

# NEB 5-alpha F' I<sup>q</sup> Competent *E. coli* (High Efficiency)



## C2992H

20 x 0.05 ml/tube

Lot: 94

Store at **-80°C**

**CAUTION:** This product contains DMSO, a hazardous material. Review the MSDS before handling.

**Description:** Chemically competent *E. coli* cells suitable for high efficiency transformation in a wide variety of applications.

### Features:

- DH5 $\alpha$ <sup>TM</sup> derivative
- Transformation efficiency 1–3 x 10<sup>9</sup> cfu/ $\mu$ g pUC19 DNA
- Efficient transformation of unmethylated DNA derived from PCR, cDNA and many other sources (*hsdR*)
- Tight control of expression by *lacI<sup>q</sup>* allows potentially toxic genes to be cloned
- Activity of nonspecific endonuclease I (*endA1*) eliminated for highest quality plasmid preparations
- Resistance to phage T1 (*thiA2*)
- Suitable for blue/white screening by  $\alpha$ -complementation of the  $\beta$ -galactosidase gene
- F' allows cells to be infected with bacteriophage M13 for ssDNA production
- Reduced recombination of cloned DNA (*recA1*)
- K12 Strain
- Free of animal products

### Reagents Supplied:

20 x 0.05 ml/tube of chemically competent NEB 5-alpha F' I<sup>q</sup> Competent *E. coli* cells (**Store at -80°C**)

20 ml of SOC Outgrowth Medium (**Store at room temperature**)

0.025 ml of 50 pg/ $\mu$ l pUC19 Control DNA (**Store at -20°C**)

### Quality Control Assays

**Transformation Efficiency:** 100 pg of pUC19 plasmid DNA was used to transform NEB 5-alpha F' I<sup>q</sup> Competent *E. coli* following the high efficiency protocol provided. 1–3 x 10<sup>9</sup> colonies formed/ $\mu$ g after an overnight incubation on LB-ampicillin plates at 37°C.

Untransformed cells were also tested for resistance to phage  $\phi$ 80, a standard test for resistance to phage T1, cells are resistant to tetracycline, and sensitivity to ampicillin, chloramphenicol, kanamycin, nitrofurant, spectinomycin and streptomycin. The cells were shown to be suitable for blue/white screening by  $\alpha$ -complementation of the  $\beta$ -galactosidase gene using pUC19.

### High Efficiency Transformation Protocol

Perform steps 1–7 in the tube provided.

1. Thaw a tube of NEB 5-alpha F' I<sup>q</sup> Competent *E. coli* cells on ice for 10 minutes.
2. Add 1–5  $\mu$ l containing 1 pg–100 ng of plasmid DNA to the cell mixture. Carefully flick the tube 4–5 times to mix cells and DNA. **Do not vortex.**
3. Place the mixture on ice for 30 minutes. Do not mix.

**STORAGE AND HANDLING:** Competent cells should be stored at **-80°C**. Storage at **-20°C** will result in a significant decrease in transformation efficiency. Cells lose efficiency whenever they are warmed above **-80°C**, even if they do not thaw.



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4. Heat shock at exactly 42°C for exactly 30 seconds. Do not mix.
5. Place on ice for 5 minutes. Do not mix.
6. Pipette 950  $\mu$ l of room temperature SOC into the mixture.
7. Place at 37°C for 60 minutes. Shake vigorously (250 rpm) or rotate.
8. Warm selection plates to 37°C.
9. Mix the cells thoroughly by flicking the tube and inverting, then perform several 10-fold serial dilutions in SOC.
10. Spread 50–100  $\mu$ l of each dilution onto a selection plate and incubate overnight at 37°C. Alternatively, incubate at 30°C for 24–36 hours or 25°C for 48 hours.

### 5 Minute Transformation Protocol

The following protocol results in only 10% efficiency compared to the High Efficiency Transformation Protocol. Perform steps 1–6 in the tube provided.

1. Remove cells from **-80°C** freezer and thaw in your hand.
2. Add 1–5  $\mu$ l containing 1 pg–100 ng of plasmid DNA to the cell mixture. Carefully flick the tube 4–5 times to mix cells and DNA. **Do not vortex.**
3. Place the mixture on ice for 2 minutes. Do not mix.
4. Heat shock at exactly 42°C for exactly 30 seconds. Do not mix.
5. Place on ice for 2 minutes. Do not mix.
6. Pipette 950  $\mu$ l of room temperature SOC into the mixture. Immediately spread 50–100  $\mu$ l onto a selection plate and incubate overnight at 37–42°C. NOTE: Selection using antibiotics other than ampicillin may require some outgrowth before plating on selective media. Colonies develop faster at temperatures above 37°C, however some constructs may be unstable at elevated temperatures.

