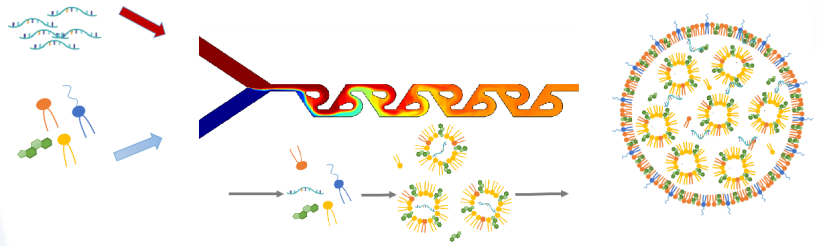
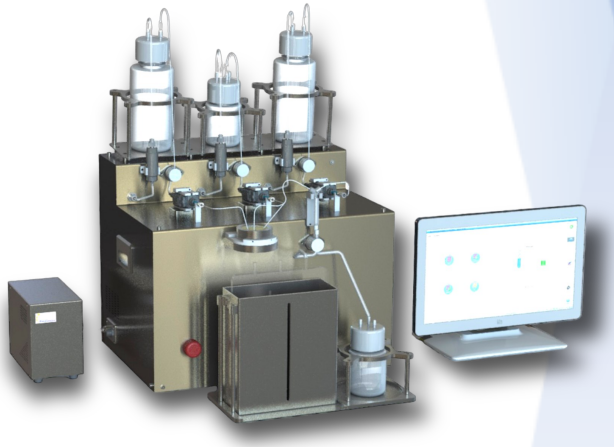
PreciGenome

Product Catalog

NanoGenerator®
Nanoparticle Synthesis for LNP & PLGA





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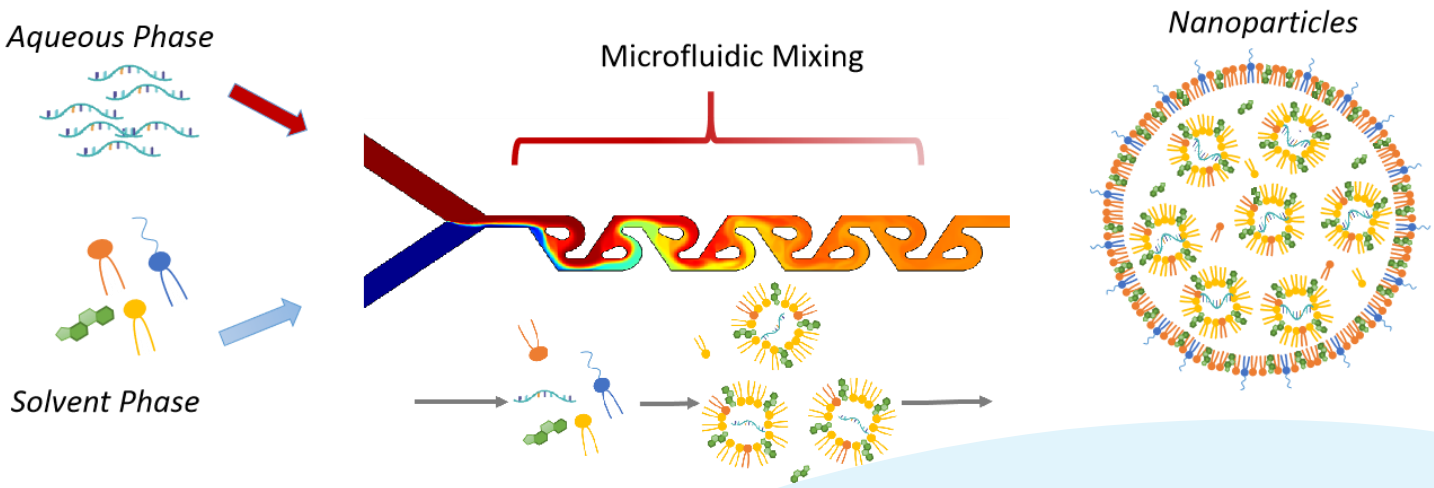

Nanoparticle synthesis via microfluidic mixing has superior control of size, homogeneity, and repeatability to conventional batch synthesis methods. Two streams, aqueous and solvent, meet in a narrow mixing channel, forming nanoparticles with payload encapsulated.

PreciGenome's NanoGenerator® platform uses pressure-based microfluidics for reliable nanoparticle synthesis at several production scales. It has been widely used to produce various types of nanoparticles, such as lipid nanoparticles (LNPs), liposomes, PLGA nanoparticles, etc.

Microfluidic Mixing System

- Controllable particle size
- Low PDI
- High encapsulation efficiency
- High reproducibility

System Benefits

High Performance & Efficiency

- Tunable size (40-200 nm)
- Low PDI
- High encapsulation efficiency

Open Platform

- Reagents
- Microfluidic chips

Scalable Throughput

- Scalable output from 100uL to >20L

Simple Operation

- Easy setup
- Compact size
- Intuitive UI w/ touchscreen

Cost Effective

- Affordable configuration
- Low cost consumables

Custom design &OEM

- Research collaboration
- Custom design
- OEM & Contract manufacturing

Payloads

- mRNA/siRNA/other RNA
- DNA
- Proteins and peptides
- Small molecule drugs
- Other payloads

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Path from Discovery to Commercialization

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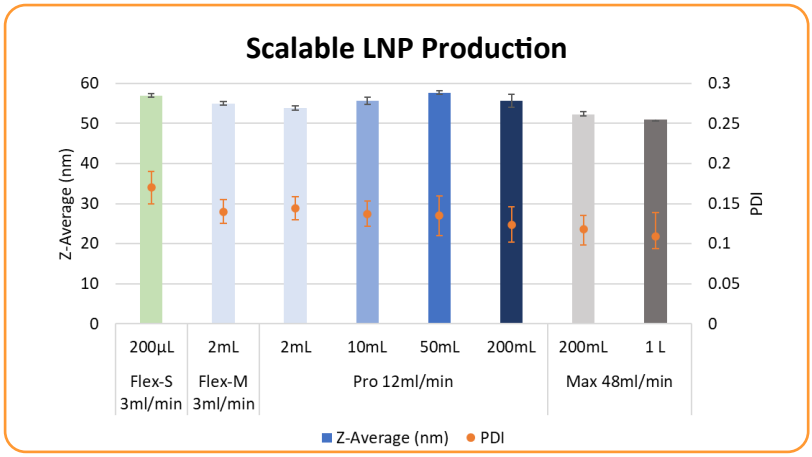
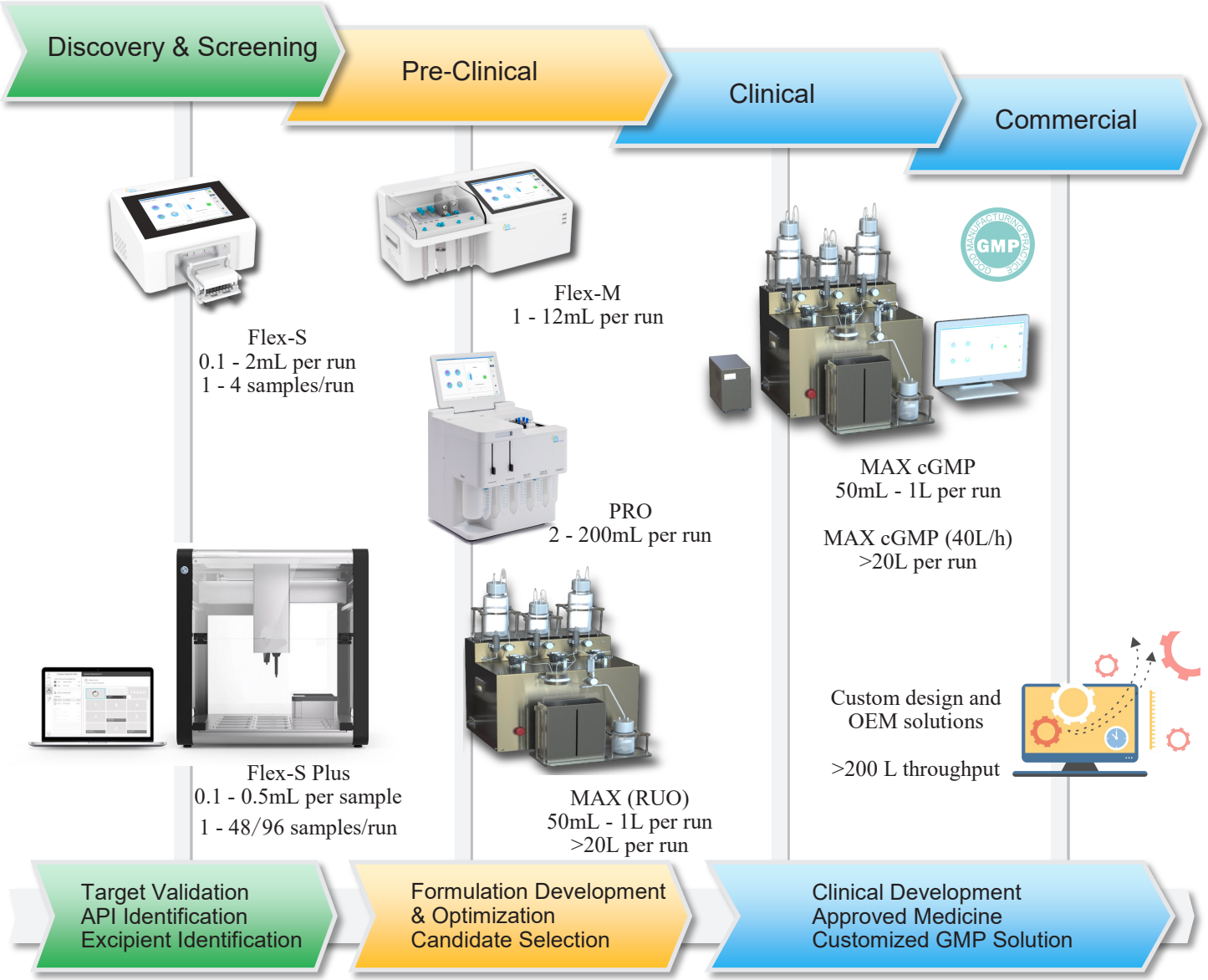
NanoGenerator® offers controllable and reproducible mixing conditions, ensuring the accurate synthesis of LNPs through its scalable architecture found in the entire NanoGenerator® product line. Options are available for all production stages, allowing seamless transfer of crucial process parameters and guaranteeing consistent critical quality attributes (CQAs). LNPs produced from NanoGenerator® may be used for a wide range of applications, such as vaccine development, gene therapy, cell therapy, etc.





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NanoGenerator® Flex-S Nanoparticle Synthesis System

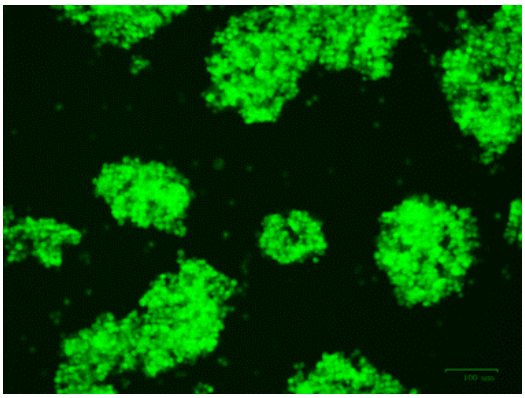
NanoGenerator® Flex-S

The NanoGenerator® Flex-S is designed for small scale production. It may run 1 to 4 samples at once, each sample from 0.1 to 0.5 ml. The throughput volume is therefore 0.1 to 2 ml per run, perfect for formulation screening and early discovery and saving over 80% in the reagent cost versus larger volumes.

Even smaller output volumes (<0.1 ml per run), special total flow rate and flow rate ratio are attainable at special request by recipe optimization.

Model	NanoGenerator® Flex-S
Mixing Cartridge	CHP-MIX-4
Throughput	0.1 to 2 ml per run. 1 to 4 samples per run.
Total Flow Rate	3 ml/min, 4 ml/min
Flow Rate Ratio (W:O)	3:1
Size Range	40 to 200 nm
PDI	0.05 to 0.2
Encapsulation Efficiency	85-95%
Payloads	DNA, mRNA, siRNA, protein, small molecules

eGFP mRNA LNP Delivery to Jurkat Cells



Jurkat Cells transfected with Formulation #9. Green fluorescence image at 48 hours post transfection.

Example of Formulation Screening by Flex-S

Screening Panel			LNP Characterization			Cell Study
Formulation	Ionizable Lipid	N/P Ratio	Size (nm)	PDI	EE%	GFP expression
#1	40%	3.57	56.6	0.19	86%	+
#2	40%	5.35	79.9	0.246	84%	+
#3	40%	8	75.2	0.214	85%	++
#4	60%	5.35	128.5	0.13	81%	NA
#5	40%	5.35	62.8	0.186	90%	++
#6	40%	8	54.3	0.184	93%	++
#7	50%	8	79	0.155	88%	+
#8	50%	11	82.2	0.126	90%	NA
#9	50%	8	87.5	0.12	91%	+++

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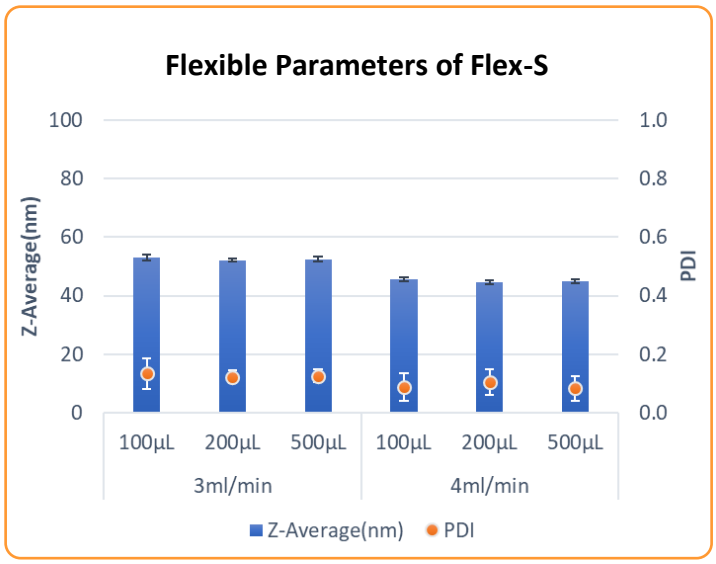


New features of NanoGenerator® Flex-S:

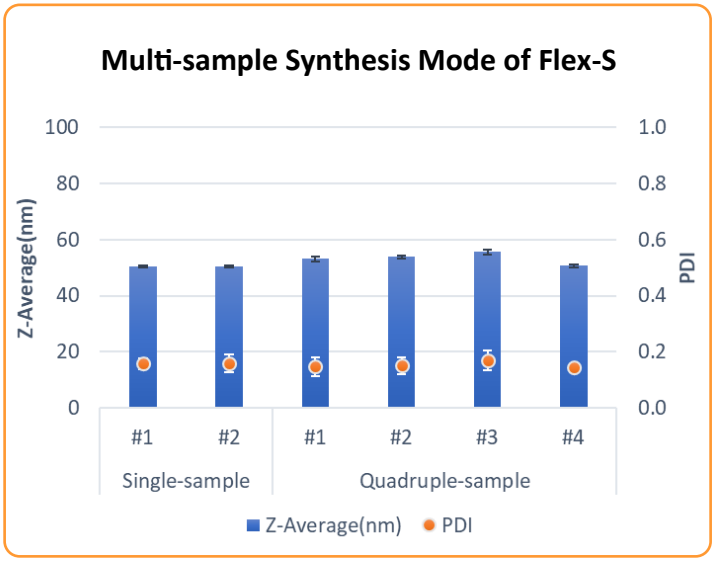
- **More total flow rate settings.** Users can choose 3 or 4 ml/min to conduct LNP synthesis. Higher total flow rate generates smaller LNPs. Other total flow rate and flow rate ratio are attainable at special request. *LNP size and PDI also depend on other factors such as the payload and formulation choice.*

