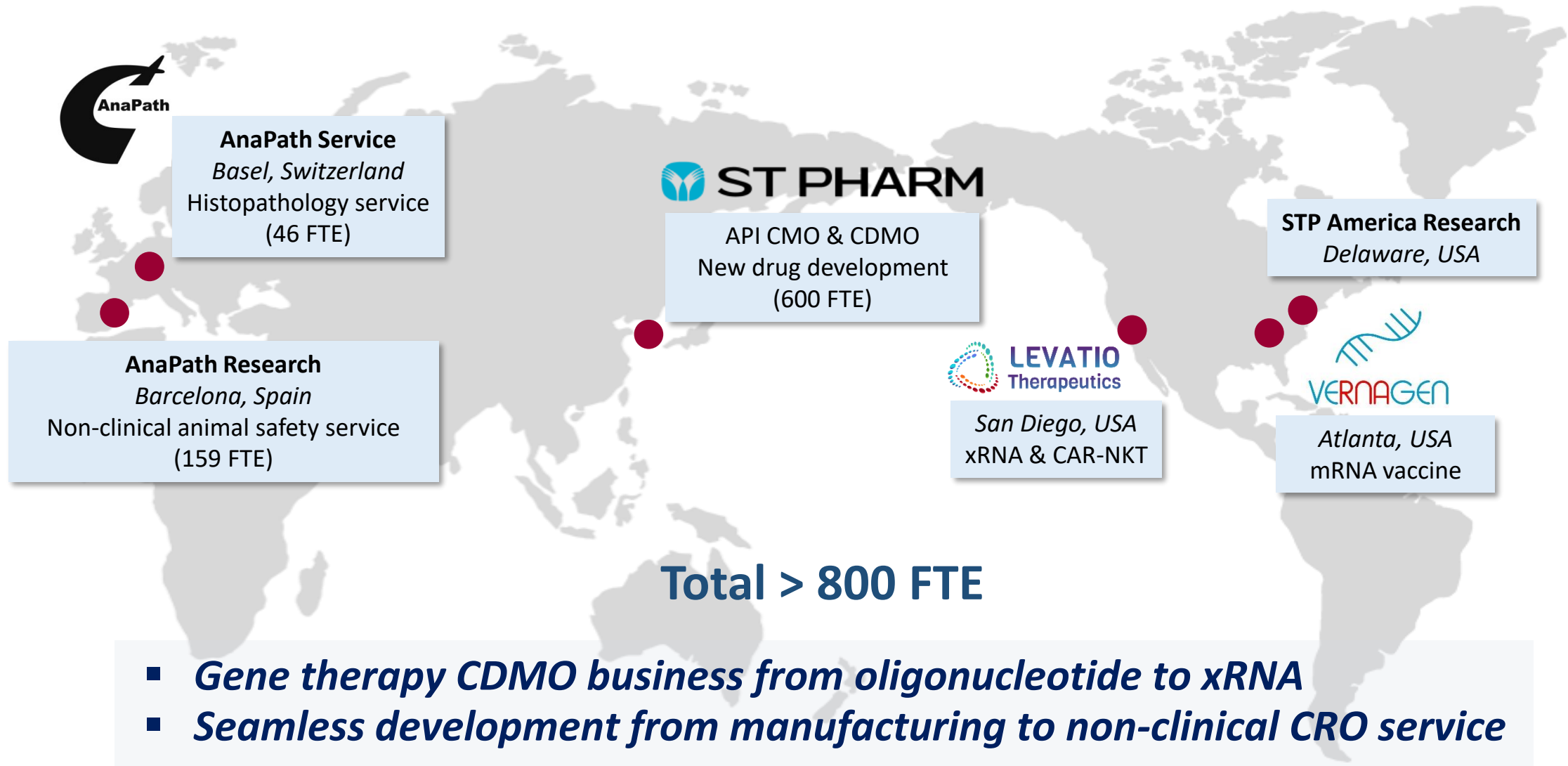




Expediting xRNA vaccine development strategy: Now and Future

May 2022

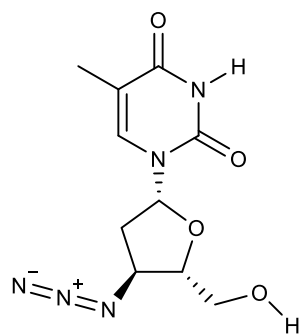
ST PHARM Family



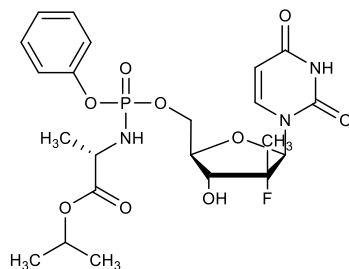
Journey from Monomer to Polynucleotide CDMO Business

