Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Ion-mediated control of structural integrity and reconfigurability of DNA nanostructures

Aleksandra Bednarz,[1,2,§] Steffan M. Sønderskov,[1,§] Mingdong Dong,[1] and Victoria Birkedal [1,2]*

[1]Interdisciplinary Nanoscience Center (iNANO), Aarhus University, 8000 Aarhus, Denmark

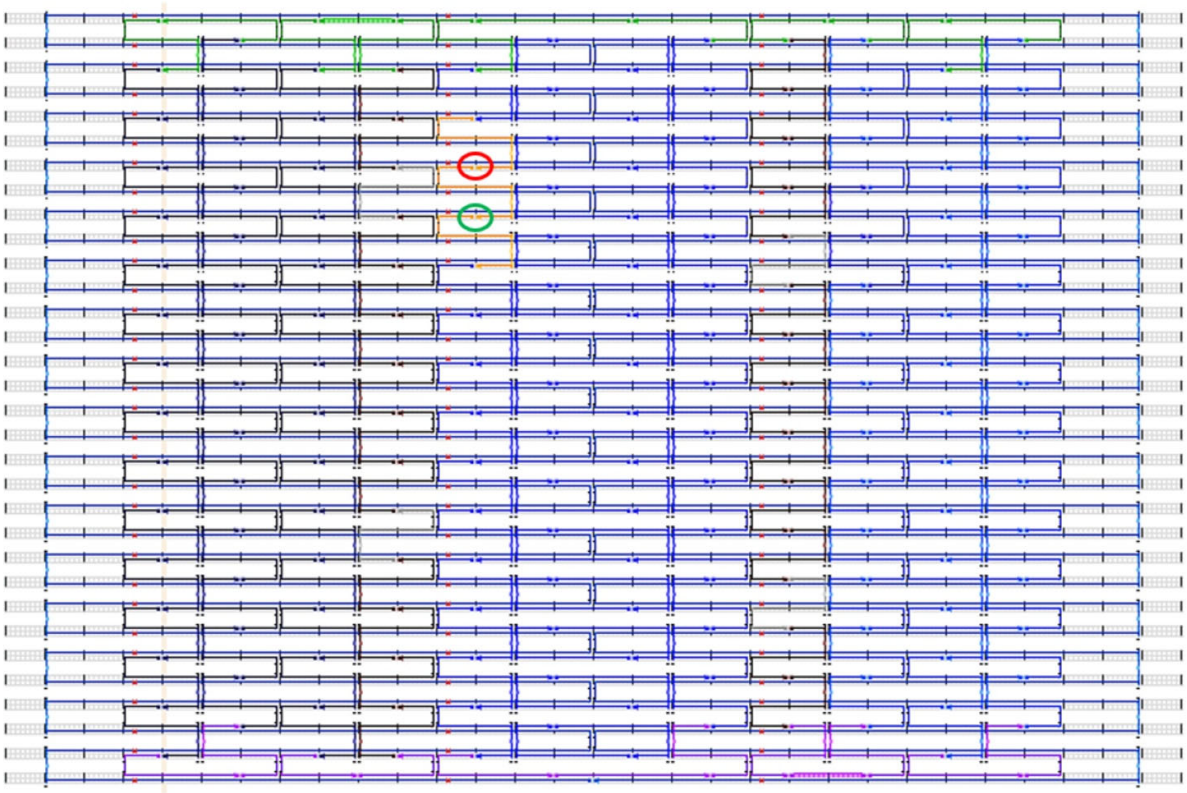
[2]Department of Chemistry, Aarhus University, 8000 Aarhus, Denmark

§ A.B. and S.M.S contributed equally to this work

*Corresponding author: vicb@inano.au.dk

Contents list:

(a)



(b)

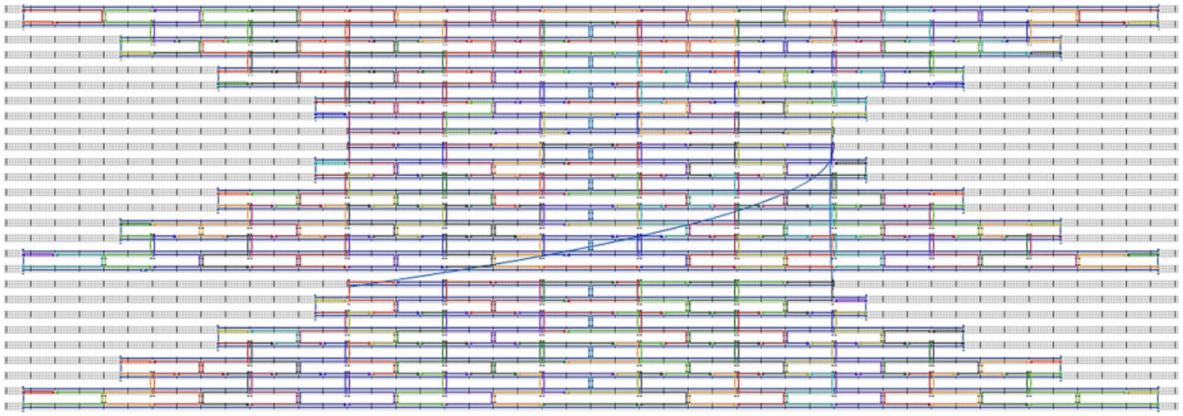


Fig. S1. DNA origami design for the rectangular (a) and triangular (b) nanostructures. The placement sites of the donor- and acceptor- labeled DNA duplexes, protruding from the surface of rectangular origami, are marked with green and red circles, respectively.