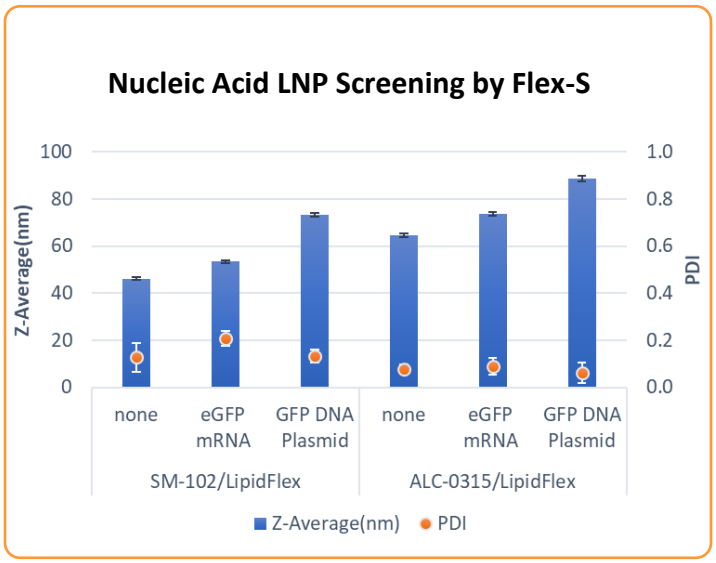
- **Output volume as low as 100 µl** is attainable by loading 75 µl aqueous samples (e.g. mRNA samples) and 25 µl lipid formulation.

Multi-sample Synthesis by NanoGenerator® Flex-S:

- **10 seconds, 4 samples!** Users can enable multi-sample synthesis mode to conduct formulation screening. The screening time is as low as 10 seconds

- **Reliable screening results.** Using PreciGenome's advanced air-flow control technology, users can obtain reliable LNP results on both single- and multi-sample synthesis modes.





- **Affordable formulation screening.** With the NanoGenerator® Flex-S, users can conduct formulation screening with minimal reagent consumption and reduced reagent cost.

- **Excellent batch-to-batch consistency.** Ease of operation and reliable components ensure consistent performance.

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NanoGenerator® Flex-S Plus Nanoparticle Synthesis System

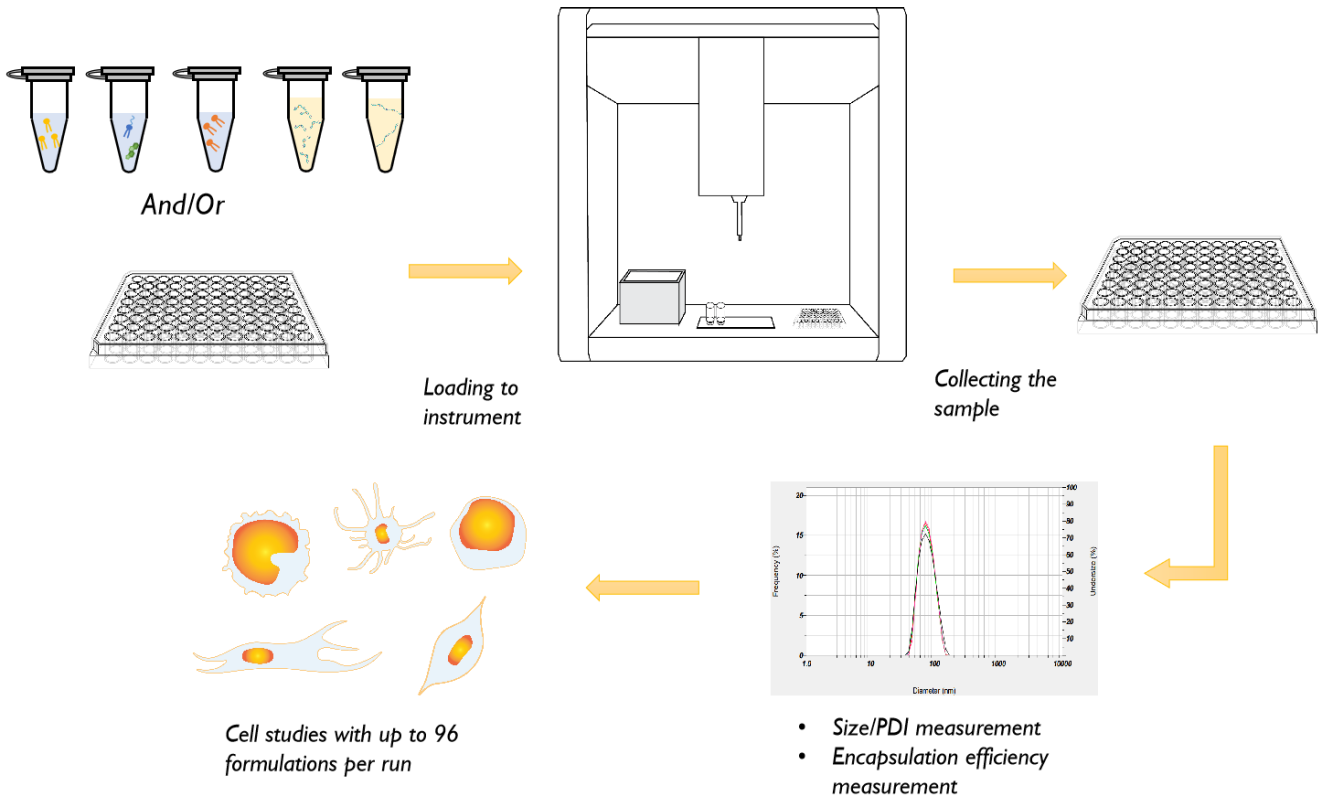
NanoGenerator® Flex-S plus high throughput screening system

The Flex-S Plus System facilitates the rapid screening of nanoparticle formulations and early-stage mRNA candidates, offering a substantial increase in project efficiency.

With a max throughput of 48/96 experiments an hour, the Flex-S Plus greatly streamlines screening processes. It offers comprehensive automation of complex protocols, enabling users to concentrate on other laboratory duties.

The system also permits experimentation with as little as 20 µl of payload reagent (e.g. mRNA) while providing control over collection volumes. This allows users to optimize the use of valuable materials.

