

Loop assembly protocol v1.0

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Abstract

This protocol is used for performing Type IIS assembly by either *BsaI* or *SapI*-mediated restriction/ligation using the Loop assembly system.

Loop assembly comprises 8 receiver plasmids in odd and even levels (4 per level), which contain directional overhangs for higher level assembly. Odd and even level receiver plasmids are used in a recursive schema for assembly in iterative 'loops'. Any assembly (except for L0 part composition into a L1 transcriptional unit) requires the usage of 4 donor plasmids (each in a specific position) and one receiver plasmid. *BsaI* is used for assembly into odd levels using kanamycin selection, and *SapI* is used in even levels using spectinomycin selection. Loop odd receivers use the Common Syntax standard for L0 part assembly into TUs (Patron, *et al.* 2015 [10.1111/nph.13532]). Then, 4 L1 plasmids (positions 1-4) are assembled into an even receiver plasmid to provide a L2 assembly (4 TUs). For higher level assemblies the same assembly structure is followed, 4 L2 plasmids (positions 1-4) with an odd receiver to yield a L3 assembly (16 TUs).

The Loop type IIS assembly protocol is based on:

"Patron, NJ (2016) DNA Assembly for Plant Biology. Current Protocols in Plant Biology 1:1-13 [doi: 10.1002/cppb.20038]", but with slight modifications for DNA concentrations:

This protocol uses a target amount of each donor DNA of 15 fmol and 7.5 fmol for receiver plasmid DNA in a 10 μ L reaction. In order to perform accurate dispensing, the plasmid DNA is diluted to their corresponding concentration of 15 fmol/ μ L for donor parts and of 7.5 fmol/ μ L for the receiver plasmid, and then 1 μ L of each plasmid is added to the DNA mix. The plasmid part target concentration (in ng/ μ L) equals to each donor plasmid length / 100, and of the receiver plasmid length / 200.

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Guidelines

Each level (odd and even) contains four 'receiver' plasmids:

pOdd-1, 2, 3, 4

pEven-1, 2, 3, 4

For the assembly of L0 parts into a L1 TU, a variable number of parts can be used for the assembly of the TU, however, for higher level assemblies only 4 donor modules can be assembled into any receiver.

Before start

Thaw 10X T4 ligase buffer at RT and then leave on ice. Keep BSA on ice. Briefly vortex 10X ligase buffer before using.

Materials

- 🔪 T4 DNA Ligase Reaction Buffer - 6.0 ml [B0202S](#) by [New England Biolabs](#)
- 🔪 BSA-Molecular Biology Grade - 12 mg [B9000S](#) by [New England Biolabs](#)
- 🔪 T4 DNA Ligase (2,000,000 units/ml) - 20,000 units [M0202T](#) by [New England Biolabs](#)
- 🔪 BsaI - 1,000 units [R0535S](#) by [New England Biolabs](#)
- 🔪 SapI - 250 units [R0569S](#) by [New England Biolabs](#)
- ✓ Ultrapure Distilled, Nuclease Free Water by Contributed by users
- X-Gal [B4252](#) by [Sigma-aldrich](#)

Protocol

Calculate plasmid target concentrations

Step 1.

The required concentration for each donor part in ng/μL is plasmid length / 100. That will yield a concentration of 15 fmol/μL. For the receiver plasmid the target concentration is length / 200, yielding 7.5 fmol/μL.

Prepare DNA mixture

Step 2.

Add into a PCR tube:

1 μL of each donor part at 15 fmol/ μL .

1 μL of receiver plasmid at 7.5 fmol/ μL .

Add water up to 5 μL (assemblies from L1 and above do not need adjustment since 5 plasmids are used)

Master mixes

Step 3.

Odd and even level assemblies use different formulations due to specific requirements of the restriction enzymes used.

For odd levels (BsaI), 10x T4 DNA ligase buffer is used.

For even levels (SapI), 10x Cutsmart buffer is used supplemented with DTT and ATP.

Optionally, to obtain higher efficiency, PEG1000 (Sigma cat. 76293) can be used in any of the reactions master mixes (not essential). 2 % PEG1000 final concentration is used.

For BSA (bovine serum albumin), check stock concentration. NEB 'molecular biology grade BSA' comes at 20 mg/mL, depreciated NEB purified BSA comes at 10 mg/mL. Prepare 20 μL of 1 mg/mL diluted BSA in water solution.

Thaw buffers at RT, then place on ice.

Prepare reaction master mix

Step 4.

Count the number of reactions to be performed and include an extra reaction to account for pipetting errors.

For each odd level reaction:

Odd level Loop Bsal Ligase 2x master mix (LBL 2x):

Reagent	Concentration	Volume (μL)
HPLC H ₂ O		3
T4 DNA ligase buffer	10X	1
Diluted BSA (Bovine Serum Albumin)	1 mg/mL	0.5
T4 DNA ligase	400 U/μL	0.25
Bsal	10 U/μL	0.25

Even level Loop SapI Ligase 2x master mix (LSL 2x)

Reagent	Concentration	Volume (μL)
HPLC H ₂ O		1.5
Cutsmart buffer	10X	1
DTT	100 mM	1
ATP	10 mM	1
T4 DNA ligase	400 u/μL	0.25
SapI	10 U/μL	0.25

Mix by pipetting (enzymes in glycerol will be in the bottom of the tube). Then pipette from the top for accurate dispensing.

Mix DNA and reaction master mix

Step 5.

Add the 5 μL of reaction master mix to the 5 μL of DNA mix and mix thoroughly by pipetting.

Incubate reaction

Step 6.

Place the reaction on a thermocycler (PCR machine). And run the following program:

Step 1 - 37 °C for 1 min

Step 2 - 16 °C for 1.5 min

Repeat 25x step 1 and 2

Step 3 - 50 °C - 10 min

Total running time: 90 minutes

Note: number of cycles can be adjusted but the reaction efficiency may decrease. If assemblies show low efficiency, increase incubation time of step 1 and 2 to 3 and 4 minutes, respectively.

Transform and plate

Step 7.

Use 1 μ L of reaction to transform chemically competent cells.

Recover in SOC for 1 hour incubating at 37 °C in a shaking incubator.

Prepare plates with respective antibiotics with 50 μ g/mL of X-GAL and 1 mM IPTG.

Pick colony grow overnight and validate

Step 8.

Pick 2 white colonies for each construction and grow in 25 mL of LB + respective antibiotic and perform plasmid purification. Validate assembly by means of restriction digest. Suggested enzymes: ThermoFischer XbaI and PstI FastDigest enzymes.

Warnings

Avoid several freeze/thaw cycles and replace 10X T4 ligase buffer every month or so. Protect X-Gal from light.