

# Electrotransformation of *Escherichia coli* with plasmid DNA L5

*Duša Hodžić, Saša Haberl Meglič*

*University of Ljubljana, Faculty of Electrical Engineering*

Duration of the experiments: day 1: 60 min; day 2: 30 min

Max. number of participants: 4

Location: Microbiological laboratory

Level: Basic

## PREREQUISITES

Participants should be familiar with Laboratory Safety (S1). No other specific knowledge is required for this laboratory practice.

## THEORETICAL BACKGROUND

The ability to introduce plasmid DNA into bacterial cells is of great practical importance in molecular biology and genetic engineering. Namely, bacteria with introduced plasmid DNA can have new pathways for production of proteins or can degrade organic pollutants (bioremediation), which is useful in biotechnology. Since majority of bacterial species does not show a naturally occurring ability to take up DNA (competence) it is thus convenient to have methods that allow us such genetic manipulation of bacteria. The most known methods are: chemical transformation, electrotransformation, biolistic transformation and sonoporation. Main advantages of electroporation compared to other methods are shorter time needed for transformation (less than 15 minutes), easy application and no need of toxic chemicals. Nevertheless, optimization of electric pulses and other parameters is needed for high yields of transformants.

Electrotransformation is transformation of bacteria by means of electroporation, a phenomenon that occurs when the cell is exposed to the external electric field of sufficient amplitude and duration which leads to permeabilization of the membrane. Increasing electric field amplitude or duration of pulses increases the level of cell membrane permeabilization and thus transformation effectiveness. When electric field parameters used are below the critical value, cell membrane can reseal and treated bacteria survive. This is also known as reversible electroporation.

**The aim** of this laboratory practice is to demonstrate transformation of *Escherichia coli* with plasmid DNA by means of reversible electroporation (electrotransformation).

## EXPERIMENT

Our experimental organism will be competent bacteria *E.coli* DH5 $\alpha$  and the plasmid pSEUDO-GFP. We will detect transformed and surviving bacteria by counting colony forming units (CFU count) on LB agar plates with antibiotic erythromycin.

**Protocol 1/2 (Electroporation of bacteria):** On the first day of experiment 200  $\mu$ l of competent bacterial cells in 10% glycerol and water medium will be mixed with plasmid DNA (pSEUDO-GFP), incubated for 2 minutes on ice and exposed to electric field. Electric pulses will be applied with prototype pulse generator. Samples for treatment are placed in cuvettes with integrated aluminium electrodes, electrode distance 2 mm (Peqlab, Germany). Immediately after electroporation the recovery medium SOC will be added to bacterial suspension. After 30 minutes incubation at 37 °C and vigorous

shaking, bacteria will be plated on LB agar with selective antibiotic for transformants (erythromycin). Control sample will be the untreated suspension of bacteria. To determine the number of bacterial cells you will need to prepare serial dilutions of resuspended bacteria ranging from  $10^{-1}$  to  $10^{-6}$ . Dilute 100  $\mu$ l of bacterial suspension in tubes containing 900  $\mu$ l of sterile 0,9 % NaCl. Pipette 100  $\mu$ l of suspension per LB agar plate and spread them evenly with sterile rod. All agar plates will be incubated overnight at 37 °C.

**Protocol 2/2 (Counting bacterial colonies):** Determine electrotransformation efficiency and total cell count. The efficiency of reversible electroporation is expressed as number of transformants per microgram of DNA and can be monitored by plating the treated sample on nutrient agar with selective antibiotic and counting the number of CFU. Each colony may arise from one or a group of cells and they represent the cells that have successfully undergone the transformation.

#### FURTHER READING:

Calvin N.M., Hanavalt P.C. High-efficiency transformation of bacterial cells by electroporation. *Journal of Bacteriology* 170: 2796-2801, 1988.

Yoshida N., Sato M. Plasmid uptake by bacteria: a comparison of methods and efficiencies. *Applied Microbiology and Biotechnology* 83:791-798, 2009.

Kotnik T., Frey W., Sack M., Haberl Meglič S., Peterka M., Miklavčič D. Electroporation-based applications in biotechnology. *Trends in Biotechnology. Review* 33:480-488, 2015.

#### NOTES & RESULTS

Electric pulse parameters $n \times t$ ( $\mu$ s) $E$ [kV/cm], $f$ [Hz]	1 x 100 $\mu$ s 12.5 kV/cm 1 Hz	1 x 500 $\mu$ s 12.5 kV/cm 1 Hz	1 x 1 ms 12.5 kV/cm 1 Hz
Total cell count [ <i>number of viable cells / ml</i> ]			
Transformation efficiency [ <i>number of transformants / <math>\mu</math>g pDNA</i> ]			

**NOTES & RESULTS**

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