**T4 Polynucleotide Kinase**

**Description:** Catalyzes the transfer and exchange of P, from the γ position of ATP to the 5′-hydroxyl terminus of polynucleotides (double- and single-stranded DNA and RNA) and nucleoside 3′-monophosphates. Polynucleotide Kinase also catalyzes the removal of 3′-phosphoryl groups from 3′-phosphoryl polynucleotides, deoxynucleoside 3′-monophosphates and deoxynucleoside 3′-diphosphates (1).

**Applications:**
- End-labeling DNA or RNA for probes and DNA sequencing (2)
- Addition of 5′-phosphates to oligonucleotides to allow subsequent ligation
- Removal of 3′-phosphoryl groups (3)

**Reagents Supplied with Enzyme:**
- 10X T4 Polynucleotide Kinase Reaction Buffer (RNase free).
- 1X T4 Polynucleotide Kinase Reaction Buffer: Incubate at 37°C.

**Quality Assurances:**
- Physical Purity: Purified to > 95% homogeneity as determined by SDS-PAGE analysis using Coomassie Blue detection.
- RNase Activity: Incubation of 100 units with 2 µg MS2 phage RNA for 1 hour at 37°C in 50 µl 1X T4 Polynucleotide Kinase Reaction Buffer followed by agarose gel electrophoresis showed no degradation.

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**Quality Control Assays**

**16-Hour Incubation:** A 50 µl reaction containing 1 µg of λ DNA and 500 units of enzyme incubated for 16 hours showed no degradation.

**Exonuclease Activity:** Incubation of 300 units of enzyme with 1 µg sonicated [3H] DNA (106 cpm/µg) for 4 hours at 37°C in 50 µl reaction buffer released < 0.1% radioactivity.

**Endonuclease Activity:** Incubation of 200 units of enzyme with 1 µg X174 RF I DNA for 4 hours at 37°C in 50 µl reaction buffer resulted in < 10% conversion to RF II.

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**Note:** T4 Polynucleotide Kinase requires ATP for activity, but its supplied reaction buffer does not contain ATP because it interferes with radiolabeling reactions. Typically, a kinase reaction is followed by a ligation reaction. To simplify this process, T4 Polynucleotide Kinase is optimized for use in T4 DNA Ligase reaction buffer (which contains the appropriate amount of ATP). We recommend performing the kinase reaction in ligase buffer for 30 minutes; you can then proceed to ligation without a buffer change or heat inactivation.

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**Source:** An *E. coli* strain that carries the cloned T4 Polynucleotide Kinase gene. It is purified by a modification of the method of Richardson (1).
Other Activities: ²³P end labeling of 5'-hydroxyl terminated d(T), with 50 units for 30 minutes at 37°C in 50 μl 1X T4 Polynucleotide Kinase Reaction Buffer followed by 20% acrylamide gel electrophoresis revealed that less than 1% of the product had been degraded by exonuclease or phosphatase activities.

Heat Inactivation: 65°C for 20 minutes.

Notes On Use: [³²P] ATP may be substituted for [³³P] ATP.

For radioactive labeling, use 1–50 pmol of 5'-termini in a 50 µl reaction containing 1X T4 Polynucleotide Kinase Reaction Buffer, 1 mM ATP and 10 units of T4 Polynucleotide Kinase. Incubate at 37°C for 30 minutes. 1X T4 DNA Ligase Reaction Buffer contains 1 mM ATP and can be substituted in non-radioactive phosphorylations (T4 Polynucleotide Kinase exhibits 100% activity in this buffer).

Fresh buffer is required for optimal activity (in older buffers, loss of DTT due to oxidation lowers activity).

The efficiencies of blunt and recessed 5'-end phosphorylation can be improved by heating to 70°C for 5 minutes, then chilling on ice prior to kinase addition and by adding PEG-8,000 to 5% (w/v) (2).

For non-radioactive phosphorylation use up to 300 pmol of 5' termini in a 50 µl reaction containing 1X T4 Polynucleotide Kinase Reaction Buffer, 1 mM ATP and 10 units of T4 Polynucleotide Kinase. Incubate at 37°C for 30 minutes. 1X T4 DNA Ligase Reaction Buffer contains 1 mM ATP and can be substituted in non-radioactive phosphorylations (T4 Polynucleotide Kinase exhibits 100% activity in this buffer).

Fresh buffer is required for optimal activity (in older buffers, loss of DTT due to oxidation lowers activity).

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The following levels of inhibition of T4 Polynucleotide Kinase are observed when the supplied reaction buffer is supplemented with:

- 50 mM NaCl - no inhibition
- 100 mM NaCl - 30% inhibition
- 150 mM NaCl - 50% inhibition
- 7 mM phosphate - 50% inhibition
- 7 mM (NH₄)₂SO₄ - 75% inhibition

Since Polynucleotide Kinase is inhibited by ammonium ions, DNA should not be precipitated in the presence of ammonium ions prior to phosphorylation.

Dephosphorylation prior to end-labeling can be avoided by utilizing the exchange reaction, although this results in lower specific activity labeling (4). Sufficient incorporation levels can be attained using the supplied buffer supplemented with 100 μM ADP in the final reaction. However, higher levels of incorporation with the exchange reaction are achieved when using the buffer described in (2).

Gaps can be phosphorylated with elevated levels of ATP. Nicks are not phosphorylated efficiently.

CTP, GTP, TTP, UTP, dATP or dTTP can be substituted for ATP as a phosphate donor (1).

References: