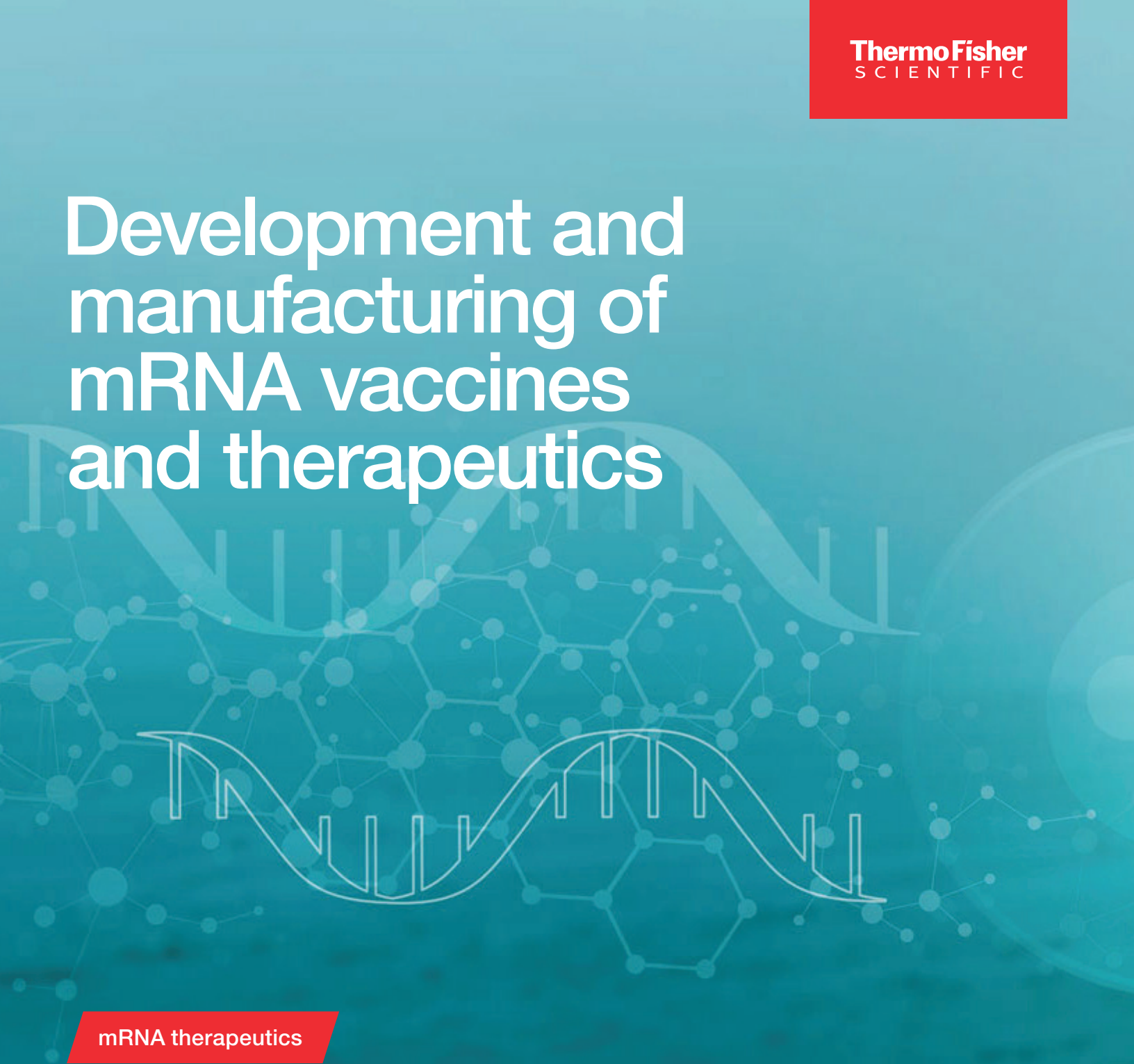


# Development and manufacturing of mRNA vaccines and therapeutics



mRNA therapeutics

Access leading-edge portfolios, services, and support

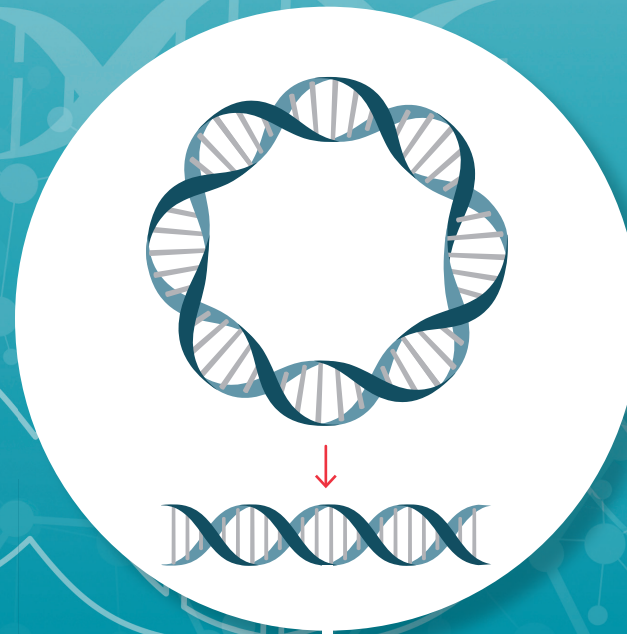
# mRNA production process overview

## Target design and DNA template generation



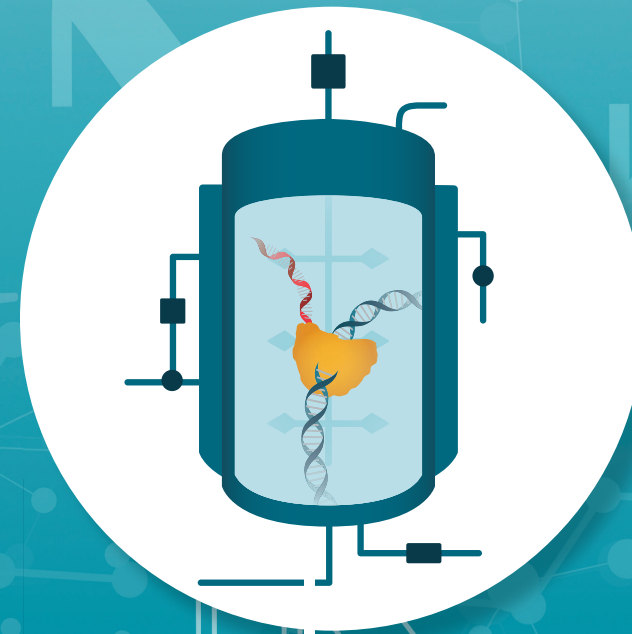
Target genes for mRNA therapeutics and vaccines are often discovered and validated using techniques such as NGS. The target sequence will be selected, optimized, synthesized, and inserted into a DNA plasmid template. The DNA template will be used for mRNA synthesis to produce the mRNA therapeutic or vaccine.

## Plasmid production, purification, and linearization



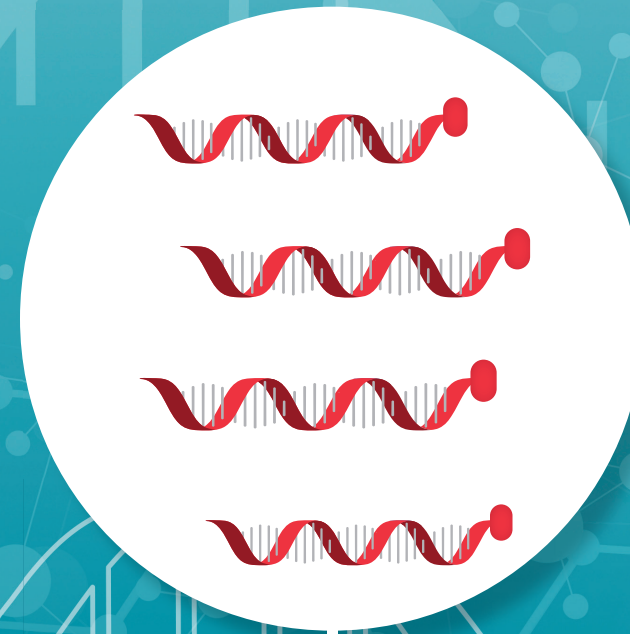
