, China, Ireland, and Portugal, and development laboratories in Portugal and the US, the company provides branded pharmaceutical customers services for the development and compliant manufacture of innovative drugs, including highly potent compounds. For generic pharmaceutical customers, the company offers niche API products. Hovione also provides proprietary product development and licensing opportunities for drug products. In the inhalation area, Hovione is the only independent company offering a complete range of services. For more information, visit Hovione at **www.hovione.com.**

Integrated Contract Manufacturer

Jubilant HollisterStier is an integrated contract manufacturer of sterile injectables, ophthalmics, otics and sterile and non-sterile topicals and liquids. Our facilities in North America provide specialized manufacturing for the pharmaceutical and biopharmaceutical industries. We provide a full-range of support and services to streamline the manufacturing process such as on-site assistance from process qualifications through product release. With over 100 years of manufacturing expertise with a global reach, our team is committed to meeting your project's milestones efficiently. For more information, visit Jubilant HollisterStier at **www.jublhs.com.**

Medical Manufacturing



Kahle Automation designs and builds machines for the assembly and inspection of all types of medical devices and drug delivery products. Kahle's services include custom equipment design, system integration, parts feeding, material and package handling, and equipment validation, along with the documentation to meet the unique requirements of all types of manufacturing applications. Kahle' staff is dedicated to designing solutions for only one industry, allowing us the opportunity to develop the expertise required to build turnkey production systems with a complete understanding of the challenges that face the Medical Manufacturing community. For more information, visit Kahle Automation at **www.KahleAutomation.com.**

Formulation & Manufacture

LATITUDE Pharmaceuticals provides innovative drug formulation services and GMP manufacturing for early phase clinical trials. Having completed more than 1,000 projects since 2003, LATITUDE's extensive experience in a wide range of dosage forms addresses the most difficult formulation challenges, including solubility, instability, and bioavailability. LATITUDE scientists have particular expertise in complex injectables (nanoemulsions, liposomes, microspheres, and nanoparticles). Furthermore, LATITUDE Pharmaceuticals provides GLP- and GMP-compliant manufacture and analytical testing, specializing in rapid customer response and delivery of Phase 1 and Phase 2 clinical trial materials. LATITUDE can manufacture sterile injectable, ophthalmic, non-sterile, oral, and topical dosage forms to support GLP-tox studies or early stage clinical trials. LATITUDE is especially proficient in the manufacture of complex liquid formulations, including nanoemulsions, liposomes, and nanoparticles. For more information, visit LATITUDE Pharmaceuticals at **www.latitudepharma.com.**

Capsules, Health & Ingredients

Lonza CHI is a preferred global partner to the pharmaceutical, biotech, and nutraceutical markets. Our pioneering Capsugel® capsules and encapsulation technologies help improve speed of development and execution and the match of dosage form performance to ingredients or API application. Our product portfolio and product services for pharmaceutical partners include: Capsules including customizations, Equipment, and Ingredient/API formulation services. We work to prevent illness and promote a healthier world by enabling our customers to deliver new and innovative medicines that help treat a wide range of diseases. We achieve this by combining technological insight, with world class formulation, manufacturing, scientific expertise and process excellence. For more information, visit Lonza CHI at **https://www.capsugel.com/.**

Lyophilization Services & Solutions

Founded 1992, Lyophilization Technology, Inc. is a Contract Development and Manufacturing Organization providing development services and technical support focused on lyophilized products. Experience with a wide variety of products, including small molecules, cytotoxics, biologics, highly potent compounds, vaccines, medical devices, and diagnostic agents, LTI has provided services and support spanning start-up, virtual, and multinational companies. A comprehensive range of services consists of product design, formulation development, process engineering, and clinical supplies manufacturing for pharmaceuticals, biologics, diagnostics, and biopharmaceuticals. Technical support encompasses consultation on technology transfer, validation, product and process evaluation, troubleshooting, streamlining operations, compliance auditing and training. When your needs are lyophilization, our focus is on your product. For more information, visit **www.lyotechnology.com** or call (215) 396-8373.