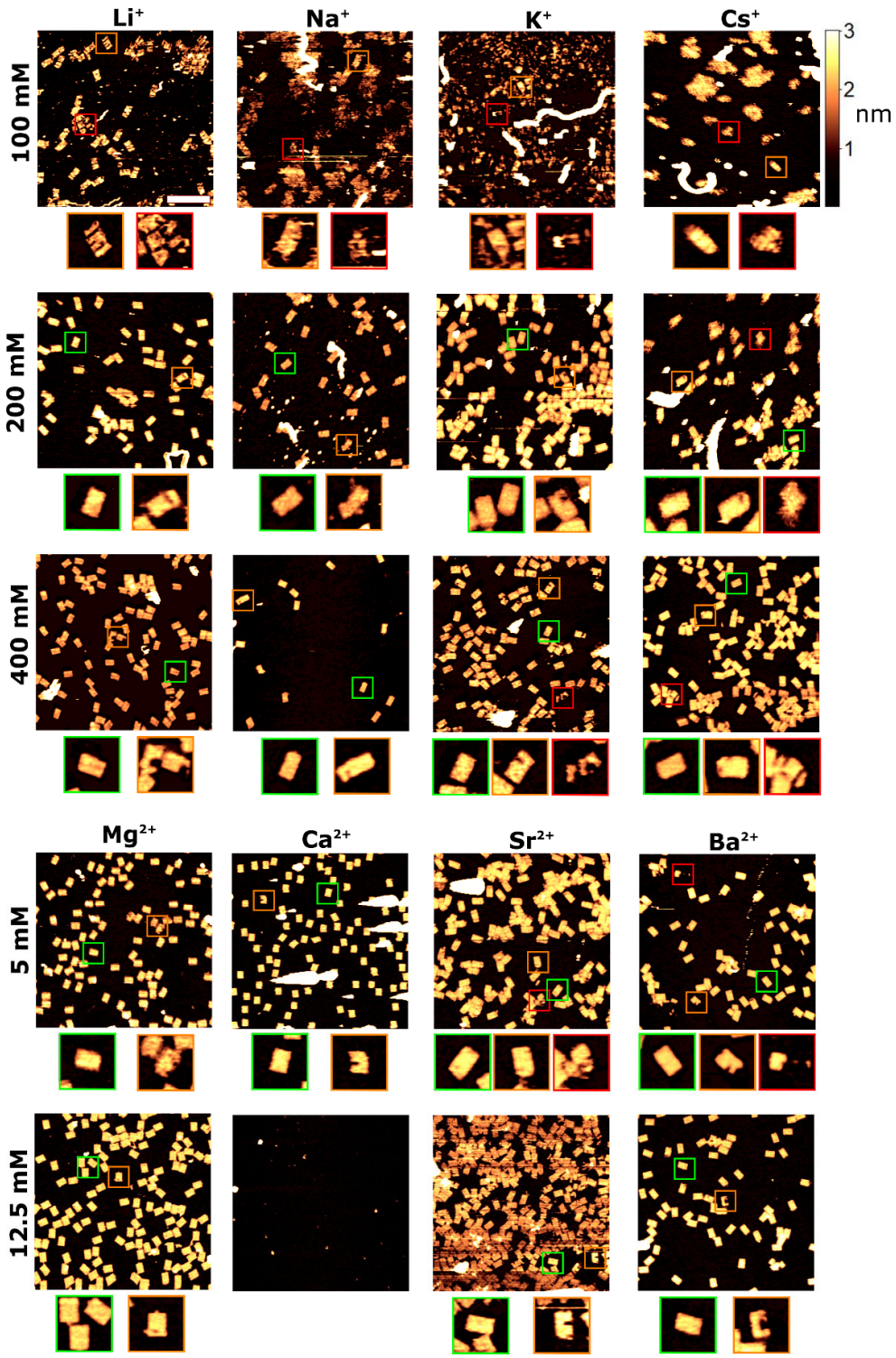


Fig. S2. AFM images showing rectangular DNA origami assembled in different ionic conditions. Below the images, examples of folded (green frame), semi-folded (orange frame) and unfolded (red frame) structures are shown. Scalebar: 500 nm.

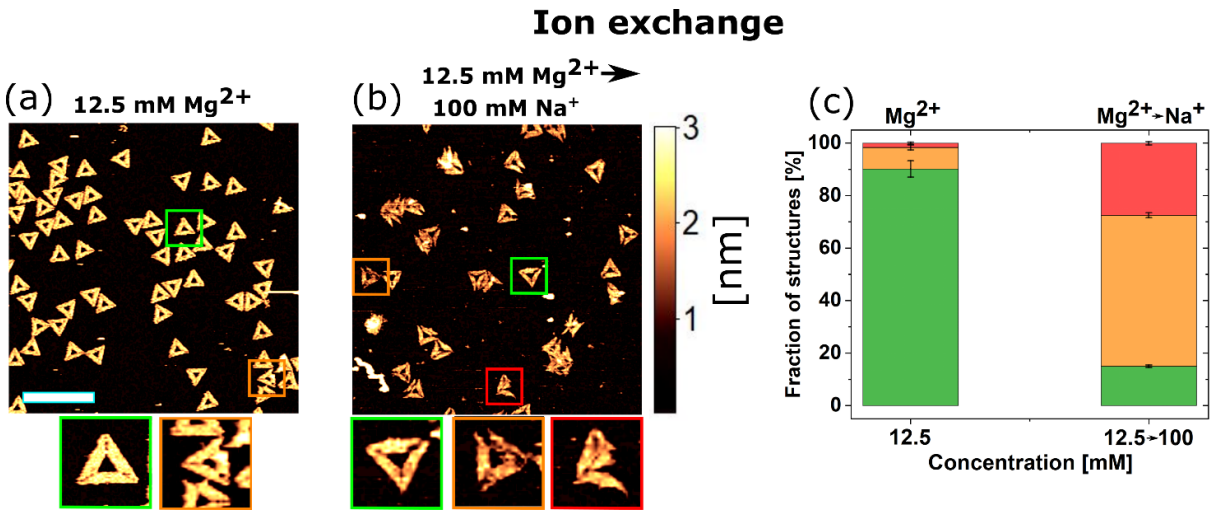


Fig. S3. Investigation of the ion-mediated responsivness of the triangular origami under ion exchange conditions. (a) Constructs folded under optimal conditions in 12.5 mM Mg^{2+} (control) and following ion exchange to 100 mM Na^{+} (b). Scalebar: 500 nm. (c) Corresponding folding statistics.

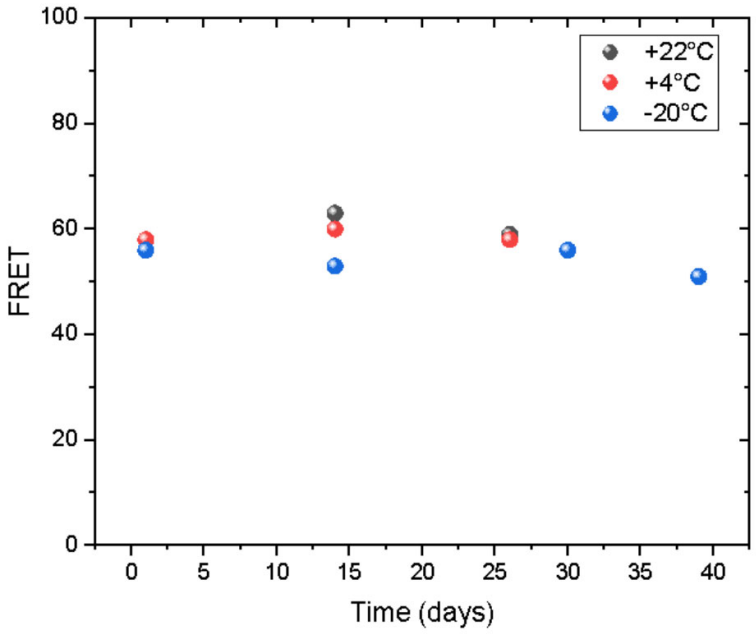


Fig. S4. Time- and temperature-dependent stability study of ion exchange samples from 12.5 mM $MgCl_2$ to 100 mM NaCl. Three individual samples were stored for the time periods specified on the x-axis at different temperatures. No significant changes in FRET were observed.