Plasmid production is performed by microbial fermentation using a single-use fermenter to produce large quantities of DNA plasmid template. The resulting DNA plasmid product is then purified and tested. Restriction enzymes are then used to cut and linearize the circular plasmid DNA to prepare the DNA template needed for mRNA production.

## mRNA synthesis



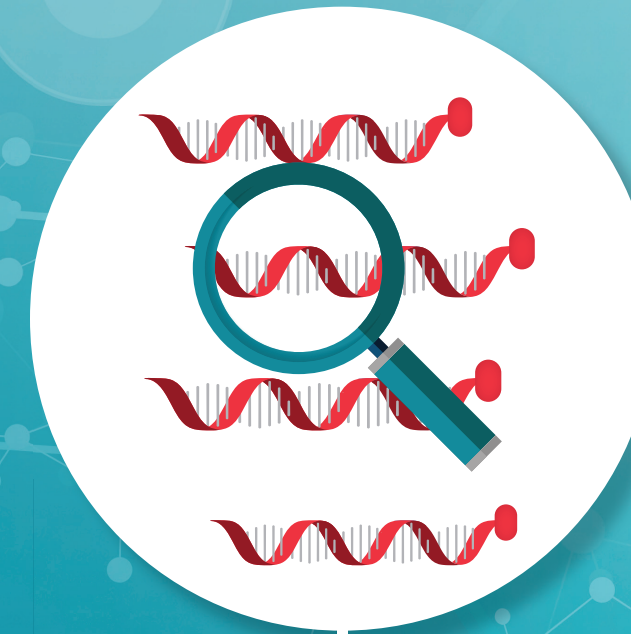
The DNA template is transcribed into mRNA through in vitro transcription. This process is performed in a bioreactor using a mixture of nucleotides and RNA polymerase. The synthesized mRNA is also modified at the ends of the mRNA strand. These modifications can improve stability and increase protein translation efficiency and reduce immunogenicity of the mRNA.