• **1983**
Samchully Pharm

Nucleoside Nucleotide



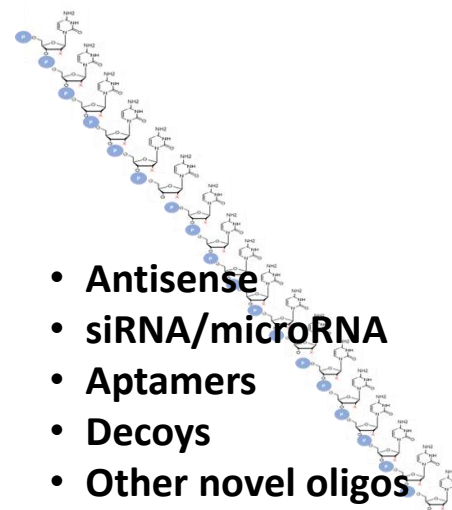
Zidovudine



Sofosbuvir

• **2008**
Oligo GMP Manufacturing

Oligonucleotide



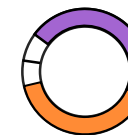
• **2018**
mRNA R&D

Polynucleotide

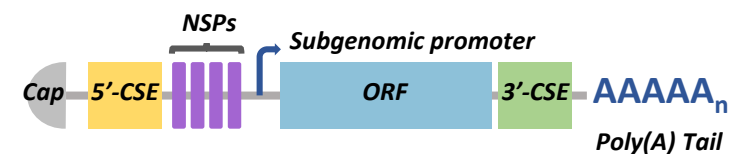
Conventional mRNA



CircRNA



Self Amplifying mRNA



Oligonucleotide CDMO

Fully Integrated In-House Production of Monomer and Amidite Manufacture Capability
"One-Stop Service" from Nucleosides to Oligonucleotides

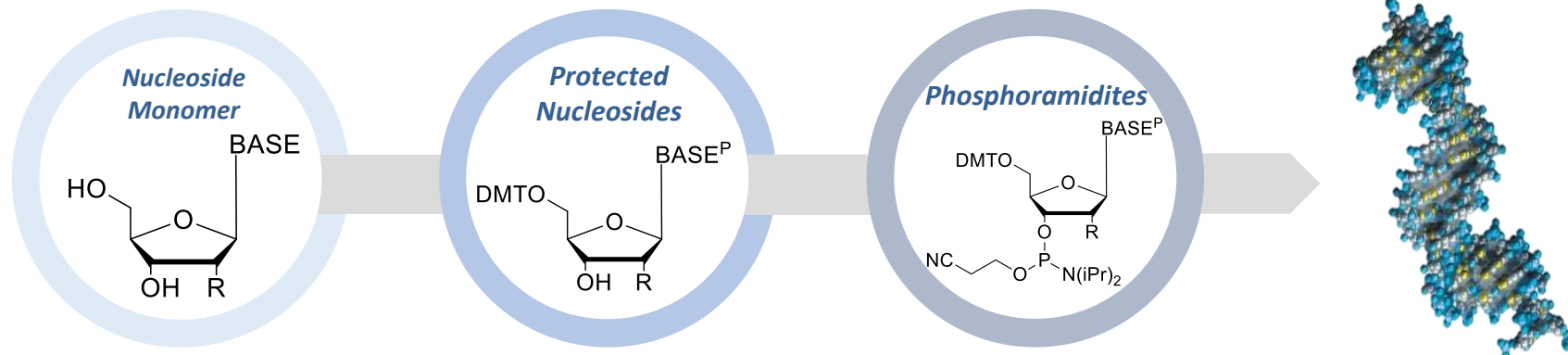
▪ Innovative technology & manufacturing system

- ✓ Oligonucleotide GMP manufacturing with *very low endotoxin limit*
- ✓ *Minimizing PO impurity formation* in the PO/PS mixed backbone oligonucleotides
- ✓ Oligonucleotide purification process with *on-column detritylation*