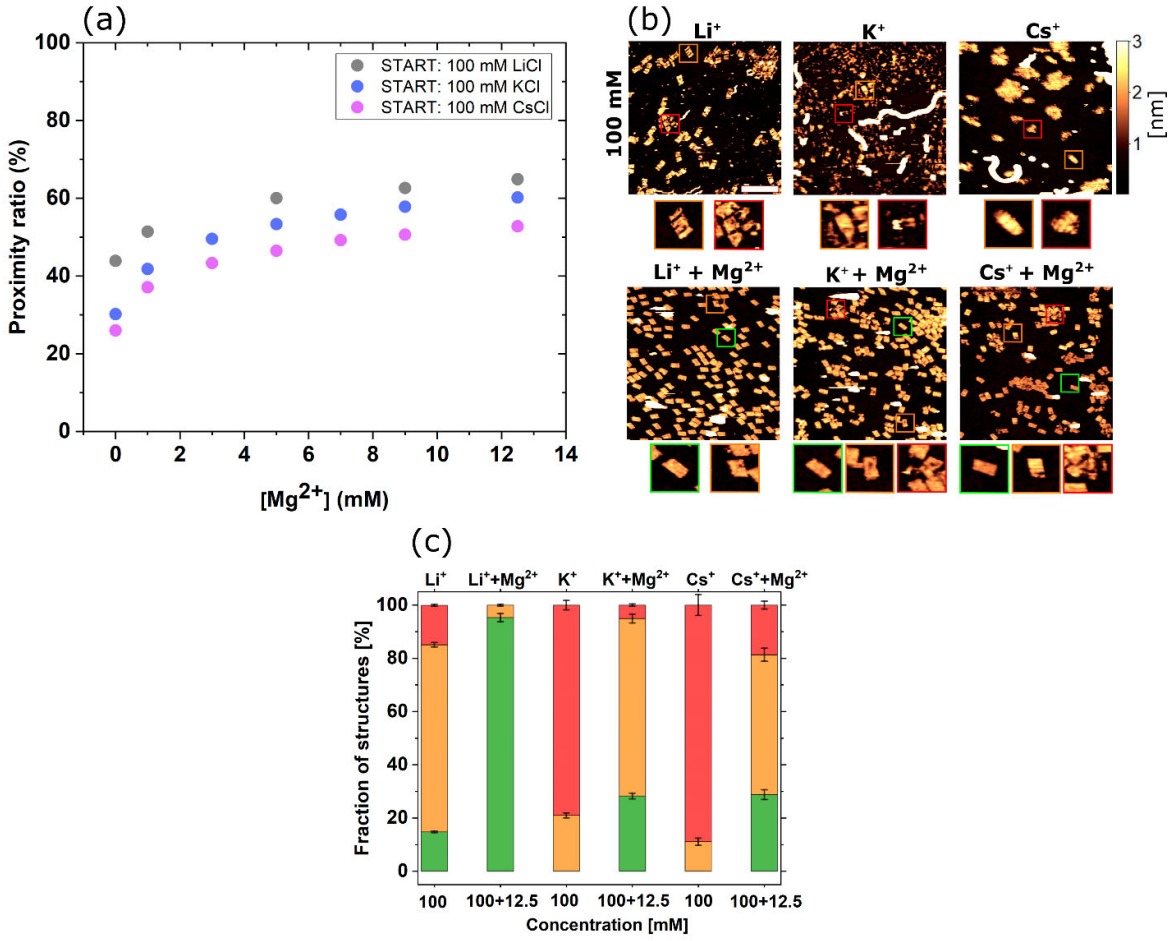


Fig. S5. Ion-mediated repair of rectangular constructs. (a) Magnesium-driven repair of origami samples folded in 100 mM LiCl, KCl and CsCl monitored by ensemble FRET. (b) After reaching the final concentration of $MgCl_2$ of 12.5 mM, the repaired samples were imaged with AFM and compared to structures before repair. Scalebar: 500 nm. **(c)** Folding statistics before and after the addition of $MgCl_2$.

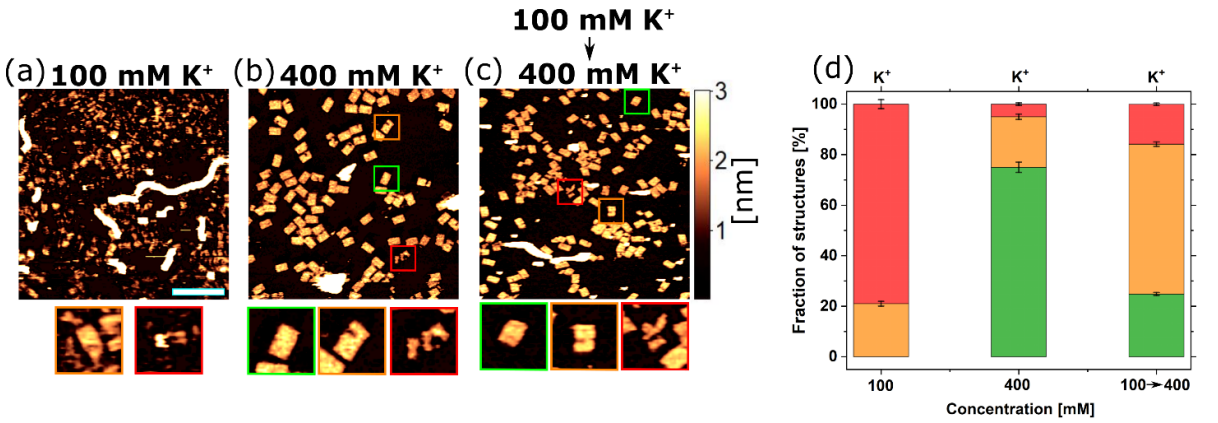


Fig. S6. Repair of origami samples by using monovalent ions. (a) DNA origami annealed in 100 mM KCl. (b) DNA origami annealed in 400 mM KCl. (c) DNA origami annealed in 100 mM KCl undergoing repair by adding KCl to a final concentration of 400 mM. Scalebar: 500 nm. (d) Folding statistics.

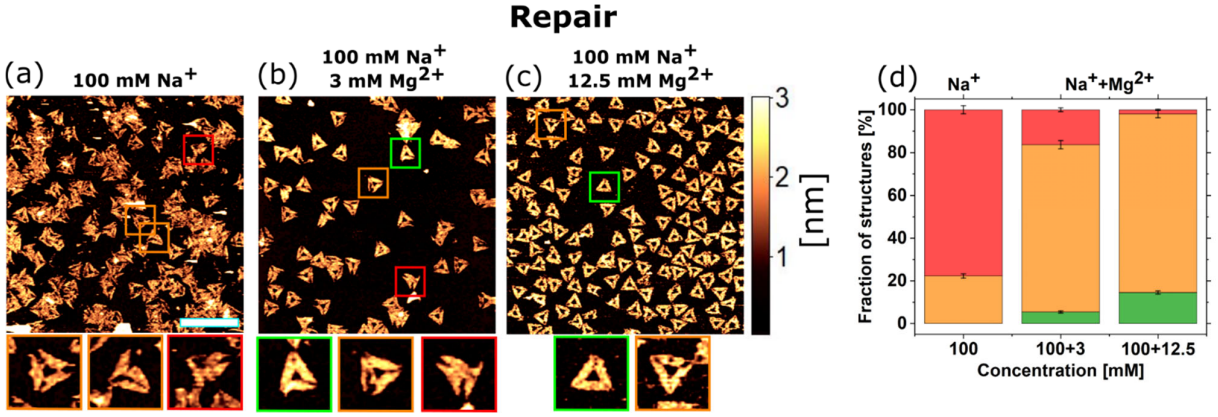


Fig. S7. Investigation of the ion-mediated responsivness of the triangular origami under self-repair conditions. DNA origami sample folded in (a) 100 mM Na^+ and undergoing repair in (b) 100 mM Na^+ + 3 mM Mg^{2+} and (c) 100 mM Na^+ + 12.5 mM Mg^{2+}. Scalebar: 500 nm. (d) Corresponding folding statistics.

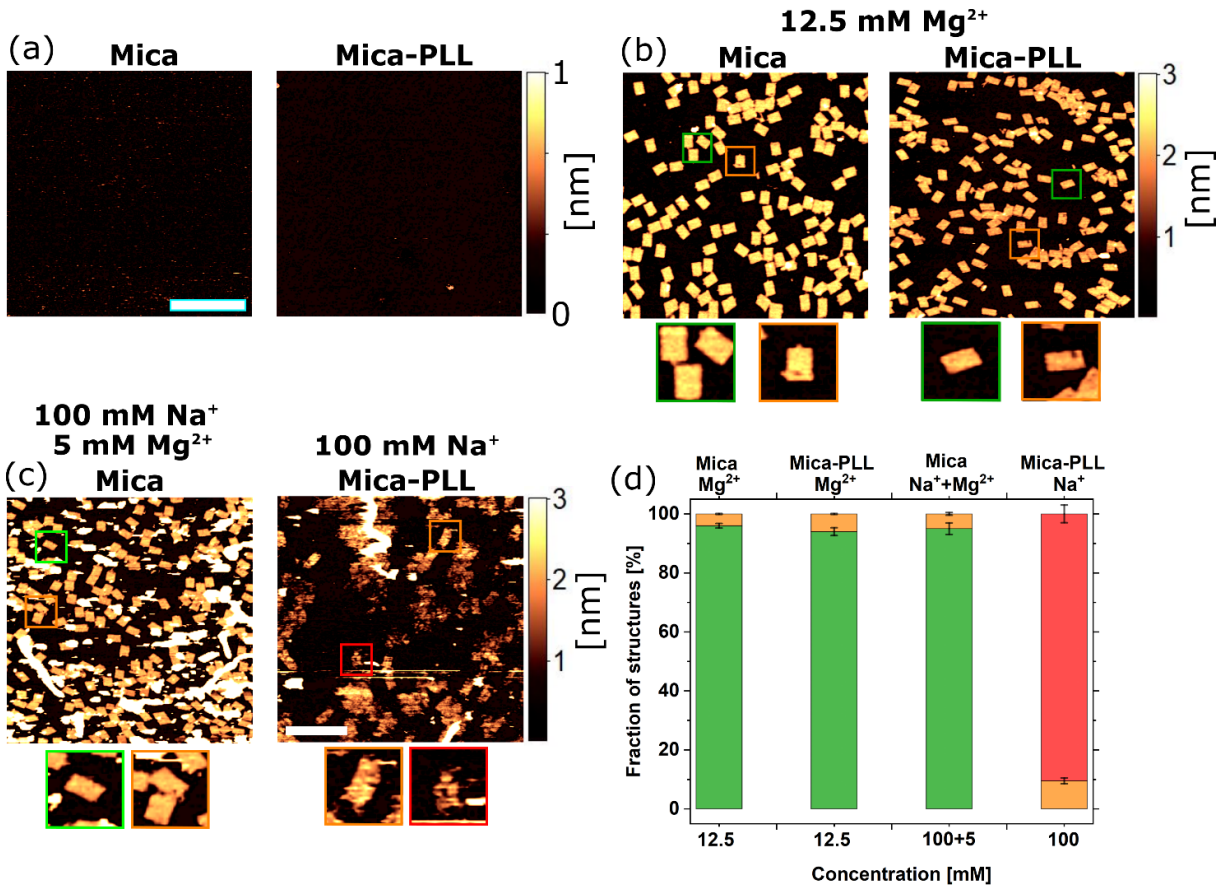


Fig. S8. Impact of origami deposition strategy on the structural integrity. (a) Comparison of mica and mica-PLL surfaces both showing near atomic flatness. (b) Deposition of DNA origami (annealed in 12.5 mM $MgCl_2$) on mica and mica-PLL surfaces. (c) Deposition of DNA origami (annealed in 100 mM) on mica (requires addition of 5 mM Mg^{2+}) and on mica-PLL (Mg^{2+}-free deposition). The presence of Mg^{2+} facillitates substantial repair of otherwise non-folded structures. Scalebar: 500 nm. (d) Corresponding folding statistics.

Table S1. Full list of staple strands in the rectangular construct. The modified oligonucleotides are marked in bold with respective extentions in yellow and fluorescent or bioitn modifications specified.

5' end	3' end	Sequence
0[31]	2[32]	GGTGTATTCAGAACCGCCACCCTTTGTCGT
0[63]	2[64]	CGAGAGGGCAGAGCCACCACCCTCCAGCCCTC
0[79]	0[64]	GGCGGATAAGTGCCGT
0[95]	2[96]	TTTTGCTAGCCCAATAGGAACCACAAACTA
0[127]	0[96]	ACTCCTCAAGAGAAGGATTAGGATTAGCGGGG
0[167]	1[159]	ACCTATTATTCTGAAGCAGTCT
0[191]	2[192]	TTAATGCCTCATACATGGCTTTTGAGAACCAC
1[48]	0[32]	GCCACCCTTTGATATAAGTATAGCCCGGAATA
1[112]	2[128]	GTAACACTAATAAATCCTCATTAATTGATATT
1[144]	0[128]	TGGAAAGCACATGAAAGTATTAAGAGGCTGAG
1[160]	3[159]	CTGAATTTCAGGAGGTTGAGGCACTTTTCA
1[176]	0[168]	AGTAAGCGCCCTGCCTATTTCGGA
1[208]	0[192]	GGAGTGTAGAGTAACAGTGCCCGTATAAACAG
2[31]	4[32]	CTTTCCATTGCTAAACAACTTTGATACCGA
2[63]	4[64]	ATAGTTAGGTGAGAATAGAAAGGACTTGCTTT
2[79]	0[80]	TCCACAGAATTTTCAGGGATAGCACAGTACCA
2[95]	4[96]	CAACGCCCGAATAATAATTTTTAAAGGAGC
2[127]	1[111]	CACAAACAGAGTTTCGTCACCAGTCATGTACC
2[191]	4[192]	CACCAGAGCCACCACCGGAACCGCGATAGCAG
3[48]	1[47]	TCAGCGGACGTAACGATCTAAAGTTCAGAACC
3[112]	4[128]	AAAATCTCTCGGTCATAGCCCCCTGTTTTCAT
3[144]	1[143]	TTTGCCATGGTCAGACGATTGGCCAGCCAGAA
3[160]	5[159]	TAATCAAACAAGTTTGCCTTTAGAGGTGAA
3[176]	1[175]	AACCAGAGCCGCCGCCAGCATTGAACCGTTCC
3[208]	1[207]	GAGCCGCCCCTCAGAGCCGCCACCATGATACA
4[31]	6[32]	TAGTTGCAACCGATATATTCGGTGCCACTA
4[63]	6[64]	CGAGGTGAGGAGTTAAAGGCCGCTGGAAGTTT
4[79]	2[80]	TTTATCAGACAACTAAAGGAATTGTGTAGCAT
4[95]	**6[96]**	**CTTTAATCCTCAGCAGCGAAAGGAGGCTTT**TTGTACTC
4[127]	3[111]	CGGCATTTCAAAAAAAAGGCTCCATCACGTTG
4[191]	6[192]	CACCGTAAATTTGGGAATTAGAGCTTTGTCAC
5[48]	3[47]	GCTTGCAGATTTCTTAAACAGCTTCAACAGTT
5[112]	6[128]	GGAACGAGGAAGGTAAATATTGACAACCGATT
5[144]	3[143]	TTCATTAACGTCAGACTGTAGCGCTATTAGCG
5[160]	7[159]	TTATCACCTACCAGCGCCAAAGACTGGCAT
5[176]	3[175]	CTTGAGCCTCAGTAGCGACAGAATATCACCGG
5[208]	3[207]	TCACCAGTCACCAATGAAACCATCCTCCCTCA
6[31]	8[32]	CGAAGGCACTAAAACACTCATCGAAAGAGG
6[63]	8[64]	CCATTAAATATACCAAGCGCGAAATCAATCAT
6[79]	4[80]	TTTCATGATTTGCGGGATCGTCACTGTATCGG