Automated Screening Workflow



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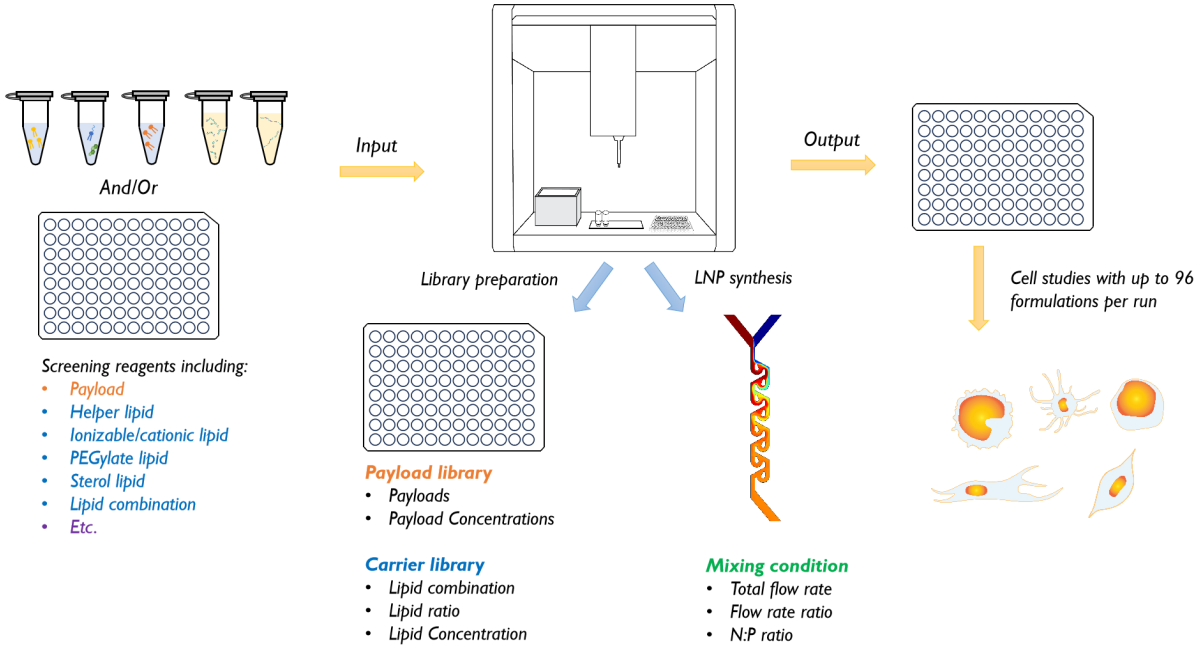
Formulation Screening & Discovery with High-throughput

Example screening factors with the Flex-S Plus include payloads, carrier formulation, total flow rate, flow rate ratio, N:P ratio, and LNP concentration. Precise control of parameters ensures consistent CQAs, guaranteeing speed, cost-effectiveness, and reliability at every stage of the experiment.



System Benefits

High Throughput & Efficiency

- Multiple sample (1/4/48/96) per run.
- Runtime <5 min for 4 samples, <1 hour for 48/96 samples

Regulatory Compliance

- Intuitive software (21 CFR Part 11 compliant)
- Single-use mixing cartridge

Scalable & Reproducible

- Direct transfer from discovery to clinical manufacturing
- Reproducible manufacturing

Automation

- Automated workflow
- Real-time data monitoring & recording
- Electronic batch records

High Yield

- Small reagent volume (minimum 50 µl) for each sample.
- Save up to 80% of RNA/lipid cost

Custom Design & Service

- On-site 3Q installation & qualification
- Custom design & OEM

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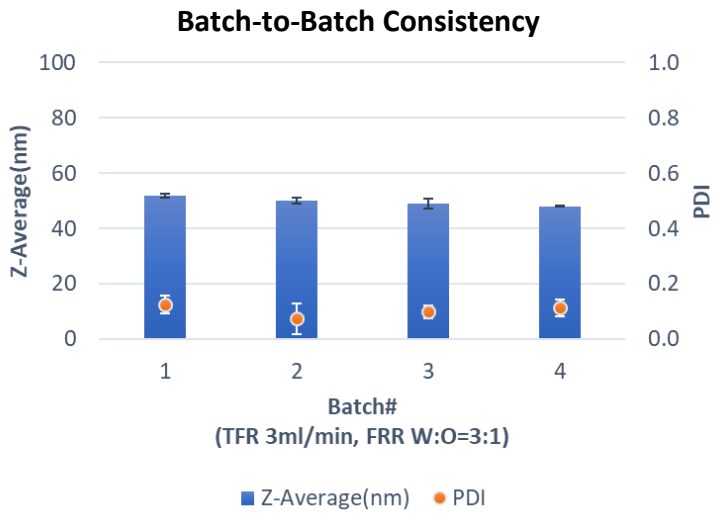
NanoGenerator® Flex-M Nanoparticle Synthesis System

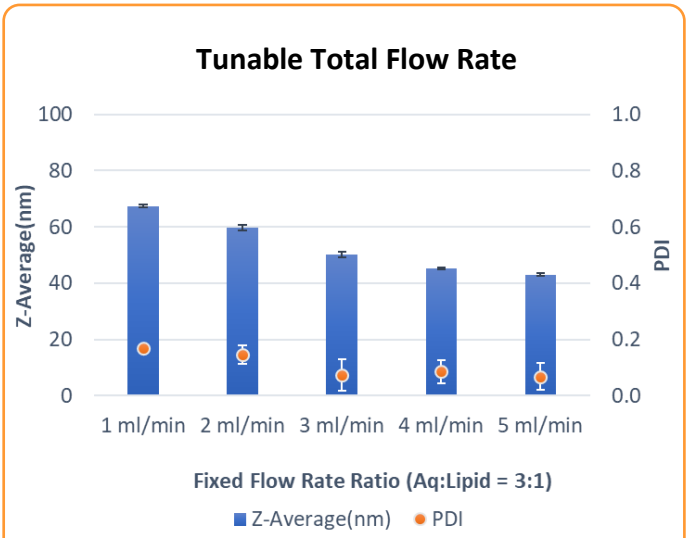
NanoGenerator® Flex-M

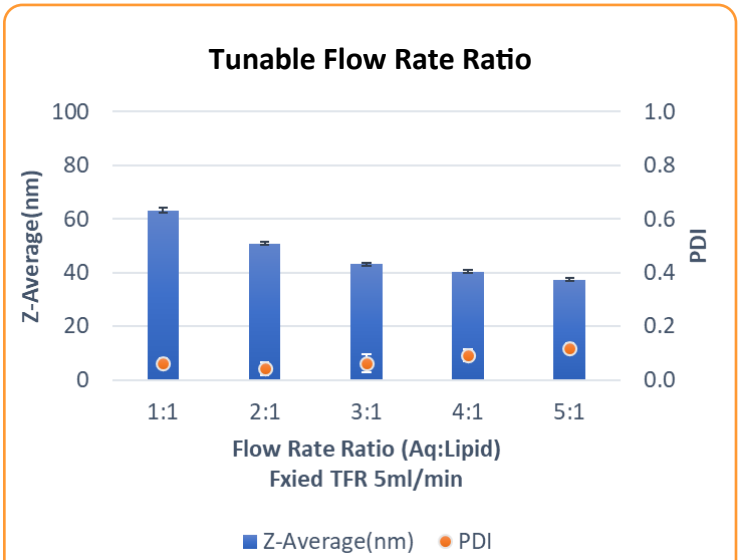
The NanoGenerator® Flex-M is designed for small to medium scale production. It has a throughput range from 1 to 12 ml, suitable for a variety of applications from early screening to animal studies.

An add-on package is available for in-line dilution, allowing users to instantly reduce ethanol concentration during production. This further stabilizes LNPs right before collection.

Model	NanoGenerator® Flex-M
Mixing Cartridge	CHP-MIX-4
Throughput	1 to 12 ml
Total Flow Rate	1 to 5 ml/min
Flow Rate Ratio (W:O)	1:1 to 5:1
In-line Dilution (optional)	0.5:1 to 2:1
Size Range	40 to 200 nm
PDI	0.05 to 0.2
Encapsulation Efficiency	85-95%







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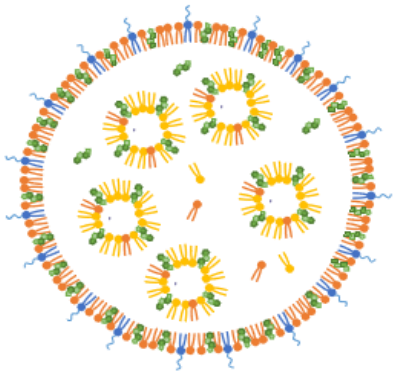
Case Study:

T Cell Transfection by mRNA Lipid Nanoparticles



Since the first FDA approval of chimeric antigen receptor (CAR) T cell therapy in 2017, T cell engineering has continued to be the hottest research field in immunotherapy and cell therapy. Current CAR T cell engineering methods use viral transductions, which induce permanent CAR expression and have potential safety concerns. To overcome these concerns, researchers are highly interested in non-viral gene delivery methods.

