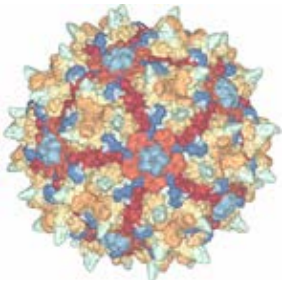
PIONEER FORWARD

GENE THERAPY DEVELOPMENT

INTRODUCTION

Pace® Life Sciences offers a full suite of integrated research, development and testing services for the biopharmaceutical industry. We provide expertise for the development of novel gene therapy drugs, covering numerous chemical modalities, including mRNA, oligonucleotide, and adeno associated virus (AAV). Utilizing state-of-the-art equipment, our team of experts will be an integral component in driving success of your gene therapy development, commercialization and product release.



MASS SPECTROMETRY

PROTEIN, DNA, RNA, LIPID

- **UPLC /HPLC with Triple Quad and Q-TOF**
  - Identification of Process Impurities/ Related Substances
  - Intact, Reduced, De-glycosylated Mass Determination
  - 5′ Cap Identity and Purity
  - Sequencing (Peptide Mapping, Oligonucleotides)
  - Disulfide Bonding/Structural Elucidation
  - Glycosylation (N- and O-linked)
  - Carbohydrate Analysis (Released Glycans, Monosaccharides, Sialic Acid)
  - Chemical & Post-Translational Modifications Extractables & Leachables
  - HCP Identification
- **GC-MS with Headspace & FID**
  - Residual Solvents
  - Impurities

CLEANING VERIFICATION – VALIDATION

- **API and Excipient Residuals**
- **Surfactants**
- **Flocculation/Antifoam Reagents**
- **Processing Reagents /Impurities**

LAB SCALE PROCESSING

- **Tangential Flow Filtration (TFF)**
- **Lyophilization**
- **Spray Drying**
- **Fast Protein Liquid Chromatography (FPLC)**

GMP CLINICAL SUPPLIES MANUFACTURING

- **Formulation Development**
- **Aseptic fill-finish**
  - Vials
  - Pre-filled syringes

COMPATIBILITY TESTING

- **Processing Conditions/Equipment**
- **Filtration**
- **Container/Closure**
- **Silicone Oil, Stainless Steel, PTFE**
- **Infusion/Injection Delivery Devices**

Technology transfer from our early-phase development laboratory in Boston, MA, to our Oakdale, MN state-of-the art GMP testing facilities enables our clients to seamlessly and confidently advance their programs through pre-clinical and clinical studies onto commercialization in a manner compliant with regulations and industry standards.

PACE PHARMACEUTICAL & BIOPHARMACEUTICAL PRODUCT DEVELOPMENT

RESEARCH & DEVELOPMENT R&D LABS	CLINICAL TRIAL MATERIALS CLINICAL LABS	MANUFACTURING SERIVCES GMP LABS
Basic Research Lead Optimization Preclinical Development	Clinical Development Phase 1, 2, 3	Commercialization & Manufacturing Product Line Extension Post Approval Change

CHROMATOGRAPHY

PROTEIN, DNA, RNA, LIPID

- **UPLC /HPLC Detection**
  - UV/FLR/ELSD
  - RI/MALS
  - MS (Triple Quad and High Res)
- **UPLC/HPLC Separation**
  - Reversed Phase, IP-RP, HIC, HILIC
  - Ion Exchange (IEX)
  - Size Exclusion Chromatography (SEC)
  - FFF – Field Flow Fractionation
- **Applications**
  - Lipid Content and Purity
  - Oligo Content and Purity
  - Poly-A Tail Length and Purity
  - Disulfide Boding
  - Glycosylation and Carbohydrate Analysis
  - Deamidation, Oxidation, Deamination
  - Sequence Variants
  - Peptide Mapping
  - Amino Acid Composition Analysis
  - Surfactants (PS20, PS80, Poloxamer)
  - Soluble Aggregates / Oligomeric State
  - Raw Material Protein Characterization

ELECTROPHORESIS

PROTEIN, DNA, RNA

- **Capillary Electrophoresis**
  - PA800 (CE-SDS/CZE/cIEF)
  - Maurice (icIEF, iCGE)
- **Lab Chip**
- **Fragment Analyze**
- **Applications**
  - Protein Size and Charge State
  - Disulfide Bonding
  - RNA/DNA Content and Purity
  - Poly-A Tail Length

BINDING ASSAYS

- **ELISA (96 & 384-well formats)**
  - Colorimetric
  - Fluorescent/Luminescent
  - kD-Determining

PHYSICAL & COMPENDIAL TESTING (USP, EP, JP)

PROTEIN, DNA, RNA, LIPID

- **Extinction Coefficient Determination**
- **Protein and Nucleic Acid Concentration by SoloVPE UV/Vis**
- **Sub-visible Particle Analysis:**
  - Dynamic Light Scattering (DLS)
  - HIAC particle counter
  - MFI – Micro-Flow Imaging
  - Zeta potential
- **Osmolarity (Freezing Point, Vapor Pressure)**
- **Viscosity**
- **Refractive Index**
- **Opalescence**
- **Solubility**
- **Specific Gravity**
- **Reconstitution Time**
- **Fill Volume**
- **Functional Testing (PFS, Autoinjector, Cartridge)**
- **Container Closure Integrity**
- **Water Content by KF**
- **Elemental Impurities: ICP-MS, ICP-OES, AA**

MOLECULAR BIOLOGY

- **dPCR/qPCR**
- **Dye Binding Assays**
- **qPCR Virus Detection**
- **Mycoplasma Determination**
- **Agarose Gel Analyses**
- **RNA/DNA ID & Integrity Testing**

IMPURITY ASSAYS

- **Host Cell Residual DNA Content**
- **dsRNA content**
- **Host Cell Protein (Generic & Specific)**
- **Residual Protein A,L,G**

EXTENDED CHARACTERIZATION

- **Vector Size Distribution, Structure, Stability**
  - Light Scattering (MALS, DLS)
  - Circular Dichroism (CD)
  - Differential Scanning Fluorimetry (DSF)
  - Differential Scanning Calorimetry (DSC)
  - Intrinsic Fluorescence
  - FTIR

MICROBIOLOGY

- **Sterility Testing**
- **Bacterial Endotoxin Testing**
- **Microbial Limits & Enumeration Testing**
- **Microbial Bioburden**
- **Antimicrobial & Disinfection Efficacy Testing**

Pace® is committed to supporting our partners in transforming the potential of gene therapy into patient outcomes. Our state-of-the-art laboratories, robust quality systems and world-class expertise remove challenges at every stage of the pharmaceutical development process and clear the way for our partners to keep pioneering forward. That's potential, transformed.

Pace Analytical®