6[95]	**8[96]**	**Cy3-GAGTACTTGAGGACTTTTGTATCATCGCCTATGTTACTTTCGAGGT**
6[127]	5[111]	GAGGGAGGGGTAGCAACGGCTACAACAGCATC
6[191]	8[192]	AATCAATAATGTTAGCAAACGTAGTAGCAATA
7[48]	5[47]	CCAGCGATCGGGTAAAATACGTAATCGCTGAG
7[112]	8[128]	GTGTCGAAGAAACGCAATAATAACCCAGAAGG
7[144]	5[143]	CAAAAGAACAAAAGGGCGACATTCGGAAATTA
7[160]	9[159]	GATTAAGAAGAAAAGTAAGCAGAGAATTAA
7[176]	5[175]	TACGCAGTGAAAATTCATATGGTTGTCACCGA
7[208]	5[207]	TACATAAACACGGAATAAGTTTATCAGCAAAA
8[31]	10[32]	ACAGATGGACCTTCATCAAGAGCGATTTTA
8[63]	10[64]	AAGGGAACCGGATATTCATTACCCTTTCAACT
8[79]	**6[80]**	**Biotin-GCAGACGGCAAAGTACAACGGAGAAAAGACTT**
8[95]	**10[96]**	**Cy5-ACCTCGTTTAGCCGGGCTGCTCATTCAGTGCGAGTAGT**
8[127]	7[111]	AAACCGAGATCCGCGACCTGCTCCGATAAATT
8[191]	10[192]	GCTATCTTGGGTAATTGAGCGCTAATTATTTA
9[48]	7[47]	ACAAGAACCGAACTGACCAACTTTTTTGACCC
9[112]	10[128]	TTGCCCTGAACATAAAAACAGGGACCTTTACA
9[144]	7[143]	AGACGGGATAGCCGAACAAAGTTAGGAATACC
9[160]	**11[159]**	**Biotin-CTGAACACTTTTGTTTAACGTCAATCAAGA**
9[176]	7[175]	AAGTCAGAACCGAAGCCCTTTTTACTCCTTAT
9[208]	7[207]	GAGATAACGCAAGAAACAATGAAAAAAATACA
10[31]	12[32]	AGAACTGAAATCTACGTTAATAAAAACCAA
10[63]	12[64]	TTAATCATCAACATTATTACAGGTCTATCATA
10[79]	8[80]	TGGTTTAAAAATCAACGTAACAAAAACGAGGC
10[95]	12[96]	AAATTGGTGAGATTTAGGAATAAAAGGAAT
10[127]	9[111]	GAGAGAATACGAGAAACACCAGAAAATAAGGC
10[191]	12[192]	TCCCAATCACAATTTTATCCTGAAATTACCGC
11[48]	9[47]	TAACGGAATGTGAATTACCTTATGTAATCTTG
11[112]	12[128]	AACTAATGCTCCCGACTTGCGGGAAGGCGTTT
11[144]	9[143]	AGCCTTAAAAAATGAAAATAGCAGAGCGCATT
11[160]	13[159]	TTAGTTGCTAGAAGGCTTATCCGAAACCAA
11[176]	9[175]	ACCCAGCTCAAATAAGAAACGATTCCTGAACA
11[208]	9[207]	ACGCTAACCAAAATAAACAGCCATATATCAGA
12[31]	14[32]	AATAGCGGGGTAATAGTAAAATAAAAGATT
12[63]	14[64]	ACCCTCGTGTCCAATACTGCGGAATATTATAG
12[79]	10[80]	GAGCAACAAGAAAGATTCATCAGTGCTTGAGA
12[95]	14[96]	TACGAGGTTGAATCCCCCTCAACATAAATC
12[127]	11[111]	TAGCGAACCAGATACATAACGCCACCACATTC
12[191]	14[192]	GCCCAATATCATTCCAAGAACGGGACGACGAC
13[48]	11[47]	TGGATAGCTTACCAGACGACGATAAAACGAAC
13[112]	14[128]	AACAGTTCATAATATCCCATCCTAGTCCTGAA
13[144]	11[143]	GCATGTAGGTATTCTAAGAACGCGGGTTTTGA
13[160]	15[159]	TCAATAATCAGAACGCGCCTGTTTTGAGAA
13[176]	11[175]	TTTCCTTAGCAAGCAAATCAGATATATTTTGC

13[208]	11[207]	CAAGTACCTTTCATCGTAGGAATCTCTTACCA
14[31]	16[32]	AAGAGGATCGAGCTTCAAAGCGTGGAAGTT
14[63]	16[64]	TCAGAAGCAACTCCAACAGGTCAGATGTTTTA
14[79]	12[80]	ACCCTGACTCGTCATAAATATTCACATAGTAA
14[95]	16[96]	AAAAATCTAATTGCTCCTTTTGTTAATTGC
14[127]	13[111]	CAAGAAAAAGAAAACGAGAATGACATGCTTTA
14[191]	16[192]	AATAAACATGTAATTTAGGCAGAGTAAATAAG
15[48]	13[47]	CGGAAGCAAAAGCGGATTGCATCAGTTTAGAC
15[112]	16[128]	TCATTTTTGTATAAAGCCAACGCTATACAAAT
15[144]	13[143]	GGGCTTAATATCAACAATAGATAAATTTACGA
15[160]	17[159]	TCGCCATATAGAAAAAGCCTGTTAATCGCA
15[176]	13[175]	CGCCAACAACATGTTCAGCTAATGCGGCTGTC
15[208]	13[207]	GAGCCAGTAAGTAATTCTGTCCAGTATTAAAC
16[31]	18[32]	TCATTCCGTAGATTTAGTTTGAAGCCTCAG
16[63]	18[64]	AATATGCAGCAAATGGTCAATAACCAAGGCAA
16[79]	14[80]	AGCTCAACGATTAGAGAGTACCTTAGGTCTTT
16[95]	18[96]	TGAATATTCATTTGGGGCGCGAAGTAGCAT
16[127]	15[111]	TCTTACCAGCGGATGGCTTAGAGCATAAGAGG
16[191]	18[192]	AATAAACATTCAAATATATTTTAGCTGAGAAG
17[48]	15[47]	TACATTTCACTAAAGTACGGTGTCAACCAGAC
17[112]	18[128]	GGTGGCATATATAACTATATGTAACGGCTTAG
17[144]	15[143]	GCAAATCCTAGTATCATATGCGTTCAACAGTA
17[160]	19[159]	AGACAAAGCATAGGTCTGAGAGAAGTACAT
17[176]	15[175]	AAAACTTTCCGGAATCATAATTACTTTAACAA
17[208]	15[207]	ATCTTCTGGTGATAAATAAGGCGTGCATTTTC
18[31]	20[32]	AGCATAACCTGTAATACTTTTGGATAAATT
18[63]	20[64]	AGAATTAGTTCAACGCAAGGATAACACCATCA
18[79]	16[80]	CATACAGGCTGTTTAGCTATATTTAATGCTGT
18[95]	20[96]	TAACATCCATATATTTTAAATGAAAGGGTG
18[127]	17[111]	GTTGGGTTCAATTCTACTAATAGTGCTGAAAA
18[191]	20[192]	AGTCAATACCTTGCTTCTGTAAATGAATTATT
19[48]	17[47]	GCCTTTATCAAAATTAAGCAATAACCATTAGA
19[112]	20[128]	GAGTAATGATTTCATTTGAATTACTTAATTAC
19[144]	17[143]	ATGGAAACCTACCTTTTTAACCTCATGCTGAT
19[160]	21[159]	AAATCAATAGATGATGAAACAAATCAGGTT
19[176]	17[175]	GTGAATAAGTGAATTTATCAAAATAACGCGAG
19[208]	17[207]	TTAATTAAAGCTTAGATTAAGACGTTAATTTC
20[31]	22[32]	AATGCCGGGCTATCAGGTCATTTCGCATTA
20[63]	22[64]	ATATGATACAAACAAGAGAATCGATTAAATTG
20[79]	18[80]	AGTCAAATAAATTTTTAGAACCCTCAATAAAT
20[95]	22[96]	AGAAAGGAACTAGCATGTCAATCCAAAAAC
20[127]	19[111]	ATTTAACATGTAGGTAAAGATTCACAATGCCT
20[191]	22[192]	CATTTCAACAGTACCTTTTACATCTCAATATA
21[48]	19[47]	GTCTGGAGTTCAACCGTTCTAGCTCGGGAGAA

21[112]	22[128]	CCCCGGTTGTAAAACAGAAATAAATCAAAATT
21[144]	19[143]	GTAGATTTCATCAAGAAAACAAAACTTTTTTA
21[160]	23[159]	TAACGTCACTGAATAATGGAAGGACGTTAT
21[176]	19[175]	TACAGTAATTACCTGAGCAAAAGAATATGTGA
21[208]	19[207]	CAATAACGAAAATCGCGCAGAGGCCGTCGCTA
22[31]	24[32]	AATTTTTCGCCATCAAAAATAAGAGGGGAC
22[63]	24[64]	TAAACGTTCTGTAGCCAGCTTTCATGGGCGCA
22[79]	**20[80]**	**Biotin-GCAAATATTGAACGGTAATCGTAACCGGAGAC**
22[95]	24[96]	AGGAAGAGCGAGTAACAACCCGACCGTAAT
22[127]	21[111]	ATTTGCACGATAATCAGAAAAGCCCATATGTA
22[191]	24[192]	ATCCTGATTATCATTTTGCGGAACGGAGCACT
23[48]	21[47]	TGGCCTTCAATATTTTGTTAAAATGCCTGAGA
23[112]	24[128]	TCCGTGGGATTCGACAACTCGTATTTAGACTT
23[144]	21[143]	TTGCCCGAGTTAGAACCTACCATAGAAATTGC
23[160]	**25[159]**	**Biotin-TAATTTTAAATAGATAATACATTTCTAAAG**
23[176]	21[175]	AGTAACATTGTTTGGATTATACTTGATGAATA
23[208]	21[207]	CACCAGAAAGATGATGGCAATTCAGGGAGAAA
24[31]	26[32]	GACGACAGCTTTCCGGCACCGCCACGACGT
24[63]	26[64]	TCGTAACCCAGGCAAAGCGCCATTATTAAGTT
24[79]	22[80]	GGTGTAGATCAACATTAAATGTGATTGTATAA
24[95]	26[96]	GGGATAGCAACTGTTGGGAAGGAGCTGGCG
24[127]	23[111]	TACAAACAAACAAACGGCGGATTGTCGGATTC
24[191]	26[192]	AACAACTATCAAACCCTCAATCAACCATTAAA
25[48]	23[47]	CCGGAAACGTGCATCTGCCAGTTTTTCGCGTC
25[112]	26[128]	TGCGGGCCTGCCACGCTGAGAGCCACACCGCC
25[144]	23[143]	ATGAAAAATGAGGATTTAGAAGTATAAATCCT
25[160]	27[159]	CATCACCTAGATAAAACAGAGGTCCAACAG
25[176]	23[175]	CTCAAATAATAGATTAGAGCCGTCAAAGTTTG
25[208]	23[207]	CAGTTGGCATCTAAAATATCTTTAAAAGAAAC
26[31]	28[32]	TGTAAAAGTCGACTCTAGAGGAGCTCACTG
26[63]	28[64]	GGGTAACGTCGAATTCGTAATCATATGAGTGA
26[79]	24[80]	GCAAGGCGCGCCATTCAGGCTGCGGTCACGTT
26[95]	28[96]	AAAGGGGTGTGTGAAATTGTTAGAAGCATA
26[127]	25[111]	TGCAACAGTCTTCGCTATTACGCCGCGATCGG
26[191]	28[192]	AATACCGAGCGTAAGAATACGTGGGGAAAAAC
27[48]	25[47]	TACCGAGCCCAGGGTTTTCCCAGTTTCTGGTG
27[112]	28[128]	CAATTCCATCACACGACCAGTAATTTGGCAGA
27[144]	25[143]	CATTCTGGGAGGCGGTCAGTATTAAGCAGCAA
27[160]	29[159]	AGATAGAAACGCTCAATCGTCTGGTAGCAA
27[176]	25[175]	ACCTGAAAACGAACCACCAGCAGATGCTGAAC
27[208]	25[207]	ATATTTTTTAGCCCTAAAACATCGTATCTGGT
28[31]	30[32]	CCCGCTTTAATGAATCGGCCAATGGTGGTT
28[63]	30[64]	GCTAACTCGTTTGCGTATTGGGCGGGTTTGCC
28[79]	26[80]	GGTGCCTAGGTCATAGCTGTTTCCGATGTGCT