Technology & Service Provider

Micropore Technologies

From lab experiments through to aseptic/cGMP manufacturing, Micropore's award-winning membrane-based, formulation equipment offers the precision of microfluidics (CV of less than 10%) without the manufacturing burden of process parallelization or "scale-out." The low-shear processing prevents damage to protein-based therapies and other sensitive APIs in controlled-release, sterile injectable drug products and allows the replacement of undesirable emulsifying agents. Crossflow mixing also simplifies the solvent injection approach to nanoformulation, enabling efficient liposome, lipid nanoparticle, and polymer nanoparticle self-assembly. We offer early stage formulation development services, cGMP process consultation, tech transfer of production hardware, and global manufacturing support. For more information, visit Micropore Technologies at **www.micropore.co.uk/.**

Life-Saving Therapies

MilliporeSigma

MilliporeSigma is a leading science and technology company in healthcare, life science, and performance materials. MilliporeSigma offers more than 400 pharmaceutical formulation raw materials for solid, liquid, and semi-solid dosage forms, a wide range of active pharmaceutical ingredients and drug delivery compounds that include activated PEGs, lipids, and PEG lipids for bioavailability enhancement. In addition, MilliporeSigma provides extensive documentation and support to ensure regulatory compliance and to help advance the promise of life-saving therapies. For more information, visit MilliporeSigma at **www.embmillipore.com.**

Functional Chemicals

MITSUBISHI GAS CHEMICAL

Mitsubishi Gas Chemical (MGC) is a leading company in the field of functional chemicals, such as oxygen barrier and absorbing polymers. MGC established the Advanced Business Development Division in 2015 for tackling a variety of today's problems, and the division created OXYCAPT™ Multilayer Plastic Vial & Syringe to solve some issues of existing primary packaging for injectable drugs. OXYCAPT Vial & Syringe consists of three layers. The inner and outer layers are made of cyclo-olefin polymer (COP), the most reliable polymer in the pharmaceutical industry. The middle layer is made of state-of-the-art polyester developed by MGC. The oxygen-barrier property is almost equivalent to glass and much better than COP. OXYCAPT also provides an ultra violet (UV) barrier. For more information, visit Mitsubishi Gas Chemical at **www.mgc.co.jp/eng/products/abd/oxycapt.html.**

Patient-Focused Delivery Devices

Nemera
we put patients first

As a world-leading drug delivery device solutions provider, Nemera's goal of putting patients first enables it to design and manufacture devices that maximize treatment efficacy. Nemera is a holistic partner and helps its customers succeed in the sprint to market with its combination products. From early device strategy to state-of-the-art manufacturing, Nemera is committed to the highest quality standards. Agile and open-minded, the company works with its customers as colleagues. Together, they go the extra mile to fulfil its mission. For more information, visit Nemera at **www.nemera.net.**

Injection Trainers

one world™
Design & Manufacturing Group

For 25 years, **One World DMG** has been the pioneer and leading provider of injection trainers to the commercial device and pharmaceutical industries. Our clients have come to trust our design and engineering solutions will provide the best patient experience possible in the medical setting and, more importantly, at home where it is needed most. To date, we have created injection trainers for 50 brands across all platforms. We provide a full array of trainers for autoinjectors, pens, prefilled syringes, wearables, and respiratory devices. These are supported with patient onboarding materials, packaging, and video/print instructions, which are designed by our award-winning team and manufactured at our facility. Let us put our innovation to work for you. For more information, contact One World DMG at info@oneworlddmg or visit **oneworlddmg.com.**

Injectable Drug Delivery

Owen Mumford
Pharmaceutical Services

Owen Mumford Pharmaceutical Services is a specialist in the design, development, and manufacture of injectable drug delivery systems for the pharmaceutical, biotech, and generics industries. These include single-dose and multi-dose reusable and disposable auto-injectors, pens, and syringes for subcutaneous and intramuscular administration. Our innovative products are designed to meet both the need of our pharmaceutical partners and their patients by facilitating ease of use and improving safety and patient compliance. Our devices are also designed with the aim of reducing complexity and risk for the pharmaceutical and biotech industry in the development of their combination products. Our products are supported by our services, and we work with our partners every step of the way, supporting and guiding from initial concept stage through to taking the solution to market. For more information, visit Owen Mumford Pharmaceutical Services at **www.ompharmaservices.com.**