▪ Strong Track Record

- ✓ Selected as *Asia-Pacific's Top Oligonucleotide API Manufacturer*
- ✓ World's third largest oligonucleotide manufacturing capacity
- ✓ *Roche CDMO Award 2019*: Oligo New Drug (First in global), Small Molecule New Drug (First in Asia)

- ✓ Cost competitive
- ✓ Supply continuity
- ✓ Quality stability
- ✓ Expedition of process

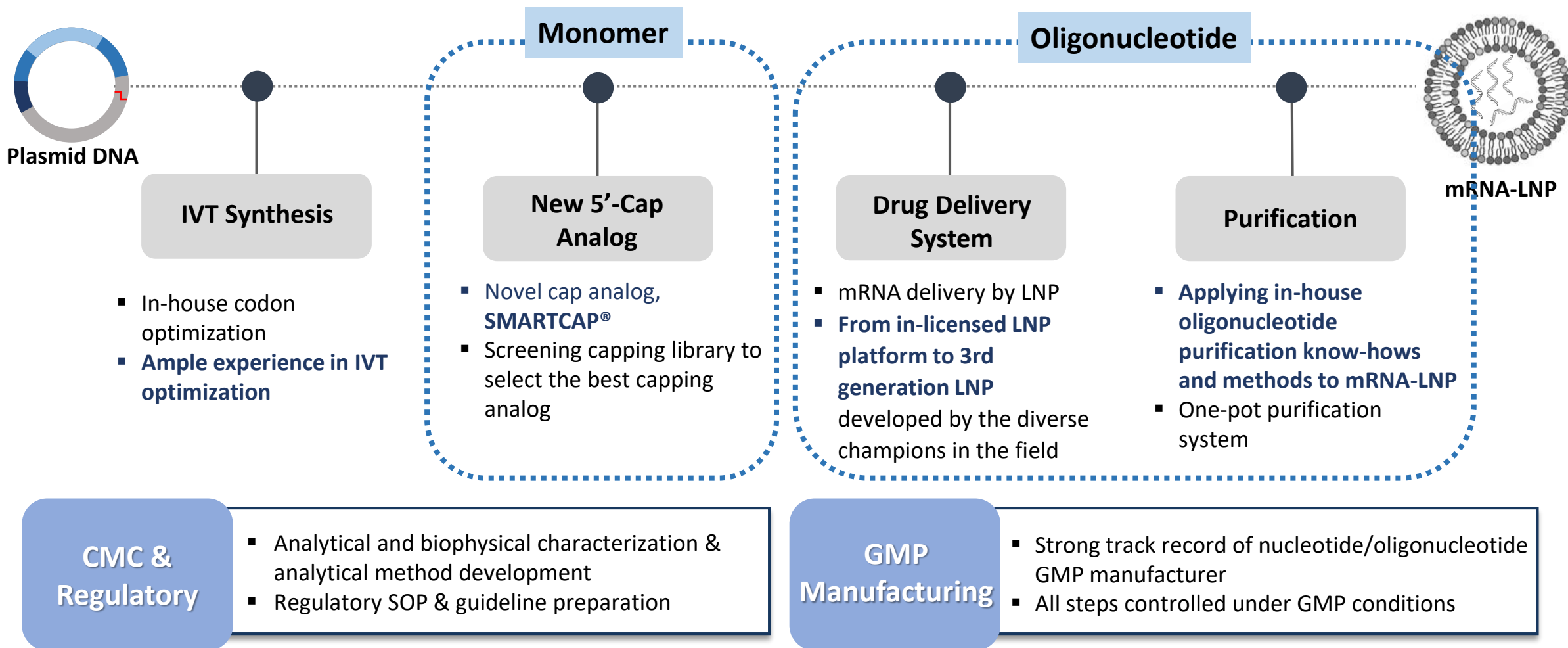


Oligonucleotide

- siRNA/microRNA
- Aptamers
- Antisense
- Decoys
- Other novel oligos

ST PHARM's mRNA Platform Technology

mRNA and Lipid Nanoparticle (LNP) Platform at ST PHARM



SMARTCAP® and Capping Library

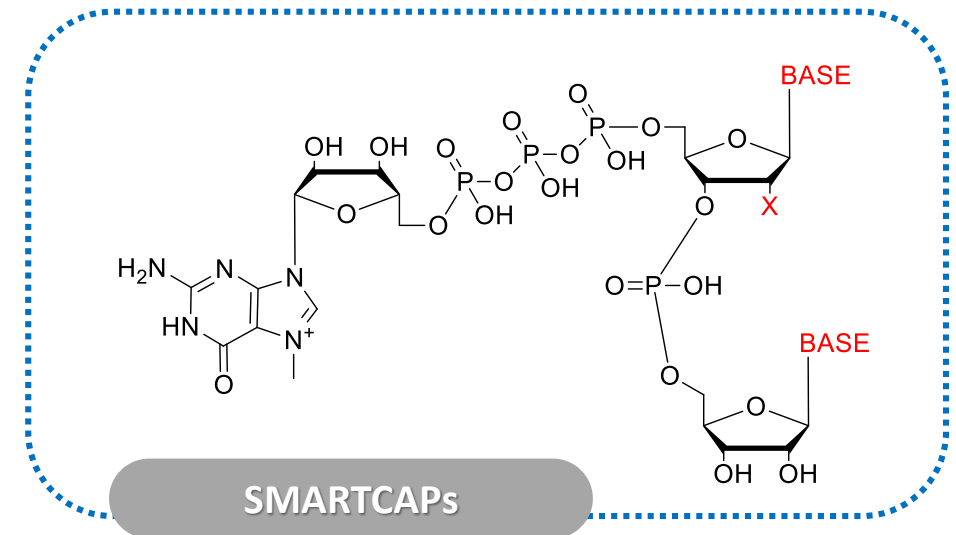
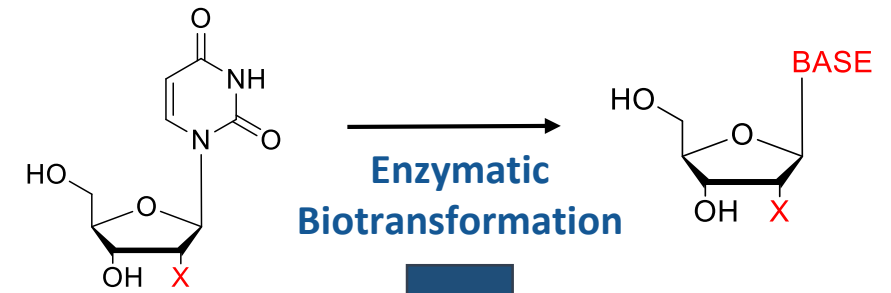
From Nucleoside to 5'-Capping Reagent

SMARTCAP®

- In-house cap analogs (ca. 30) with different ribose and base combination
- Utilizing the know-hows & experience from oligonucleotide RSM synthesis
- Strong IP position
- **Updating stability data**
→ Both powder and solution form are stable at room temperature (> 6 months)

Capping Library

- Screening capping library to identify the most suitable 5'-cap analog with highest efficiency
- ORF-specific screening and selection



ST PHARM's Lipid Nanoparticles (LNP) – STLNP™ & SMARTLNP™

From Conventional to 3rd Generation LNP

ST PHARM is running three different LNP platform strategies

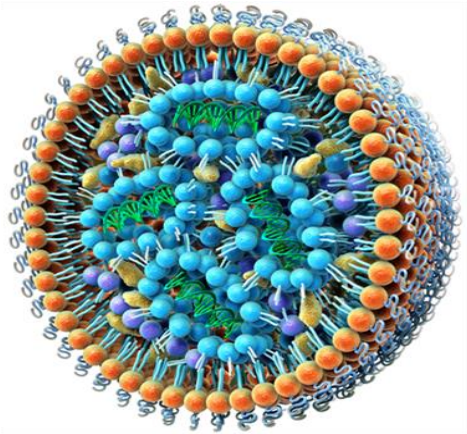


Image Source from Precision Nanosystems

In-licensed LNP

- In-licensing LNP technology from biotech company
- Globally proven, unsurpassed and best LNP technology
- Applied to COVID-19 mRNA vaccine development

STLNP®

- ST PHARM's first LNP: STLNP™
- Used for mRNA vaccine discovery & CDMO business
- Further application to cancer and autoimmune disease vaccines

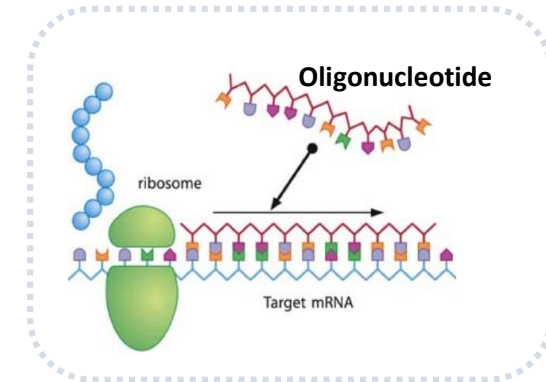
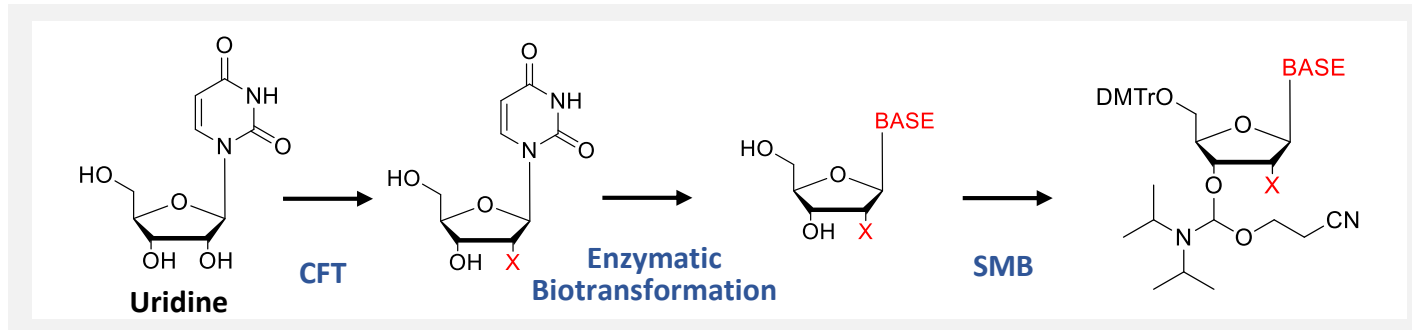
SMARTLNP®

- ST PHARM's second LNP: SMARTLNP™
- Developed by collaborations with Ewha W. U. in KOREA
- Focused on increasing stability and improving immune response

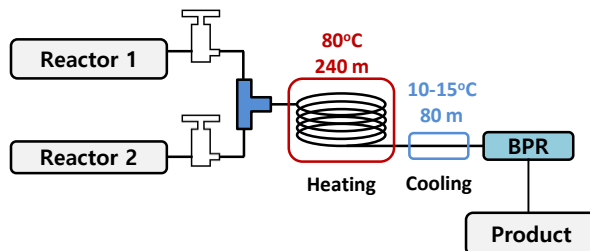
Capping Reagent Mass Production

- Incorporating oligonucleotide CFT and SMB technology for capping mass production
- Mass production for diverse capping reagents including capping reagents of key companies, Pfizer-BioNTech & Moderna, and ST PHARM's SMARTCAP® from key raw materials (> multi-kilograms/year)
- **Both non-GMP and GMP-grade intermediate and product available**

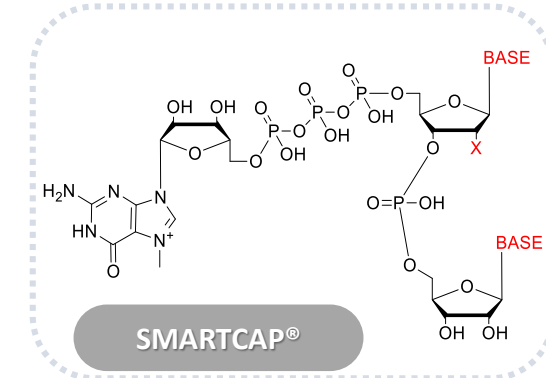
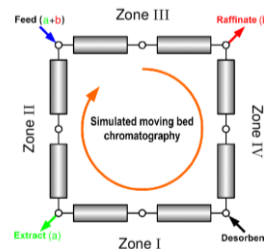
5'-capping reagent mass production scheme



Continuous Flow Technology (CFT)



