Changing Lives Through Delivery Technology

www.drugdeliveryexperts.com
Vision
Changing Lives Through Delivery Technology

Partnering for the Best Drug Product Solutions
Mission
Center of Excellence

Specialists in combination drug product development
Complex formulation design and device integration
Extensive experience in biologics drug development
30 highly qualified PhD and BS scientists
Leveraging a deep understanding of molecular properties, formulation, and device
Integrating delivery system R&D projects into your development program
Optimizing target product profile to enhance value proposition

**Discovery Support**
- Lead molecule profiling
- Clinical candidate evaluation
- Biologic half-life extension

**Drug Product Development**
- Formulation design
- Drug product development
- Analytical methods

**Device Selection**
- Device identification
- Integration with formulation
- Combination product development
Capabilities

• Pharmaceutical R&D Laboratory
  • Formulation, analytical, process, chemistry, device development
  • Specialists in complex drug product development
  • Peptide and small molecule chemistry, conjugation (e.g., PEGylation)
  • Lead candidate selection, optimizing pharmaceutical properties

• Drug Product Development Strategic Partnership
  • Strategic product development and hands-on technical support
  • Participation in CMC teams (analytical, formulation, chemistry, device)
  • Ideation and translation of innovative technologies from research to clinic

• Partnering to Develop New Delivery Technologies
  • Sustained release injectable delivery technology
  • Self assembling delivery technology
  • Oral capsule device for targeted delivery
Leadership Leverages 200+ Years of Pharma / Biotech Experience

Chris Rhodes, Ph.D., President & CEO
Founded Drug Delivery Experts in 2014 after 20 years in biotech and drug delivery companies in both technical and executive leadership roles

Robert Jennings, Ph.D., COO
Rob joined DDE in 2017 with over 25 years of pharmaceutical development experience and was most recently site head for two startup pharmaceutical companies

David Litzinger, Ph.D., V.P., R&D
Dave joined Drug Delivery Experts in 2015 and has over 22 years of drug discovery and development experience, including technical and leadership roles in pharmaceutical and biotech companies

Lawrence D’Souza, Ph.D.
Discovery, Chemical Development, Formulation

Catherine H. Charles, Ph.D.
Formulation, Bioanalysis, Recombinant Protein

Fu Chen, Ph.D.
Analytical Methods Development and Formulation

Jui-Chen Lin, Ph.D.
Formulation, Drug Product Development, Aseptic Manufacturing

Shu Fen Wen, Ph.D.
Drug Product Development, Manufacturing

Laxma Reddy, Ph.D.
Formulation, Small molecules, Biologics
Leadership Experience Base
Companies and Products our Leaders have worked with

Companies

- Amgen
- Pfizer
- Lilly
- Allergan
- Wyeth
- biogen idec
- Nitto
- MedinCell
- OHR Pharmaceutical Inc.
- Ardea Biosciences
- AGOURON INSTITUTE
- AGuilford Pharmaceuticals
- MannKind Corporation
- Ambrx
- Biota
- GUILFORD PHARMACEUTICALS
- scios

Products

- Afrezza (insulin human) Inhalation Powder
- LUSEDRA (tospropicitol diosodium) Injection
- Kineret (anakinra)
- Sensipar (cinacalcet) Tablets
- Viracept (nelfinavir mesylate tablets and oral powder)
- ZURAMPIC®
- BYDUREON®
- myalept (metreleptin) for injection
- SymlinPen (pramlintide acetate)
- GIADEL Wafer (carboxymethyl cellulose implant)
- Prevnar 13 (Pneumococcal 13-valent Conjugate Vaccine (Diphtheria CRM197 Protein))

FERRING PHARMACEUTICALS

A member of the AstraZeneca Group
Project Experience

Molecules

- Protein
- Oligo
- Peptide
- Small molecule

Therapeutic Area

- Cancer
- Infectious
- Alzheimer's
- Anti-fungal
- Cardiovascular
- Ocular
- Metabolic
- Nasal
- Diabetes
- Orphan Indications

Programs

- Topical Ocular Delivery
- Lead Selection
- Preformulation

Partners

- Microsphere, Liposomes, SR
- Int'l biotech
- Public US biotech
- Private US biotech
Sustained Release Formulation Approaches

- **Daily Injection**
- **Weekly Injection**
- **Monthly Injection**
- **Quarterly Injection**

Increasing Drug Potency

- **Suspension**
- **Liposome**
- **In Situ Gel-Forming System**
- **Microsphere**
- **Non-Aqueous Solution/Suspension**
- **Implant**
Sustained Exposure
Conjugate Approaches

- **Daily Injection**
  - Acylation (albumin binder)
- **Weekly Injection**
  - Carbohydrate analogues
  - Poly Amino Acid Fusions (XTEN, ELP, PASylation)
- **Monthly Injection**
  - PEGylation
  - Albumin or Fc Fusion (FcRn recycling)

Various including Reversible PEG

HESylation, Glycosylation
Specialists in Biologics

• Lead Molecule Selection and Molecular Design
  • Structural modifications to improve physico-chemical properties and extend half-life
  • Amino acid variants for site-specific conjugation
  • Mutation series and Fc fusions
• Non covalent modifications to alter properties
  • Salts and complexes to slow dissolution
• Recombinant protein expression, peptide and oligonucleotide synthesis
• Structural characterization, stability, and degradation products identification
Project Supporting Activities