CDMO Services

Pace® Life Sciences provides a full suite of contract CMC development, CTM manufacturing, regulatory compliance, consulting, and facility support services to the pharmaceutical, biopharmaceutical, and gene therapy industries. Pace® Life Sciences operates from a network of CDMO sites, GMP analytical testing laboratories, and manufacturing support service centers across the United States. Our experienced, highly trained industry experts, and our investment in state-of-the-art development and manufacturing facilities emphasize our commitment to efficiently advancing client programs through the clinic to commercialization. We are dedicated to delivering the best and most reliable services with positive customer experiences across all channels of our business. For more information, visit Pace® Life Sciences at **www.pacelifesciences.com.**

Global CDMO

PCI is a leading global CDMO, providing integrated end-to-end drug development, manufacturing and packaging solutions to increase product speed to market and opportunities for commercial success. PCI brings the proven experience that comes with more than 90 successful product launches each year and over 5 decades in the healthcare services business. We currently have 30 sites across Australia, Canada, US, UK, and Europe, with over 4,300 employees that work to bring life-changing therapies to patients. Leading technology and continued investment enable us to address global drug development needs throughout the product lifecycle, collaborating with our clients to improve patients' lives. For more information, visit PCI at **www.pci.com.**

Specialized Products & Services

Pfanstiehl is a leading cGMP manufacturer of parenteral grade excipients and highly potent APIs. Pfanstiehl develops and manufactures high-purity, low-endotoxin (HPLE) carbohydrates such as trehalose, sucrose, mannitol, galactose, and mannose utilized as injectable excipients for the stabilization of proteins, mAbs, and vaccines. These HPLEs are also used as supplements for industrial cell culture, cell therapy, and cryopreservation media. Pfanstiehl also works closely with some of world's largest multinational pharmaceutical and biopharmaceutical firms, as well as with virtual pharmaceutical companies, to synthesize proprietary and commercial compounds in quantities ranging from grams to MT quantities. Manufacturing and development occur at Pfanstiehl's a 13-building campus located near Chicago, IL. For more information, visit us at **www.pfanstiehl.com.**

Global Data & Analytics

PharmaCircle is a leading provider of global data and analysis on the pharmaceutical, biotechnology, and drug delivery industries. PharmaCircle's premier database delivers an integrated scientific, regulatory, and commercial landscape view with unprecedented access to hundreds of company, product, and technology attributes. PharmaCircle connects product and pipeline information for drugs and biologics with formulation and component details, and provides due diligence level data on nearly 6,000 drug delivery technologies and devices. Drug label comparison tools and full-text document search capabilities help to further streamline research. No other industry database matches PharmaCircle's breadth of content and multi-parameter search, filtering, and visualization capabilities. To learn more, email contact@pharmacircle.com, call (800) 439-5130, or visit **www.pharmacircle.com.**

Globally Integrated Provider

Product realization has never been more complex. **Phillips-Medisize** supports today's specialization, regulation, and digitization for fast, efficient product launch on a global scale. For over 60 years, Phillips-Medisize has helped companies develop and manufacture innovative products that help people live healthier and more productive lives. Our integrated end-to-end portfolio of design, development, and manufacturing solutions is built on a solid foundation of specialized capabilities: End-to-end Services — contract design, development, and manufacturing services for all stages of the product lifecycle; Enabling Connectivity — hardware and software solutions that improve patient adherence and disease management; and Technology Accelerators — platform technologies for accelerated time to market, lower costs, and reduced risk. Phillips-Medisize offers a global presence that helps customers create innovative products that help people around the world. For more information, visit Phillips-Medisize at **www.phillipsmedisize.com.**

Drug-Development Library

Pharmaceutics International Inc. (Pii) proudly offers a library of e-books for Bio/Pharma scientists. The series of e-books is ideal for Bio/Pharma companies seeking to partner with a Contract Development and Manufacturing Organization, such as Pii, and bring a molecule from clinic to commercialization. Using state-of-the-art specialized equipment, Pii offers phase-appropriate development in early stages to support your program and accelerate timelines. In these e-books, you will learn that partnering with a CDMO garners success when dealing with the following: Aseptic Manufacturing, Sterile Fill & Finish, Lyophilization Cycle Development, Scale-Up & Tech Transfer, HPAPI; Controlled Drugs/DEA Scheduled Drugs, BCS Class II to IV Drugs, Oxygen-Sensitive Drugs, and Regulatory Hurdles. Don't delay in connecting with Pii's R&D team! Download an e-book from the Pii library! For more information, visit Pii at **https://www.pharm-int.com/ebook-drug-development-library/.**