Recently, CAR mRNA LNPs in T cell engineering have been widely studied. The transient transduction of mRNA LNPs make them safer than viral vectors. With PreciGenome's NanoGenerator® platform, customers can produce mRNA LNPs with well controlled size, high homogeneity and excellent encapsulation efficiency, all key factors for efficient T cell transfection.

The following data shows the size and PDI of GFP mRNA LNPs synthesized by NanoGenerator® Flex systems. The transfection efficiency to K562 and HepG2 cell lines and human primary T cells are presented in Figures 2 and 3.

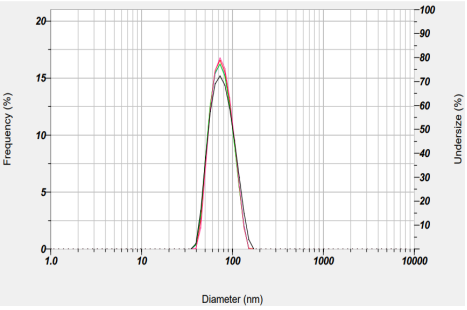


Figure 1. GFP-LNPs synthesized by PreciGenome's NanoGenerator® Flex-S. Average size is 67.3 nm. PDI is 0.106.

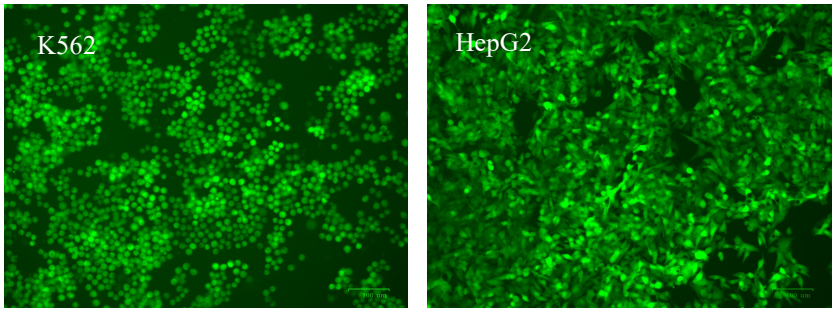
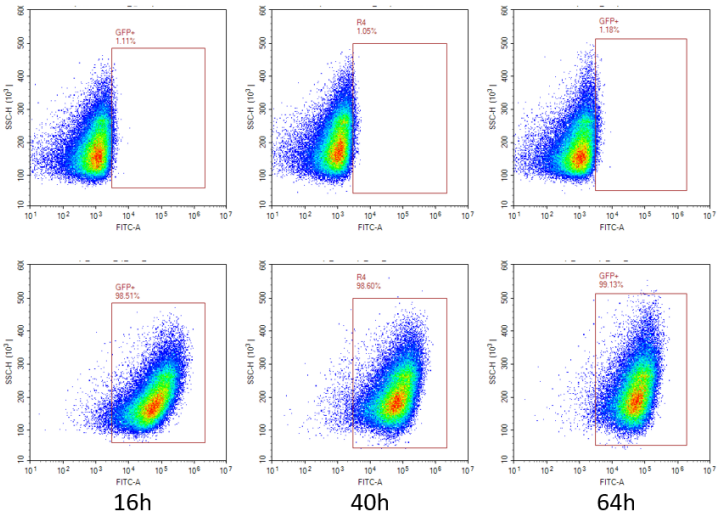


Figure 2. GFP expression in K562 (left) and HepG2 (right) cell lines 48 hours after treatment by GFP-LNPs synthesized by PreciGenome's NanoGenerator® Flex-S.

Figure 3. GFP(+) positive population of control (non-treated) and eGFP LNP treated primary T cells at 16, 40 and 64 hours.
Cells were stained (1:50) using BioLegend 7-AAD Viability Staining for 10 minutes.

Gating: First select for individual cells (excluding doublets). Then select for healthy cell population. Then select for viable cells by excluding cells positive for 7-AAD. Gate for FitC-A channel (GFP).



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NanoGenerator® Pro Nanoparticle Synthesis System

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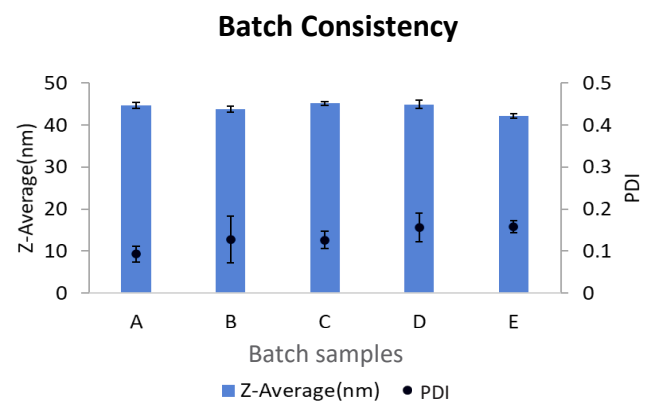
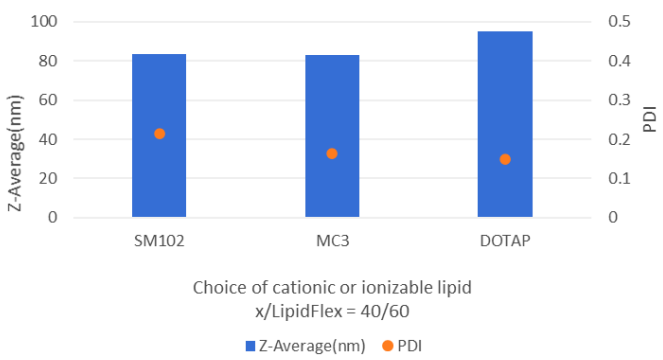
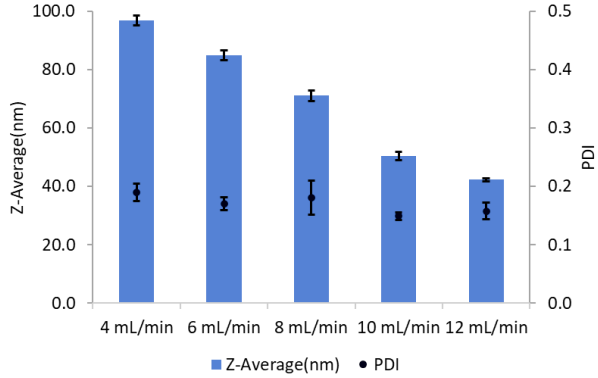
The NanoGenerator® Pro is designed for medium to large scale production. It features more powerful pressure control modules than the Flex-M, and supports a higher throughput from 2 to 200 ml. This makes it suitable for pre-clinical applications.

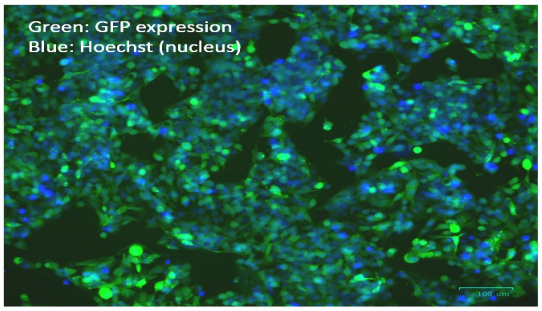
Model	NanoGenerator™ Pro
Mixing Cartridge	CHP-MIX-3
Throughput	2 to 200 mL
Total Flow Rate	4 to 20 mL/min
Flow Rate Ratio (W:O)	1:1 to 5:1
Size Range	40 to 200 nm
PDI	0.05 to 0.2
Encapsulation Efficiency	Up to 99%
Payloads	DNA, mRNA, siRNA, protein, small molecules