### Transformation Protocol Variables

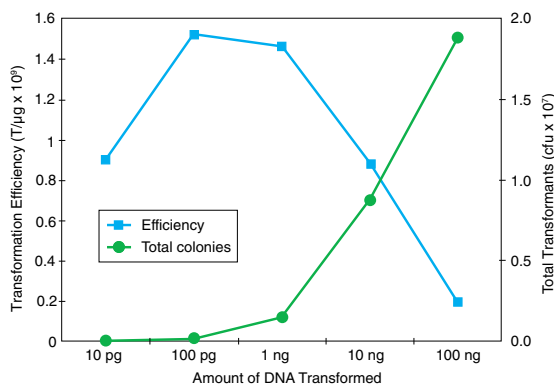
**Thawing:** Cells are best thawed on ice and DNA added as soon as the last bit of ice in the tube disappears. Cells can also be thawed by hand, but warming above 0°C will decrease the transformation efficiency.

**Incubation of DNA with Cells on Ice:** For maximum transformation efficiency, cells and DNA should be incubated together on ice for 30 minutes. Expect a 2-fold loss in transformation efficiency for every 10 minutes this step is shortened.

**Heat Shock:** Both the temperature and the timing of the heat shock step are important and specific to the transformation volume and vessel. Using the transformation tube provided, 30 seconds at 42°C is optimal.

**Outgrowth:** Outgrowth at 37°C for 1 hour is best for cell recovery and for expression of antibiotic resistance. Expect a 2-fold loss in transformation efficiency for every 15 minutes this step is shortened. SOC gives 2-fold higher transformation efficiency than LB medium; and incubation with shaking or rotating the tube gives 2-fold higher transformation efficiency than incubation without shaking.

**Plating:** Selection plates can be used warm or cold, wet or dry without significantly affecting the transformation efficiency. However, warm, dry plates are easier to spread and allow for the most rapid colony formation.



**DNA Effects on Transformation Efficiency and Colony Output:** The optimal amount of DNA to use in a transformation reaction is lower than commonly recognized. Using clean, supercoiled pUC19, the efficiency of transformation is highest in the 100 pg–1 ng range. However, the total colonies which can be obtained from a single transformation reaction increase up to about 100 ng.

(see other side)

CERTIFICATE OF ANALYSIS

## DNA Contaminants to Avoid

Contaminant	Removal Method
Detergents	Ethanol precipitate
Phenol	Extract with chloroform and ethanol precipitate
Ethanol or Isopropanol	Dry pellet before resuspending
PEG*	Column purify or phenol/chloroform extract and ethanol precipitate
DNA binding proteins* (e.g. Ligase)	Column purify or phenol/chloroform extract and ethanol precipitate

\*Ideally, DNA for transformation should be purified and resuspended in water or TE. However, up to 10 µl of DNA directly from a ligation mix can be used with only a two-fold loss of transformation efficiency. Where it is necessary to maximize the number of transformants (e.g. a library), a purification step, either a spin column or phenol/chloroform extraction and ethanol precipitation should be added.

## Calculation of Transformation Efficiency

Transformation efficiency is defined as the number of colony forming units (cfu) which would be produced by transforming 1 µg of plasmid into a given volume of competent cells. The term is somewhat misleading in that 1 µg of plasmid is rarely actually transformed. Instead efficiency is routinely calculated by transforming 100 pg–1 ng of highly purified supercoiled plasmid under ideal conditions. If you plan to calculate efficiency to compare cells or ligations, keep in mind the many variables which affect this metric.

Transformation efficiency (TE) equation:

$$TE = \text{Colonies}/\mu\text{g}/\text{Dilution}$$

Colonies = the number of colonies counted on the plate

µg = the amount of DNA transformed expressed in µg

Dilution = the total dilution of the DNA before plating

TE calculation example:

Transform 2 µl (100 pg) of control pUC19 DNA into 50 µl of cells, out-grow by adding 250 µl of SOC and dilute 10 µl up to 1 ml in SOC before plating 30 µl. If you count 150 colonies on the plate, the TE is:

$$\text{Colonies} = 150$$

$$\mu\text{g DNA} = 0.0001$$

$$\text{Dilution} = 10/300 \times 30/1000 = 0.001$$

$$TE = 150/0.0001/0.001 = 1.5 \times 10^9 \text{ cfu}/\mu\text{g}$$

## Solutions/Recipes

SOB:

