# Hi-yield T7 in vitro transcription reagent (pUTP)

**Cat.No.:HYJ242**

## Product Description

The High-Yield T7 In Vitro Transcription Kit features an optimized transcription reaction system. It uses T7 RNA polymerase for in vitro transcription, using a linear double-stranded DNA containing the T7 promoter sequence as a template and NTPs as substrates to transcribe the DNA sequence downstream of the promoter, enabling customers to quickly and easily obtain large quantities of RNA product. This kit can also use modified nucleosides as substrates to produce RNA labeled with biotin, dyes, or radioactive substances, and capped RNA using cap- or cap-like structures as substrates. The kit includes the commonly used modified nucleoside pUTP for transcription needs.

This kit can produce 150–200 μg of RNA product per reaction and is suitable for scale-up to produce milligram quantities of RNA. The transcribed RNA can be used for RNA structure and function studies, RNase protection, probe hybridization, anti-sense RNA, and RNAi applications. It can also be capped using the vaccinia virus capping system (HYJ231) and 2'-O-methyltransferase (HYJ232), and tailed using Poly(A) Polymerase (HYJ233) to generate mRNA for downstream applications such as in vitro translation and transfection.

## Components

| Components | Concentration | 50T |
|---|---|---|
| ATP | 100 mM | 100 μL |
| CTP | 100 mM | 100 μL |
| GTP | 100 mM | 100 μL |
| UTP | 100 mM | 100 μL |
| pUTP | 100 mM | 100 μL |
| 10 × Hi-Yield IVT Buffer A | / | 100 μL |
| 10 × Hi-Yield IVT Buffer B | / | 100 μL |
| Enzyme Mix | / | 100 μL |
| Control template 1 | 0.5 μg/μL | 10 μL |
| LiCl | 5 M | 1.4 mL |
| DNase I | 5 U/μL | 100 μL |

## Storage

Store at -25 to -15°C. Valid for 1 years.

## Instructions

### 1. Template preparation

Linearized plasmids, PCR products, or synthetic DNA fragments containing a T7 promoter can be used as templates for in vitro transcription using the High-Yield T7 RNA Synthesis Kit. Templates can be dissolved in TE buffer or RNase-free dd$H_2O$.

1) Plasmid Template

A linearized plasmid with a T7 promoter can be used as a transcription template. The linearization and purity of the plasmid will affect the yield and integrity of the transcribed RNA product. Circular plasmids lack effective termination, resulting in RNA products of varying lengths. To obtain RNA of a specific length, the plasmid must be completely linearized. The linearized plasmid should ensure that both strands have blunt ends or 5' overhangs. After linearization, it is recommended to purify the plasmid before using it as a template for in vitro transcription to minimize the effects of RNase, protein, and salt residues.

2) PCR Product Template

A PCR product with a T7 promoter can be used as a template for in vitro transcription. During PCR amplification, the T7 promoter is added to the 5' end of the upstream primer on the noncoding strand. Purifying the PCR product as a template will yield higher RNA yields.

3) Synthetic DNA Template

Synthetic DNA fragments with a T7 promoter can also be used as templates for in vitro transcription.

### 2. RNA synthesis methods

Wear gloves during experimental procedures and use nuclease-free reaction tubes to avoid RNase contamination. For small-volume reactions, it is recommended to perform them in nuclease-free PCR tubes or 8-tube strips.

**Conventional RNA Synthesis**

1) Thaw all components on ice, mix thoroughly, and centrifuge briefly to collect the contents at the bottom of the tube. Store on ice until needed.
2) If performing multiple reactions simultaneously, mix equal volumes of 10× Hi-Yield IVT Buffer and NTPs to create a Mix. Add 10 μL of Mix to each reaction.

3) At room temperature, add the samples in the order listed in the table below:

| Components | Volume |
|---|---|
| 10 × Hi-Yield IVT Buffer A | 2 uL |
| ATP/CTP/GTP/UTP * (100 mM each) | 2 μL each (10mM each Final) |
| Template DNA | X μL (1 μg) |
| Enzyme Mix | 2 μL |
| Nuclease-free water | Up to 20 μL |

*To reduce the immunogenicity of the product, an equal volume of UTP can be replaced with pUTP included in this kit.

4) Mix thoroughly, centrifuge briefly, and incubate at 37°C for 2 hours.

5) DNA Digestion: To remove the DNA template, add 10 U of DNase I (HYJ234) per 20 μL reaction, mix thoroughly, centrifuge briefly, and incubate at 37°C for 30 minutes.

**Capped RNA Synthesis**

Follow the standard RNA synthesis procedure, except for the addition system. Add samples at room temperature according to the order listed in the table below.

| Components | Volume |
|---|---|
| 10×Hi-Yield IVT Buffer A | 2 uL |
| ATP/CTP/GTP/UTP * (100 mM each) | 2 μL each (10mM each Final) |
| Cap analog (100 mM) | 1.6 μL |
| Template DNA | X μL (1 μg) |
| Enzyme Mix | 2 μL |
| Nuclease-free water | Up to 20 μL |

*If the transcription yield is low when using 10× Hi-Yield IVT Buffer A in the co-transcription system, 10×Hi-Yield IVT Buffer B can be used instead. Cap analogs for co-transcription include cap1(3'OH AG) (HYJ322) and cap1(3'OMe AG) (HYJ323). The UTP in the substrate can be replaced with an equivalent amount of modified nucleosides. Cap analogs and modified nucleosides can be used as needed. Examples of co-transcriptional cap analogs include Hyasen Co-capping T7 in vitro transcription reagent (pUTP, CAP GAG (3'OMe)) (HYJ251), pUTP, CAP GAG (HYJ252), N1-Me-pUTP, CAP GAG (3'OMe) (HYJ253), and N1-Me-pUTP, CAP GAG (HYJ254).

Product Purification

## 3. Product purification

### Phenol/Chloroform Purification

Phenol/chloroform purification removes proteins and free nucleotides.

1) Add 160 μL of RNase-free dd$H_2O$ to dilute the reaction product to 180 μL. Add 20 μL of 3M sodium acetate (pH 5.2) and mix thoroughly by pipetting.
2) Add an equal volume of phenol/chloroform mixture (1:1) for extraction. Centrifuge at 10,000 rpm for 5 minutes at room temperature. Transfer the supernatant to a new EP tube.
3) Add an equal volume of chloroform to the supernatant and extract twice. Collect the supernatant.
4) Add 2 volumes of anhydrous ethanol, mix thoroughly, incubate at -20°C for at least 30 minutes, centrifuge at 4°C for 15 minutes, and discard the supernatant.
5) Wash the RNA precipitate with 150-200 μL of 70% ice-cold ethanol. Centrifuge at 4°C for 15 minutes and discard the supernatant.
6) Uncap and dry for 2 minutes. Add 100-200 μL of RNase-free dd$H_2O$ or other buffer to dissolve the RNA pellet.

### Lithium chloride purification

Lithium chloride purification can remove proteins and most free nucleotides.

1) Add an equal volume of lithium chloride precipitation solution (5M) to the reaction product;
2) Mix well, precipitate at -20°C for 30 minutes, centrifuge at 12,000 rpm at 4°C for 15 minutes, and discard the supernatant;
3) Wash the RNA pellet with 200 μL of 70% ice-cold ethanol, centrifuge at 12,000 rpm at 4°C for 15 minutes, discard the supernatant, and repeat 2-3 times;
4) Uncap and air dry for 5-10 minutes. Once completely dry, add 100-200 μL of RNase-free dd$H_2O$ or other buffer to dissolve the RNA pellet.

### Column purification

Column purification can remove proteins and free nucleotides.

### Magnetic bead purification

Magnetic bead purification can remove proteins and free nucleotides.

## 4. RNA Quantification

**UV absorption method:** Free nucleotides can affect quantification accuracy.This method requires RNA purification before use. The yield of in vitro transcribed RNA is then determined by measuring the $A_{260}$ reading of the product.For single-stranded RNA, 1 $A_{260}$≈40 μg/mL.

**Dye method:** RNA quantification using RiboGreen dye is performed. Free nucleotides do not affect quantification, allowing accurate quantification of RNA in both purified and unpurified reaction products.

## Notes

1. The optimal final concentration of NTPs in the reaction system is 10 mM. The actual amount used should be adjusted based on the original NTP concentration.
2. The transcription reaction should be performed in a nuclease-free environment. It is recommended to wear gloves and use nuclease-free water, pipette tips, and reaction tubes during the reaction.
3. The reaction system should be prepared at room temperature to avoid precipitation of DNA with spermidine at 4°C.
4. If insoluble material such as crystals or precipitates is observed in the buffer after reconstitution, vortex the buffer until the insoluble material is completely dissolved before use.
5. Incomplete linearization of the template DNA may reduce the yield and integrity of the transcript.
6. For RNA less than 300 nt, 2 μg of template can be used, and the transcription time can be increased to 4-8 hours.
7. The reaction volume can be scaled up or down based on actual needs.
8. This kit contains two tubes of 10× Hi-Yield IVT Buffer. For conventional and modified nucleoside systems, it is recommended to use 10× Hi-Yield IVT Buffer A according to the instructions. For co-transcription systems, if 10× Hi-Yield IVT Buffer A produces poor yields, 10 ×Hi-Yield IVT Buffer B can be used.
9. In conventional systems, DNA templates are often designed with a GGG start sequence because T7 RNA polymerase has a higher affinity for GTP. This product's high-yield T7 in vitro transcription reagent comes with Control Template 1, which is a DNA template with a GGG start sequence.
10. For co-transcription systems, the recommended DNA template design is to use AGG as the starting sequence. The co-transcription capping T7 in vitro transcription reagent includes a control template 2, which is a DNA template with AGG as the starting sequence.