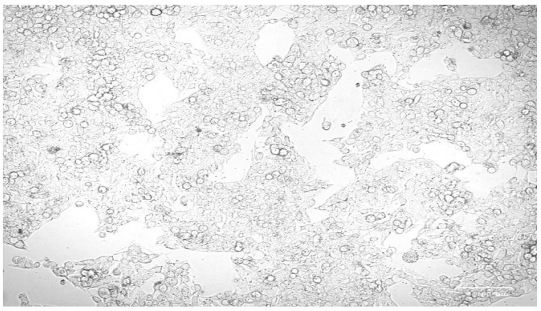




Cell Transfection using GFP mRNA LNP



Fluorescence Field



Bright Field

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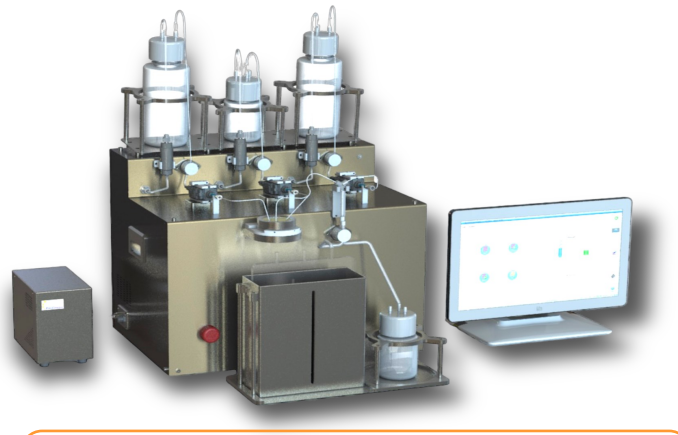
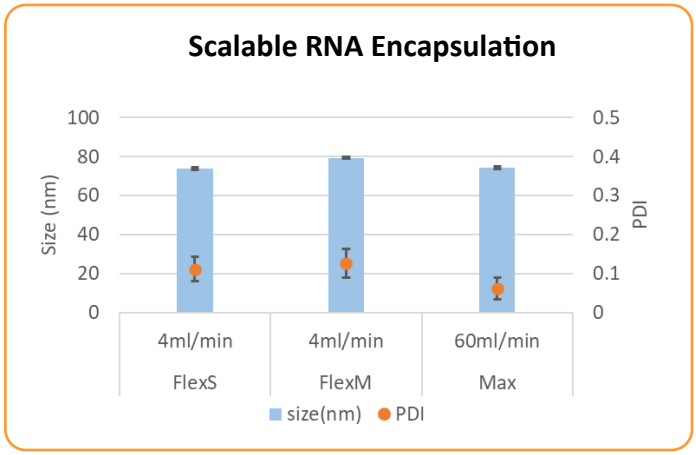
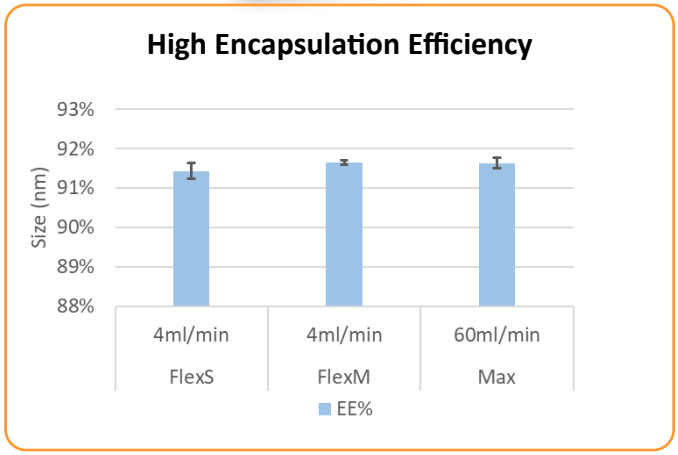
NanoGenerator® Max
Nanoparticle Synthesis System

With PreciGenome's microfluidic technology, customers can seamlessly transfer early discovery results (NanoGenerator® Flex, Pro) to the late stage production (NanoGenerator® Max).

The NanoGenerator® Max RUO version can be used for preclinical applications of LNP synthesis, while the NanoGenerator® Max GMP version is designed for clinical and commercial production.







Model	NanoGenerator® MAX			
	RUO flow kit 4.8L/h	GMP flow kit 4.8L/h	RUO flow kit 40L/h	GMP flow kit 40L/h
cGMP compliance	N/A	Yes	N/A	Yes
Software (21 CFR Part 11 compliant)	Optional	Yes	Optional	Yes
Throughput	50ml – 1L		> 20L	
Total flow rate	1.2-4.8L/h		Up to 40L/h	
Flow rate ratio	1:1 – 9:1		1:1 – 5:1	
Inline dilution	1:1 – 5:1			
Size range	40 – 200 nm			
PDI	0.05 – 0.2			
Encapsulation efficiency	Up to 99%			
Payload	DNA, mRNA, siRNA, protein, small molecules, etc.			
Dimension (L × W × H)	620 × 380 × 430 mm			
Weight	50 Kg		65Kg	

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Regulatory Compliance

The NanoGenerator® MAX GMP System is engineered to facilitate the production of genomic medicines for both clinical and commercial purposes.

Regulatory support files for the single-use mixing flow pack are available including material traceability documentation .

PreciGenome has a proven history of delivering timely support to assist our customers in fulfilling their unique country- or region-specific regulatory requirements. The GMP System is manufactured under a Quality Management System.

cGMP Compliance Documentation

- Installation qualification, operational qualification, performance qualification
- Report of consumable extractables test
- Report of endotoxin test
- Report of Rnase/Dnase free test
- Report of sterility test
- Report of ethylene oxide residual test
- Report of consumable air tightness test
- Electromagnetic compatibility report
- Safety regulations report

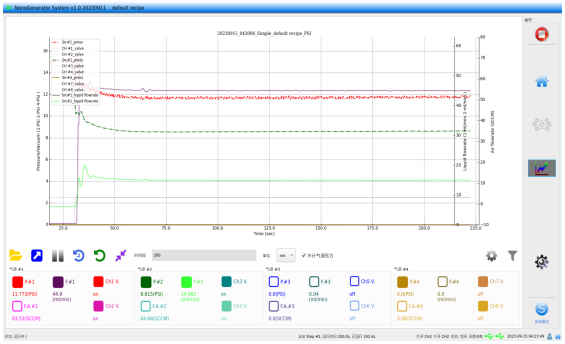
Single-use mixing flow pack

The single-use mixing flow pack is fully documented to support regulatory and quality audits for cGMP production.

It reduces the risk of cross-contamination between batches and campaigns. It also enables multi-product manufacturing in GMP facilities.

Software (21 CFR Part 11 compliant) features

- Experimental parameter tuning
- Experimental recipe save/load
- Real-time pressure/flow rate chart
- Historic experimental parameter tracking
- Historic pressure/flow rate tracking
- Self-diagnostic system
- Real-time flow rate diagnostic system
- Warning system
- Manual & automatic emergency stop system
- User management
- Audit trail
- Zero flow calibration
- Flow sensor maintenance & re-calibration (service)



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BASIC FEATURES	Flex-S	Flex-M	PRO	MAX	MAX (40L/H)
Product Model Number	PG-SYN-FS	PG-SYN-FM	PG-SYN-P	PG-SYN-G	PG-SYN-G
R&D Stage	Screening & Discovery	Screening & Discovery	Preclinical Studies & Development	Preclinical Studies & Development	Clinical Development & Production
Throughput	0.1 to 2 ml	1 to 12 ml	2 to 200 ml	50 ml to 1 L	>20L
Multiple Samples Per Run	✓	✗	✗	✗	✗
Total Flow Rate	3 or 4 ml/min	1 to 5 ml/min	4 to 20 ml/min	1.2 to 4.8 L/h	Up to 40L/h
Flow Rate Ratio	3:1	1:1 to 5:1	1:1 to 5:1	1:1 to 9:1	1:1 to 5:1
Tunable Flow Rate	✓	✓	✓	✓	✓
Intuitive & Easy To Use	✗	✓	✓	✓	✓
Compact Design	✓	✓	✓	✓	✓
Consumable Cost Per Run	$	$	$	$$	$$$
ADDITIONAL FEATURES					
Inline Dilution (Optional)	✓	✓	✗	✓	✓
Heating (Optional)	✗	✗	✗	✓	✓
Installation, Training, Warranty	✓	✓	✓	✓	✓
Qualification: IQ/OQ/PQ (Optional)	✓	✓	✓	✓	✓
Licensing Agreement & Royalty	✗	✗	✗	✗	✗
Custom Design/ OEM	✓	✓	✓	✓	✓