Simulated Moving Bed (SMB) Technology



LNP Lipids Mass Production

GMP or GMP-like LNP Manufacturing Service



❖ Mass production of lipids in LNP

- RMs are supplied by strategic domestic partners that are reliable, qualified and cost-effective
- ST PHARM is manufacturing both ionizable and PEG-lipid, required for LNP formulation
- Production of key lipids will be available upon client’s request

		Pfizer-BioNTech		Moderna	
LNP components	Ionizable lipid	ALC-0315	>3 MT/yr*	SM-102	>3 MT/yr*
	PEG lipid	ALC-0159	>1 MT/yr*	PEG2000-DMG	>1 MT/yr*

* ST Pharm’s manufacturing capacity in Sihwa campus

ST PHARM mRNA GMP Facility

mRNA synthesis from milligram to kilogram scale production

1. R&D and small-scale production (non-GMP)

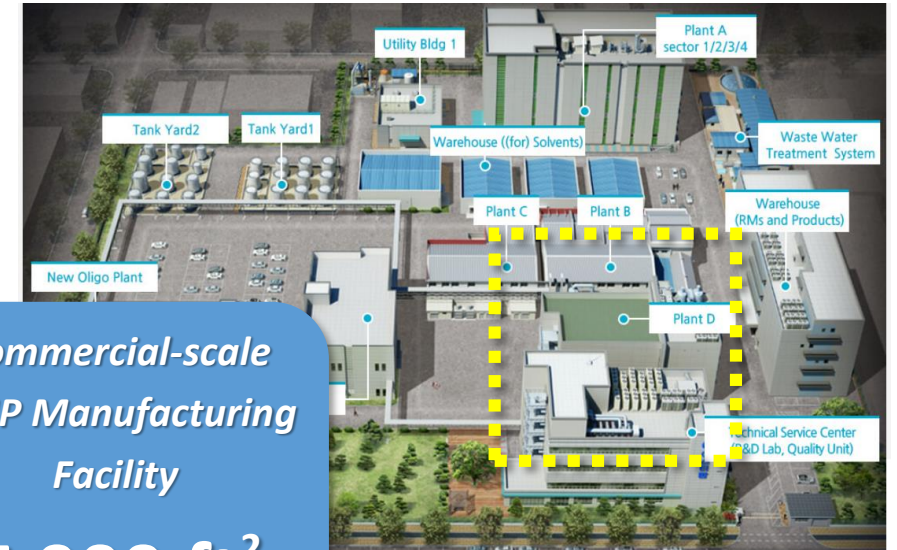
- Banwol Campus Plant D (3F): Established on August 2020
- mRNA R&D and small-scale production for non-clinical animal study

2. Mid-scale production (GMP)

- Banwol Campus Plant D (1F & 4F): Expansion for ST PHARM's COVID mRNA vaccine manufacturing on May 2021
- **Production Capacity:** Multi-gram/month

3. Commercial-scale production (GMP)

- Further expansion of mRNA manufacturing facility (Plant D 3F-6F) equipped with MF system
- **Expected expansion capacity:** Multi-kgs/month
- *Customized or dedicated facility available as per client's request*



Commercial-scale
GMP Manufacturing
Facility

7,000 ft²

Mid-scale
GMP Manufacturing
Facility

2,237 ft²



Summary

ST PHARM provides seamless GMP manufacturing service from LNP-encapsulated mRNA to key materials of caps & lipids in LNP

mRNA CDMO Business

- Manufacturer of key raw materials in GMP or non-GMP standard
- Providing one-stop service from CDMO to non-clinical GLP studies

LNP Technology and Lipid Mass Production

- In-licensed LNP technology, STLNP® and 3rd generation LNP, SMARTLNP®
- Mass production of key lipids for LNP formulation – ionizable and PEG-lipids

- In-house 5'-capping analog, SMARTCAP®
- Total 30 capping analogs for capping library screening
- Cost effective large-scale production of diverse 5'-capping reagents

5'-Capping Technology and Mass Production

- Expanding CDMO business of RNA therapeutics through strategic partnerships with various RNA companies
- Building up of xRNA projects through Levatio (circRNA) and Vernagen (mRNA)

Post-COVID Strategy



감사합니다 Natick Dankon Tainis
Danke Ευχαριστώ Dalu 唔該
Thank You köszönöm شكرا
Tack Tak
Спасибо Dank Gracias धन्यवाद
Grazie **Merci** ありがとう Toda
Tesekkür ederim Дякую khop kun
Asante Gratias Shokran cảm ơn