**Lead Molecule Selection**
- Analytical Research
- Development Assessment
- Lead Molecule Design

**Delivery System Selection**
- Analytical Development
- Delivery System Feasibility
- Preformulation
- Formulation PK Screening

**Drug Product Development**
- Formulation Development
- Analytical Methods Qualification
- Development Stability
- Process Development Scale Up
- Device Selection and Development
- Technology Transfer GMP Mfg

**Molecule Design**
- Peptide, protein variants
- Conjugates for half-life

**Delivery System Design**
- Aqueous or non-aqueous vehicle
- Sustained release formulation
- Triggered or targeted systems

**Drug Product Design**
- Pen, autoinjector
- Pre-filled syringe
- Nasal, ocular drops or spray

Test Article Supply for Preclinical and Toxicity Studies
Partnership Options

- **Project Specific Work**
  - Shorter well-defined projects
  - Typically 3 to 9 months
  - Discrete project definition
  - Payment milestones

- **Dedicated R&D Team**
  - Longer term and broader projects
  - Typically 1 to 3 years
  - Dedicated resources for program
  - Regular quarterly or monthly payments
Partner Patent Support

• Aileron chemistry and formulation composition
  • Peptidomimetic macrocycles and formulations thereof
    US 20160101145 A1
• Client applications not yet published
  • Chemical responsive formulation
  • Nasal formulation for infection
  • Sustained release peptide formulation for improved patient use
  • Co-formulation of peptides
Equipment Setup for R&D and Product Development

- High Performance Liquid Chromatography (HPLC) with diode array, fluorescence, and molecular weight detection for formulation characterization, in vitro release, and stability
- Ultraviolet-visible spectrophotometry (UV/Vis), fluorescence, and absorbance based plate readers for concentration, plasma compatibility, and solubility screening
- Particle size analyzer (laser diffraction) and dynamic light scattering for hydrodynamic radii estimation
- Tray lyophilizer for cycle development
- Osmometer and viscometer for formulation characterization
- Injection force measurement using Instron
- Liquid chromatography-tandem mass spectrometry (LCMSMS) for characterization and bioanalysis
- Scanning Electron Microscope for microsphere visualization
- Fast protein liquid chromatography (FPLC) for purification
- Stability Chambers
- Laminar flow hood, depyrogenation oven, and autoclave in clean prep room for preclinical and stability sample preparation
- Gel electrophoresis imager for imaging protein gels
Process Suite for Test Article Preparation
from Research to Toxicity Studies

- Restricted access with training required
- Suite meets ISO Class 7
- Laminar Flow Hoods
  - ISO Class 5 annual certif.
- Quality System Guidelines
  - Gowning, Cleaning, etc.
- Documentation System
Process Suite Experience

- Produced over 100 batches in the past 3 years
- Batch size 800 µL to 2 liters
- Batch records and suite preparation signed off ahead of fill
- Batch release testing with Certificate of Analysis
  - Concentration, purity, pH, osmolarity, endotoxin etc.
- Formulation composition and process
  - Aqueous and non-aqueous solutions and suspensions
  - Liposomes, microspheres, gels, salts, and others
- Formulation and fill finish manufacturing for stability studies
  - 24 mo shelf life now supporting phase 2 program
  - Stability studies to support ANDA filing
  - Several development studies for tox & clinical formulation selection
Facility
Business Advisors

Dan Bradbury
Pharma Advisor
• Former Amylin CEO, Chairman BioBrit, advisor to startups

Donald Rindell
Business Advisor
• Principal, Camino International, corporate strategy and business development

Eddie Rodriguez
Legal Advisor
• Attorney at Troutman Sanders, corporate and legal advisor

Magda Marquette
Contract Services Advisor
• Founder of Althea and Althea DX, successful sterile manufacturing
## Technical Advisors

<table>
<thead>
<tr>
<th>Name</th>
<th>Role in Industry</th>
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<tbody>
<tr>
<td>William Vincek, Ph.D.</td>
<td>President Pharma CMC, formerly SVP Development, Alpharma, Guilford Pharmaceuticals, GSK, Merck</td>
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<tr>
<td>Alain Baron, M.D.</td>
<td>CEO Elcelyx and Nazura BioHealth, formerly SVP Research, Amylin Pharmaceuticals</td>
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<tr>
<td>Phil Duffy</td>
<td>Operations consultant in life sciences, previously SVP Pacira, VP at Ligand and Schein Bayer</td>
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<tr>
<td>Solomon Steiner, Ph.D.</td>
<td>CEO Perosphere Inc., previously CEO and Founder of Biodel, Mannkind, and Emisphere Technologies</td>
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<tr>
<td>Will Clodfelter, M.B.A.</td>
<td>Market &amp; Device Development</td>
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<tr>
<td>Mark Longer, Ph.D.</td>
<td>Regulatory Strategy</td>
</tr>
<tr>
<td>Nelson Lugo, M.B.A.</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>Bill Van Antwerp</td>
<td>Device and Diagnostics R&amp;D</td>
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<tr>
<td>Molly Holman, Ph.D., J.D.</td>
<td>Intellectual Property, Legal</td>
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<tr>
<td>James Matriano, Ph.D.</td>
<td>Bioanalytical</td>
</tr>
<tr>
<td>Michelle Neoh</td>
<td>Market Research</td>
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How Can We Help Your Team?

- **Combination Drug Product Development**
  - Peptide and protein development
  - Lead molecule profiling and half-life extension
  - Subcutaneous and ocular formulation design and development
  - Sustained release injectable formulations
  - Device design and development
  - Translation from research through clinical and commercialization