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LipidFlex™

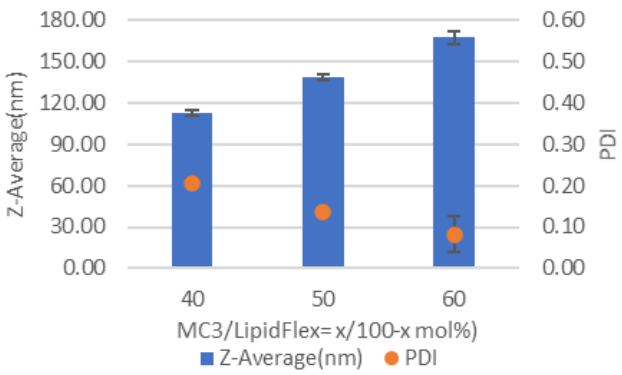
Flexible Lipid Nanoparticle Formulation

LipidFlex™ is a 3-component LNP formulation compatible with various cationic/ionizable lipids for nucleic acid encapsulation and cell transfection.

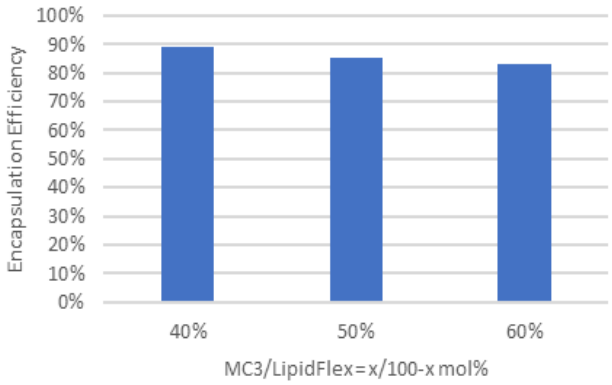
- Flexible cationic/ionizable lipid ratio
- Flexible with various N/P ratios
- High nucleic acid encapsulation efficiency
- High mammalian cell transfection rate

Model	LipidFlex™
Catalog #	PG-SYN-LF1ML
Components	Structural Lipid/Cholesterol/ Stabilizer
Product Size	1000 µl
Lipid Concentration	30 mM
Ionizable Lipid	NA

Size & PDI

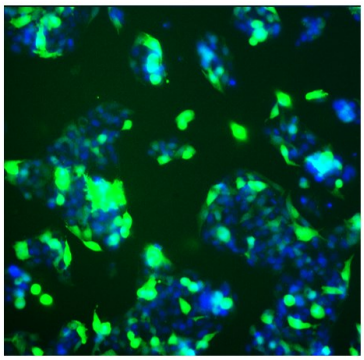


Encapsulation Efficiency



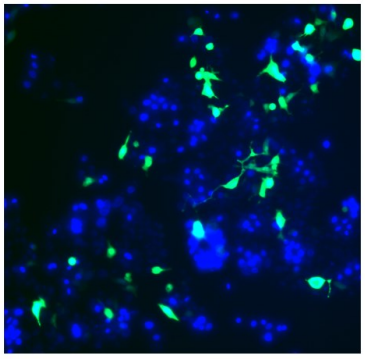
LipidFlex™ Experiment: HepG2 Cell Transfection Efficiency

Sample



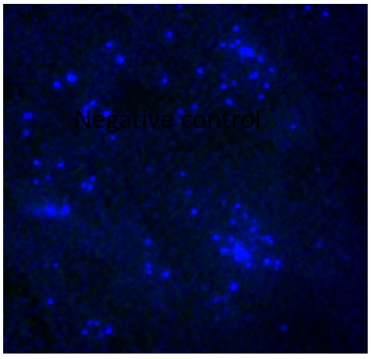
DNA LNP, PreciGenome NanoGenerator SM102/PG-LipidFlex = 40/60 mol%

Positive control



Lipofectamine™ 3000 (Thermo Fisher)

Negative control



Non-treat

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PreciGenome

LipidFlex™ T Cell Kit

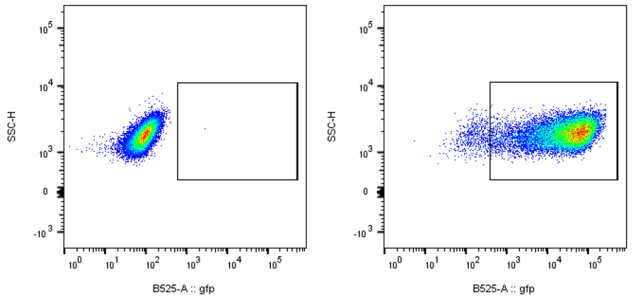
High Efficient mRNA LNP Formulation for T Cell Transfection

The LipidFlex™ T cell kit is a highly efficient lipid formulation used to synthesize mRNA LNPs for primary human T cell gene delivery. Using the NanoGenerator® Flex-S and CHIP-MIX-4 cartridge, customers can efficiently prepare potent mRNA LNPs.

- Narrow size distribution of mRNA LNP
- High transfection efficiency
- High protein expression level
- High cell viability
- Time efficient synthesis process

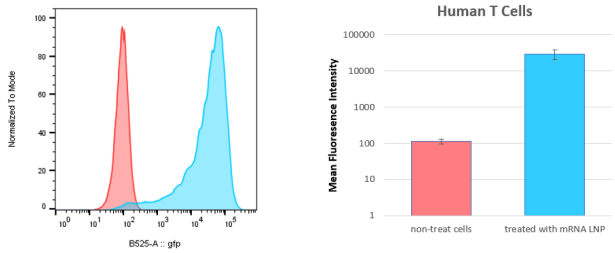
Component	Size	Storage
LipidFlex T Lipid mix	125 µl	-80°C
Formulation Buffer 1 (10x)	50 µl	4 to 8°C
Formulation Buffer 2	1 ml	4 to 8°C

High Human T Cell Transfection Efficiency



* 24 hours post-treatment Human T cells (eGFP mRNA from Trilink)

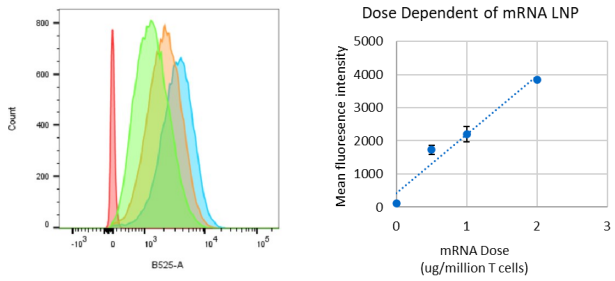
High Protein Expression Level



Non-treated cells Treated with eGFP mRNA LNP

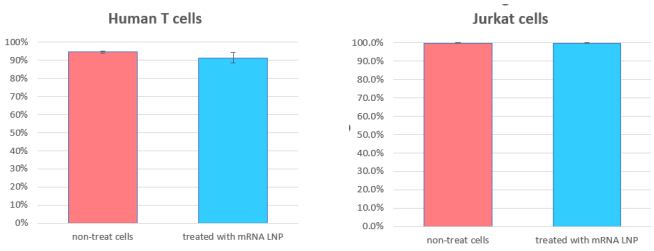
* 24 hours post-treatment Human T cells (eGFP mRNA from Trilink)

mRNA LNP Dose Dependence



* 24 hours post-treatment Jurkat cells (eGFP mRNA from ProMab)