28[95]	30[96]	AAGTGTATTTCACCAGTGAGACCCTGAGAG
28[127]	27[111]	TTCACCAGCACAACATACGAGCCGTCCGCTCA
28[191]	30[192]	GCTCATGGCACTTGCCTGAGTAGACCGATTAA
29[48]	27[47]	GAGAGGCGACATTAATTGCGTTGCTCCCCGGG
29[112]	30[128]	GCTGATTGAAAGAGTCTGTCCATCGTGAGGCC
29[144]	27[143]	TAACCGTTAAATGGATTATTTACAAAAAGGGA
29[160]	31[159]	TACTTCTTGCCAGAATCCTGAGACCACACC
29[176]	27[175]	AATAACATAAATACCTACATTTTGCCCTTCTG
29[208]	27[207]	AACTATCGGCCAGCCATTGCAACACACAGACA
30[31]	31[47]	CCGAAATCCGAGATAGGGTTGAGTGTTGTT
30[63]	31[71]	CCAGCAGGGAACAAGAGTCCACTA
30[79]	28[80]	TCCACGCTCCAGGGTGGTTTTTCTAAGCCTGG
30[95]	31[111]	AGTTGCACCAACGTCAAAGGGCGAAAAACC
30[127]	29[111]	ACCGAGTACCCTTCACCGCCTGGCGGGCAACA
30[191]	31[207]	AGGGATTTGGGCGCGTACTATGGTTGCTTTGA
31[48]	29[47]	CCAGTTTGCGAAAATCCTGTTTGACGCGCGGG
31[72]	30[80]	TTAAAGAACGTGGACTGCAAGCGG
31[112]	31[143]	GTCTATCAGGCAAGTGTAGCGGTCACGCTGCG
31[144]	29[143]	CGTAACCAAGTGTTTTTATAATCAACGCAAAT
31[160]	31[175]	CGCCGCGCTTAATGCG
31[176]	29[175]	CCGCTACATAGACAGGAACGGTACTGATTAGT
31[208]	29[207]	CGAGCACGGGAGCTAAACAGGAGGAGAACTCA

Table S2. Full list of staple strands in the triangular construct.

5' end	3' end	Sequence
0[111]	2[101]	AAAGAAGTTTTGCCAGCATAAATATTCATTGACTCAACATGTT
0[143]	2[136]	GATAAAAACCAAAATATTAAACAGTTCAGAAATTAGAGCT
0[175]	2[168]	AACACTATCATAACCCATCAAAAATCAGGTCTCCTTTTGA
0[207]	2[200]	CGCCAAAAGGAATTACAGTCAGAAGCAAAGCGCAGGTCAG
0[239]	2[232]	GAATACCACATTCAACTTAAGAGGAAGCCCGATCAAAGCG
0[271]	0[240]	ACAGGTAGAAAGATTCATCAGTTGAGATTTAG
0[303]	2[296]	TTAATAAAACGAACTAACCGAACTGACCAACTCCTGATAA
0[335]	2[328]	ACCAGTCAGGACGTTGGAACGGTGTACAGACCGAAACAAA
0[367]	2[360]	ACCTTATGCGATTTTATGACCTTCATCAAGAGCATCTTTG
0[399]	2[392]	TGGTTTAATTTCAACTCGGATATTCATTACCCACGAAAGA
0[442]	1[431]	CCTGACGAGAAACACCAGAACGAGTAGGCTGCTCATTCAGTGA
1[69]	1[79]	GGATAGCGTCC
1[80]	0[69]	AATACTGCGGAATCGTAGGGGGTAATAGTAAAATGTTTAGACT
1[264]	2[248]	GCGCAGACTCCATGTTACTTAGCCCGTTTTAA
1[432]	1[442]	ATAAGGCTTGC
2[119]	0[112]	TGCTGTAGATCCCCCTCAAATGCTGCGAGAGGCTTTTGCA
2[135]	4[133]	TAATTGCTTGGAAGTTTCATTCCAAATCGGTTGTA
2[151]	0[144]	CGGATGGCACGAGAATGACCATAATCGTTTACCAGACGAC
2[167]	4[168]	TAAGAGGTCAATTCTGCGAACGAGATTAAGCA

2[183]	0[176]	TAATTGCTTTACCCTGACTATTATGAGGCATAGTAAGAGC
2[199]	4[200]	GATTAGAGATTAGATACATTTCGCAAATCATA
2[215]	0[208]	AACTCCAAGATTGCATCAAAAAGATAATGCAGATACATAA
2[231]	4[232]	AACCAGACGTTTAGCTATATTTTCTTCTACTA
2[247]	1[263]	TTCGAGCTAAGACTTCAAATATCGGGAACGAG
2[279]	0[272]	CGACCTGCGGTCAATCATAAGGGAACGGAACAACATTATT
2[295]	4[296]	ATTGTGTCTCAGCAGCGAAAGACACCATCGCC
2[311]	0[304]	TATCATCGTTGAAAGAGGACAGATGGAAGAAAAATCTACG
2[327]	4[328]	GTACAACGAGCAACGGCTACAGAGGATACCGA
2[343]	0[336]	CCAAGCGCAGGCGCATAGGCTGGCAGAACTGGCTCATTAT
2[359]	4[360]	ACCCCCAGACTTTTTCATGAGGAACTTGCTTT
2[375]	0[368]	AAAACACTTAATCTTGACAAGAACTTAATCATTGTGAATT
2[391]	3[399]	GGCAAAAGTAAAATACGTAATGCC
2[410]	0[400]	ACCAACCTAAAAAATCAACGTAACAAATAAATTGGGCTTGAGA
3[101]	3[111]	TTAAATATGCA
3[112]	2[120]	ACTAAAGTACGGTGTCGAATATAA
3[264]	4[248]	GCCGCTTTGCTGAGGCTTGCAGGGGAAAAGGT
3[400]	3[410]	ACTACGAAGGC
4[151]	2[152]	TAAAGCTATATAACAGTTGATTCCCATTTTTG
4[167]	6[165]	ATAAAGCCTTTGCGGGAGAAGCCTGGAGAGGGTAG
4[183]	2[184]	TTAGCAAATAGATTTAGTTTGACCAGTACCTT
4[199]	6[200]	CAGGCAAGATAAAAATTTTTAGAATATTCAAC
4[215]	2[216]	CATCCAATAAATGGTCAATAACCTCGGAAGCA
4[231]	6[232]	ATAGTAGTATGCAATGCCTGAGTAGGCCGGAG
4[247]	3[263]	GGCATCAAATTTGGGGCGCGAGCTAGTTAAAG
4[279]	2[280]	ATTCGGTCTGCGGGATCGTCACCCGAAATCCG
4[295]	6[296]	CACGCATAAGAAAGGAACAACTAAGTCTTTCC
4[311]	2[312]	GACAACAAGCATCGGAACGAGGGTGAGATTTG
4[327]	6[328]	TAGTTGCGAATTTTTTCACGTTGATCATAGTT
4[343]	2[344]	AACAGCTTGCTTTGAGGACTAAAGCGATTATA
4[359]	5[367]	CGAGGTGAGGCTCCAAAAGGAGCC
4[378]	2[376]	CGGTTTATCAGGTTTCCATTAAACGGGAATACACT
5[133]	5[143]	CCAAAAACATT
5[144]	4[152]	ATGACCCTGTAATACTTCAGAGCA
5[264]	6[248]	CAACAGTTTATGGGATTTTGCTAATCAAAAGG
5[368]	5[378]	TTTAATTGTAT
6[183]	4[184]	TTAATGCCTTATTTCAACGCAAGGGCAAAGAA
6[199]	8[192]	CGTTCTAGTCAGGTCATTGCCTGACAGGAAGATTGTATAA
6[215]	4[216]	CAATATGACCCTCATATATTTTAAAGCATTAA
6[231]	8[224]	ACAGTCAAAGAGAATCGATGAACGACCCCGGTTGATAATC
6[247]	5[263]	GTGAGAAAATGTGTAGGTAAAGATACAACTTT
6[279]	4[280]	ATTTTCTGTCAGCGGAGTGAGAATACCGATAT
6[295]	8[288]	AGACGTTACCATGTACCGTAACACCCCTCAGAACCGCCAC
6[311]	4[312]	GTTTTGTCAGGAATTGCGAATAATCCGACAAT
6[327]	8[320]	AGCGTAACTACAAACTACAACGCCTATCACCGTACTCAGG
6[346]	4[344]	ACAGACAGCCCAAATCTCCAAAAAAAAATTTCTTA

