NEB 5-alpha
Competent E. coli
(High Efficiency)

C2987H
20 x 0.05 ml/tube Lot: 3271409
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:
- DH5α™ derivative
- Transformation efficiency: 1–3 x 10⁹ cfu/µg pUC19 DNA
- Efficient transformation of unmethylated DNA derived from PCR, cDNA and many other sources (hisG64)
- Activity of nonspecific endonuclease I (endA1) eliminated for highest quality plasmid preparations
- Resistance to phage T1 (fhuA2)
- Suitable for blue/white screening by -complementation of the -galactosidase gene
- 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 Competent E. coli cells (Store at –80°C)
- 20 ml of SOC Outgrowth Medium (Store at room temperature)
- 0.025 ml of 50 pg/µl 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 Competent E. coli following the high efficiency protocol provided. 1–3 x 10⁹ colonies formed/µg after an overnight incubation on LB-ampicillin plates at 37°C.

Untransformed cells were also tested for resistance to phage ϕ80, a standard test for resistance to phage T1 and sensitivity to ampicillin, chloramphenicol, kanamycin, nitrofurantoin, spectinomycin, streptomycin and tetracycline. The cells were shown to be suitable for blue/white screening by -complementation of the -galactosidase gene using pUC19.

High Efficiency Transformation Protocol
Perform steps 1–7 in the tube provided.
1. Remove cells from –80°C freezer and thaw in your hand.
2. Add 1–5 µl 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.
5. Place on ice for 2 minutes. Do not mix.
6. Pipette 950 µl of room temperature SOC into the mixture. Immediately

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 µl 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.
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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.

Certificate of Analysis

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5. Place on ice for 5 minutes. Do not mix.
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**DNA Contaminants to Avoid**

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Removal Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detergents</td>
<td>Extract with chloroform and ethanol precipitate</td>
</tr>
<tr>
<td>Phenol</td>
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</tr>
<tr>
<td>Ethanol or Isopropanol</td>
<td>Dry pellet before resuspending</td>
</tr>
<tr>
<td>PEG</td>
<td>Column purity or phenol/chloroform extract and ethanol precipitate</td>
</tr>
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<td>DNA binding proteins* (e.g. Ligase)</td>
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</tr>
</tbody>
</table>

*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 liguations, keep in mind the many variables which affect this metric.

Transformation efficiency (TE) equation:

\[
\text{TE} = \frac{\text{Colonies}}{\mu g \times \text{Dilution}}
\]

Colonies = the number of colonies counted on the plate
\(\mu g\) = the amount of DNA transformed expressed in \(\mu g\)
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, outgrow 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:

Colonies = 150
\(\mu g\) DNA = 0.0001
Dilution = 10/300 x 30/1000 = 0.001
TE = 150/0.0001/0.001 = 1.5 x 10^9 cfu/µg

**Solutions/Recipes**

**SOB:**
- 2% Vegetable peptone (or Tryptone)
- 0.5% Yeast Extract
- 10 mM NaCl
- 2.5 mM KCl
- 10 mM MgCl₂
- 10 mM MgSO₄

**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**

<table>
<thead>
<tr>
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<tr>
<td>Ampicillin</td>
<td>100 µg/ml</td>
</tr>
<tr>
<td>Carbenicillin</td>
<td>100 µg/ml</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>33 µg/ml</td>
</tr>
<tr>
<td>Kanamycin</td>
<td>30 µg/ml</td>
</tr>
<tr>
<td>Streptomycin</td>
<td>25 µg/ml</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>15 µg/ml</td>
</tr>
</tbody>
</table>

**Genotype:** thuA2 *(argF-lacZ)U169 phoA glnV44 80 (lacZ)M15 gyrA96 recA1 relA1 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 *(80α(lacZ)M15)*: makes the α-fragment of β-galactosidase (β-gal); *(argF-lacZ)* deletes the β-gal gene on the chromosome. pUC19 and similar plasmids code for the α-peptide of β-gal (lacZ).

The α-peptide can combine with the α-fragment of β-gal that is carried on 80(α-complementation). When β-gal is reconstituted in this manner it can cleave 5-bromo-4-chloro-3-indolyl-β-D-galactosidase (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 which have the RecA function deleted tend to grow more slowly than recA 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)GTG). 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.

T1 Phage Resistant *(thuA2)*: 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.

**Companion Products Sold Separately:**

- SOC Outgrowth Medium
  - #B9020S
  - 4 x 25 ml medium

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DH5α™ is a trademark of Invitrogen Corporation.