## mRNA purification



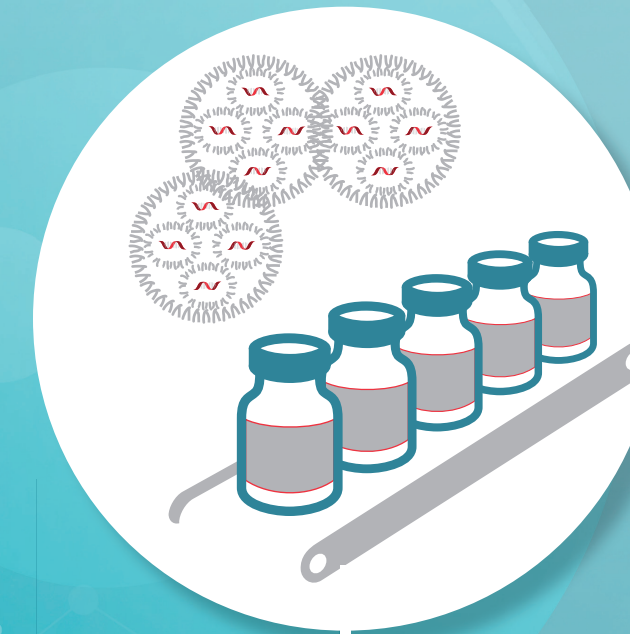
The mRNA product is isolated and purified using affinity and other chromatography and filtration techniques. After purification, the mRNA is tested for purity.

## Analytics



The purified mRNA is characterized at the molecular level to verify sequence and identify modifications. The lipid nanoparticle (LNP) component of the mRNA vaccine or therapeutic is also characterized to verify lipid identity and composition and to profile any impurities. Understanding the exact composition of the mRNA and LNP is important to ensure that the mRNA vaccine or therapeutic meets rigorous quality and regulatory standards.

## Formulation, fill, finish, and storage



Once the mRNA and excipients have been purified and analyzed, they are ready for formulation. The mRNA is compounded with excipients such as lipids, LNPs, or carbohydrates to protect the mRNA and help deliver it to target cells. The mRNA complex is then processed into the finished vaccine or therapeutic, sterilized, and aseptically packaged in vials. The filled vials undergo final testing and are loaded into ultra-low temperature freezers for storage or delivery.



# Count on a partner who knows the way

With Thermo Fisher Scientific, you have the support you need to accelerate mRNA and vaccines therapeutics from discovery to commercialization. Set yourself up for success with our comprehensive portfolio of products and services proven to meet critical process, scale, quality, and regulatory needs.



## Connect with us

Partner with us to help successfully bring your mRNA vaccine and therapeutics to commercialization.



Contact us at [thermofisher.com/mrnatx](https://thermofisher.com/mrnatx)



## Solutions development and manufacturing of mRNA vaccines and therapeutics



### DNA template generation

- Next-generation sequencing (NGS) capabilities
- Invitrogen™ GeneArt™ Gene Synthesis services

### Plasmid production, purification, and linearization

- Thermo Scientific™ TheraPure™ restriction enzymes
- Thermo Scientific™ HyPerforma™ Single-Use Fermentor (S.U.F), bioprocess controllers, and automation
- Fermentation media
- Centrifuges
- Thermo Scientific™ HyPerforma™ and imPULSE™ Single-Use Mixers (S.U.M.s)
- Thermo Scientific™ POROS™ anion exchange (AEX) resins

### mRNA production

- Thermo Scientific™ TheraPure™ enzymes, nucleotides, and capping solutions
- Thermo Scientific™ DynaDrive™ Single-Use Bioreactor (S.U.B.) with bioprocess controllers and automation

### mRNA purification

- Thermo Scientific™ POROS™ Oligo (dT) 25 resin
- Thermo Scientific™ POROS™ AEX and hydrophobic interaction chromatography (HIC) resins
- Buffers
- Liquid transfer solutions

### Analytics

- Applied Biosystems™ resDNASEQ™ residual host cell and plasmid DNA quantitation solutions
- Applied Biosystems™ MycoSEQ™ mycoplasma testing solutions
- Thermo Scientific™ Vanquish™ ultra-high performing liquid chromatography (UHPLC) systems with charged aerosol detector (CAD) and DNA Pac columns
- Thermo Scientific™ Orbitrap™ Exploris™ mass spectrometers with Thermo Scientific™ BioPharma Finder™ Software
- Thermo Scientific™ Evolution™ One Plus Spectrophotometer

### Formulation, fill, finish, and storage

- Invitrogen™ Vivofectamine™ lipid nanoparticle (LNP) delivery solutions
- Ultra-cold storage solutions
- Thermo Scientific™ Nalgene™ HDPE Platinum Certified Clean Bottles and Carboys
- Thermo Scientific™ Labtainer™ Pro BioProcess Container with BioTitan™ Retention Device
- Fill and finish services