High Cell Viability



* 24 hours post-treatment Human T cells and Jurkat cells

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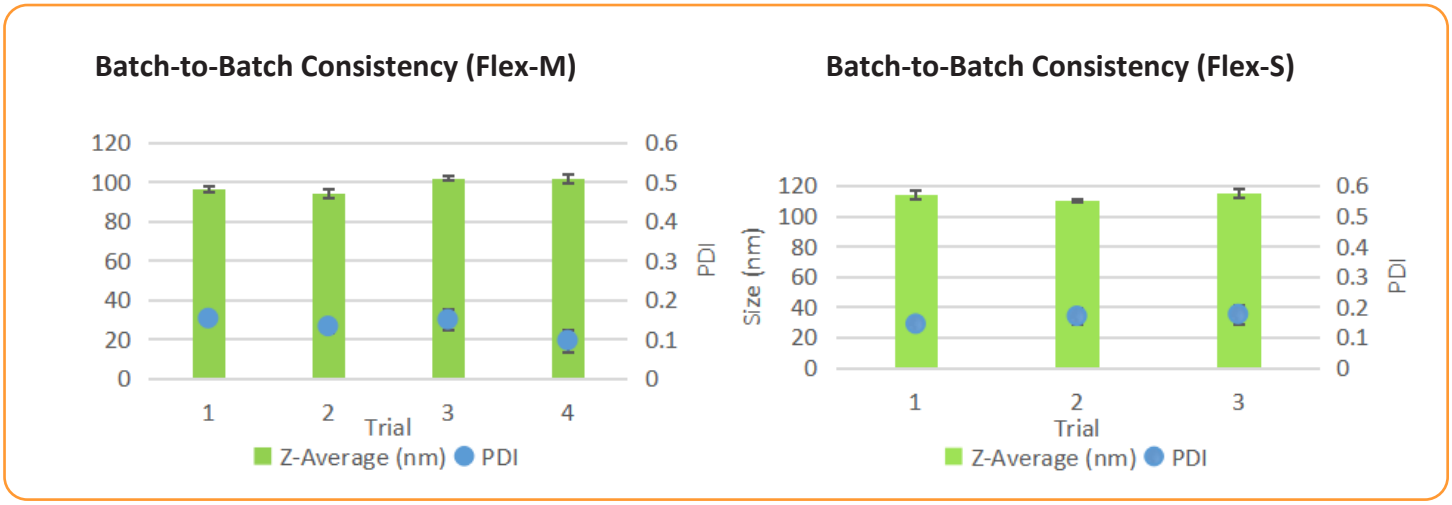
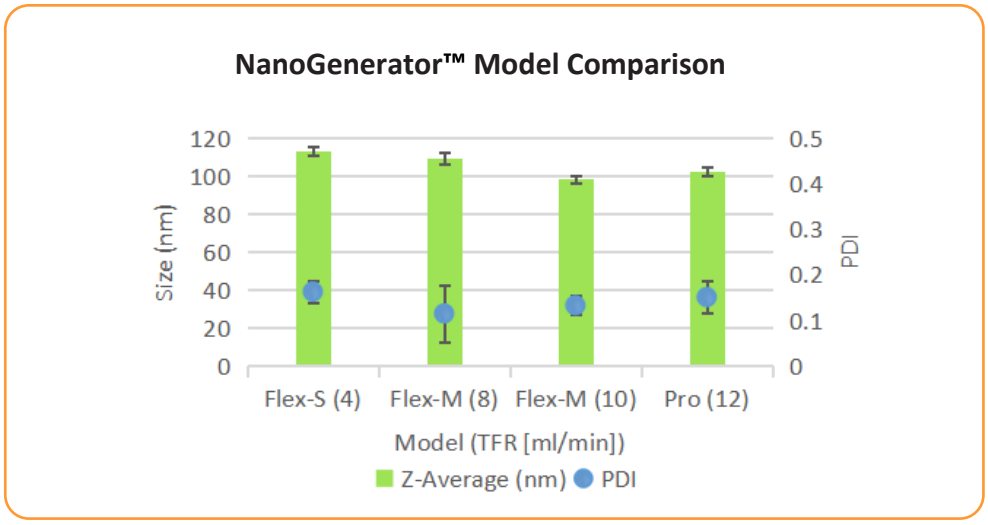
PLGA Nanoparticle Synthesis with NanoGenerator®

The NanoGenerator® platform can be used for the synthesis of PLGA nanoparticles in addition to LNPs.

For PLGA nanoparticles synthesis, successful batch-to-batch consistency is empowered by the advanced microfluidic technology used in the CHP-MIX-4 (Flex-S) and the CHP-MIX-3 (Flex-M and PRO). Like with LNPs, this consistency applies across multiple throughput ranges, ensuring scalable results from 0.1 to 200 ml.

PLGA nanoparticles size tuning is controlled by formulation parameters, total flow rate and flow rate ratio. Supported flow rate conditions differ from standard LNP settings.





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Ordering Information

PreciGenome

Platforms		
NanoGenerator Flex-S	NanoGenerator system, throughput 0.1 to 2 ml	PG-SYN-FS
NanoGenerator Flex-M	NanoGenerator system, throughput 1 to 12 ml	PG-SYN-FM
NanoGenerator Pro	NanoGenerator system, throughput 2 to 200 ml, integrated instrument	PG-SYN-P
NanoGenerator Max	NanoGenerator system with high throughput, RUO & GMP versions are available	PG-SYN-G
Microfluidic Cartridge & Consumables		
Mixing cartridge	Microfluidic mixing chip for Flex, 4 devices per chip	CHP-MIX-4
Mixing cartridge	Microfluidic mixing chip for Pro, 3 devices per chip	CHP-MIX-3
Mixing cartridge	Microfluidic glass mixing chip for Flex-M, 1 device per chip	CHP-MIX-G1
Reservoir Connectors	Reagent reservoirs for Flex-S, 20 pcs/pack	PG-MRC-SYNS-Q20
Flex-S Gasket	Gaskets for Flex-S, 20 pcs/pk	PG-GSK-SYNS-Q20
O-ring Gasket	O-ring gaskets for NanoGenerator Pro, 50 pcs/pk	PG-ORN-SYNP-Q50
Reagents (optional)		
LipidFlex™ kit	3 component lipid mixture, 1 ml	PG-SYN-LF1ML
LipidFlex™ T cell kit	T cell transfection kit	PG-SYN-LFT
LipidDemo	Included with instrument package	PG-SYN-LFD
Accessories & Service (optional)		
Flex-S flow unit	Flow unit for Flex-S	PG-SYN-MNTS
Flex-M flow unit	Flow unit for Flex-M	PG-SYN-MNTM
Tubing and connector kit	Standard tuning and connectors for Flex-M	KIT-TUB-FIT-FM
Inline dilution kit	Inline dilution device, tubing, and connectors for Flex-M	KIT-INL-DIL-FM
Extended Warranty	1 to 3 years	PG-WTY-1Y

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Customer Service

- **Formulation Design (LNP, Liposome, PNP)**
  Customize nanoparticle design based on our clients' needs by adjusting lipid composition, vesicle size, surface charge, etc.
- **Payload Encapsulation**
  Customize protocols to encapsulate drugs into LNPs or PNPs with high encapsulation efficiency.
- **Gene Delivery Study**
  In vitro cell study
  In vivo small animal study
- **Analysis and Characterization**
  Run comprehensive analysis assays for liposomes before and after encapsulation. Includes visual appearance, size distribution, stability, entrapment efficiency, encapsulation efficiency analysis, in vitro release profile analysis, release rate, etc.

Notes

Notes

Some of Our Customers

PreciGenome

PreciGenome is located in the heart of Silicon Valley, San Jose, California, USA. We have been focusing on developing nanoparticle synthesis systems and solutions for our customers. Our technology enables nanoparticle synthesis with high quality and reliable performance for lipid nanoparticles, liposomes, PLGA, etc.

HEADQUARTER

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