2% Vegetable peptone (or Tryptone)

0.5% Yeast Extract

10 mM NaCl

2.5 mM KCl

10 mM MgCl<sub>2</sub>

10 mM MgSO<sub>4</sub>

SOC:

SOB + 20 mM Glucose

LB agar:

1% Tryptone

0.5% Yeast Extract

0.17 M NaCl

1.5% Agar

Blue/White Screening:

X-gal 80 µg/ml

IPTG\* 0.3 mM

\*Omit IPTG for potentially toxic genes

## Antibiotics for Plasmid Selection

Antibiotic	Working Concentration
Ampicillin	100 µg/ml
Carbenicillin	100 µg/ml
Chloramphenicol	33 µg/ml
Kanamycin	30 µg/ml
Streptomycin	25 µg/ml

**Genotype:** F' *proA*<sup>+</sup>*B*<sup>+</sup> *lacI*<sup>h</sup> Δ(*lacZ*)M15 *zzf::Tn10* (Tet<sup>R</sup>) / *fhuA2*Δ(*argF-lacZ*) *U169 phoA glnV44 φ80*Δ(*lacZ*)M15 *gyrA96 recA1 relA1 endA1 thi-1 hsdR17*

## Strain Properties

The properties of this strain that contribute to its usefulness as a cloning strain are described below. The genotypes underlying these properties appear in parentheses.

**Blue/White Screening (F' Δ(*lacZ*)M15):** makes ω-fragment of β-gal; Δ(*lac-proAB*) deletes the β-gal gene on the chromosome. pUC19 and similar plasmids code for the α-peptide of β-galactosidase (*lacZ*). The α-peptide can combine with the ω-fragment of β-galactosidase which is carried on the F' (α-complementation). When β-galactosidase is reconstituted in this manner it can cleave X-gal and results in blue colonies on an X-gal plate. Inserts cloned into the plasmid polylinker disrupt the α-peptide gene and the colonies are white.

**Recombination Deficient (*recA1*):** *E. coli* has a repair system that will recombine homologous sequences. Genomic clones often have duplicated regions, and RecA mediated rearrangements can be problematic, particularly when regions of homology are longer than 50 bp. Strains that have the RecA function deleted tend to grow more slowly than *recA*<sup>+</sup> strains.

**Endonuclease I Deficient (*endA1*):** The periplasmic space of wild type *E. coli* cells contains a nonspecific endonuclease. Extreme care must be taken to avoid degradation of plasmids prepared from these cells. The *endA* mutation deletes this endonuclease and can significantly improve the quality of plasmid preparations.

**Restriction Deficient (*hsdR17*):** Wild type *E. coli* K12 strains carry a restriction endonuclease which cleaves DNA with sites (AAC(N6)GTGC and GCAC(N6)GTT. While *E. coli* DNA is protected from degradation by a cognate methyl-transferase, foreign DNA will be cut at these sites. The *hsdR* mutation eliminates this endonuclease activity. However, this strain has functional methyl restriction systems and may not be suitable for direct cloning of eukaryotic DNA.

**M13 phage sensitive (F<sup>'</sup>):** Infection by M13 and other similar phage requires *E. coli* surface features conferred by the F plasmid carried by some *E. coli* strains. Infection by these phage allows production of single-stranded DNA and the generation of phage display libraries. The F plasmid is frequently modified to carry other useful DNA in the cell [e.g. Δ(*lacZ*)M15 in this cell line] and when modified is called F<sup>'</sup>.

**T1 Phage Resistant (*fhuA2*):** T1, an extremely virulent phage requires the *E. coli* ferric hydroxamate uptake receptor for infectivity. Deletion of this gene confers resistance to this type of phage, but does not significantly affect the transformation or growth characteristics of the cell.

**Lac Promoter Control (*lacI*<sup>h</sup>):** The *lac* repressor blocks expression from *lac*, *tac* and *trc* promoters frequently carried by expression plasmids. If the level of *lac* repressor in *E. coli* cells is not sufficient to inhibit expression via these promoters during transformation or cell growth, even low levels of expression can reduce transformation efficiency and select against desired transformants. The extra molecules of *lac* repressor in *lacI*<sup>h</sup> strains help to minimize promoter activity until IPTG is added.

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## Companion Products Sold Separately:

SOC Outgrowth Medium

#B9020S

4 x 25 ml medium