Medical Device Manufacturing

plas-tech engineering
EXCELLENCE IN MEDICAL MANUFACTURING

Plas-Tech is a full-service medical device manufacturing company. To better support the drug delivery and biotech markets, we created Equinox Medical as a subsidiary of Plas-Tech Engineering. Together they provide value at every step of the way that enables our customers to benefit from higher quality products with leading edge design for manufacturing, assembly, tooling engineering and polymer materials expertise. With over 30 years of expertise in medical manufacturing our capabilities have proven to be advantageous for our customers in the medical device industry as well as other related industries that require difficult to manufacture products. For more information, visit Plas-Tech at **www.plastechengineering.com.**

OINDP Development Services

proveris® LABORATORIES

Proveris® Laboratories ioffers Orally-Inhaled and Nasal Drug Product Development (OINDP) expertise to pharmaceutical developers, including contract services employing new innovative in vitro techniques. These include measuring plume front velocity, evaporate rate, and quantifying deposition of inhaled drug products using human-realistic models. Employing in vitro approaches that are human-realistic can enable companies to make data-driven decisions and expedite product development and approval while saving time and resources. For more information, visit Proveris® Laboratories at **https://www.proveris.com/why-proveris/.**

Integrated Drug Substance & Drug Product Services

Quotient Sciences

Molecule to cure. Fast.™

Quotient Sciences is a pharmaceutical development & manufacturing accelerator offering fully integrated programs and tailored services from candidate selection through commercial manufacturing. Our seamless integration of drug substance, drug product development & manufacturing and clinical testing services, results in a more efficient and accelerated development plan. Integrating all activities under a single organization in an entirely non-siloed way encourages close relationships between multidisciplinary experts, creating a more agile approach to pharmaceutical development. The ultimate benefit is a significant cost savings & shortening of the timeline from candidate selection to clinical development, which in turn allows us to get medicines to patients faster. For more information, visit Quotient Sciences at **www.quotientsciences.com.**

Integrated CDMO Services

Recipharm is a leading contract development and manufacturing organiZation (CDMO) with the competence, flexibility, and facilities to take on challenging projects that require custom tailored processes. With a broad range of expertise and technologies available, we can offer our support and services, ranging from development and procurement to full-scale manufacturing. Covering a range of dosage forms, including: solids, semi-solids, liquids, inhalation, steriles, and ophthalmics, Recipharm can provide integrated services tailored to meet your product. Whether you are a big pharma company outsourcing a key stage of your production or a small to medium-sized specialty firm seeking support in the development, transfer, and production of a product; we're a reliable option. For more information, visit Recipharm at **www.recipharm.com.**

Contract Service Provider

singota® solutions

Singota is a cGMP-compliant contract service provider to the life sciences industry, offering outsourcing partnerships for formulation development, testing, labeling and kitting, and supply chain services. Headquartered in Bloomington, IN, Singota has more than 50 employees with many years of valuable experience in the pharmaceutical and biotechnology industries. Singota Solutions is a dba of BioConvergence, LLC. For more information, visit Singota at **www.singota.com.**

Glass Primary Packaging & Analytical Services

SG Stevanato Group

Established in 1949, **Stevanato Group** is the world's largest, privately owned designer and producer of glass containers for the pharmaceutical industry. From its outset, the Group has developed its own glass-converting technology to ensure the highest standards of quality. The Group comprises a wide set of capabilities dedicated to serving the biopharmaceutical and diagnostic industries: from glass containers with its historical brand Ompi, to high-precision plastic diagnostic and medical components, to contract manufacturing for drug delivery devices, to vision inspection systems, assembly, and packaging equipment. For more information, visit Stevanator Group at **www.stevanatogroup.com.**

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Actylis	58,59	Marketing@actylis.com	www.actylis.com
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Curia	88,89	corporatecommunications@curiaglobal.com	www.curiaglobal.com
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DDL	15,91	ddlinforequests@ddltesting.com	www.ddltesting.com
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Emergent	92,93	cdmo@ebsi.com	www.emergentCDMO.com
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FLEX Health Solutions	98,99	healthsolutions@flex.com	www.flex.com/healthcare
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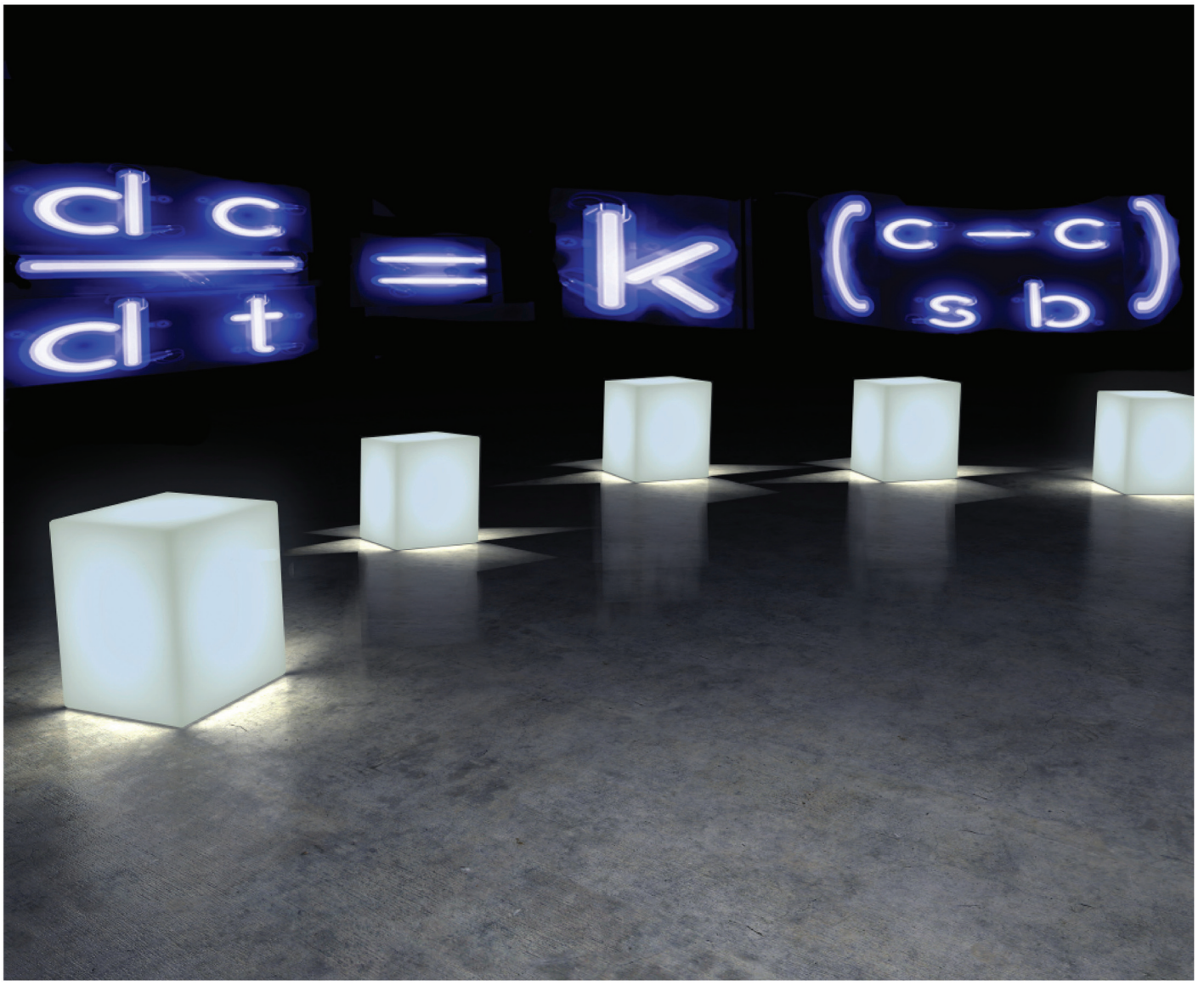
RDD	53	info@recipharm.com	www.rddonline.com
Singota	148, 149	solutions@singota.com	www.singota.com
Stevanato Group	150, 151		www.stevanatogroup.com
Vetter Pharma International	152, 153	info@vetter-pharma.com	www.vetter-pharma.com



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