7[165]	7[175]	CTATTTTTGAG
7[264]	8[248]	AGGGATAGCTCAGAGCCACCACCCCATGTCAA
7[336]	7[346]	TGTAGCATTCC
8[191]	6[184]	GCAAATATTTAAATTGAGATCTACAAAGGCTACTGATAAA
8[223]	6[216]	AGAAAAGCCCCAAAAAGAGTCTGGAGCAAACAATCACCAT
8[247]	7[263]	TCATATGTGTAATCGTAAAACTAGTCATTTTC
8[287]	6[280]	CCTCAGAACCGCCACCCAAGCCCAATAGGAACGTAAATGA
8[319]	6[312]	AGGTTTAGTACCGCCATGAGTTTCGTCACCAGGATCTAAA
9[192]	11[199]	GTTAAAATTCGCATTAATGTGAGCGAGTAACACACGTTGG
9[224]	11[231]	GCTCATTTTTTAACCAGCCTTCCTGTAGCCAGGCATCTGC
9[264]	10[248]	TCGGGAGATATACAGTAACAGTACAAATAATT
9[288]	11[295]	CCTGATTGCTTTGAATTGCGTAGATTTTCAGGCATCAATA
9[320]	11[327]	GCGCAGAGGCGAATTAATTATTTGCACGTAAATTCTGAAT
10[175]	10[165]	GTGGGAACAAA
10[247]	9[263]	CGCGTCTGATAGGAACGCCATCAACTTTTACA
10[346]	10[336]	ACCATATCAAA
11[165]	13[167]	CGGCGGATTGAATTCAGGCTGCGCAACGGGGGATG
11[184]	9[191]	GGATAGGTACCCGTCGGATTCTCCTAAACGTTAATATTTT
11[200]	13[199]	TGTAGATGGGTGCCGGAAACCAGGAACGCCAG
11[216]	9[223]	GTAACCGTCTTTCATCAACATTAAAATTTTTGTTAAATCA
11[232]	13[231]	CAGTTTGACGCACTCCAGCCAGCTAAACGACG
11[264]	12[248]	CCTGATTAAAGGAGCGGAATTATCTCGGCCTC
11[280]	9[287]	TGGCAATTTTTAACGTCAGATGAAAACAATAACGGATTCG
11[296]	13[295]	TAATCCTGATTATCATTTTGCGGAGAGGAAGG
11[312]	9[319]	GATTATACACAGAAATAAAGAAATACCAAGTTACAAAATC
11[328]	13[327]	AATGGAAGCGAACGTTATTAATTTCTAACAAC
12[143]	12[133]	CGGTGCGGGCC
12[247]	11[263]	AGGAAGATGGGGACGACGACAGTAATCATATT
12[367]	13[359]	ACAATTCGACAACTCGTAATACAT
12[378]	12[368]	AGACTTTACAA
13[133]	15[135]	TCTTCGCTATTGGAAGCATAAAGTGTATGCCCGCT
13[152]	12[144]	TGGCGAAATGTTGGGAAGGGCGAT
13[168]	15[167]	TGCTGCAAATCCGCTCACAATTCCCAGCTGCA
13[184]	11[183]	AGTTGGGTCAAAGCGCCATTCGCCCCGTAATG
13[200]	15[199]	GGTTTTCCATGGTCATAGCTGTTTGAGAGGCG
13[216]	11[215]	ACGTTGTATTCCGGCACCGCTTCTGGCGCATC
13[232]	15[231]	GCCAGTGCGATCCCCGGGTACCGAGTTTTTCT
13[264]	14[248]	GCAAATCACCTCAATCAATATCTGCAGGTCGA
13[280]	11[279]	AAGGAATTACAAAGAAACCACCAGTCAGATGA
13[296]	15[295]	TTATCTAAAGCATCACCTTGCTGATGGCCAAC
13[312]	11[311]	TAGGAGCATAAAAGTTTGAGTAACATTGTTTG
13[328]	15[327]	TAATAGATCGCTGAGAGCCAGCAGAAGCGTAA
13[344]	11[346]	TCAATAGATATTAAATCCTTTGCCGGTTAGAACCT
13[360]	15[359]	TTGAGGATGGTCAGTATTAACACCTTGAATGG
14[111]	14[101]	ATGAGTGAGCT
14[247]	13[263]	CTCTAGAGCAAGCTTGCATGCCTGGTCAGTTG

14[399]	15[391]	ACCACCAGCAGAAGATGATAGCCC
14[410]	14[400]	ATACCGAACGA
15[101]	17[111]	AACTCACATTATTGAGTGTTGTTCCAGAAACCGTCTATCATTT
15[120]	14[112]	GCGCTCACAAGCCTGGGGTGCCTA
15[136]	17[143]	TTCCAGTCCTTATAAATCAAAAGAAGCCGGCGAACGTGGC
15[152]	13[151]	TGTCGTGCACACAACATACGAGCCACGCCAGC
15[168]	17[175]	TTAATGAAGTTTGATGGTGGTTCCAAAGCGAAAGGAGCGG
15[184]	13[183]	CGCGCGGGCCTGTGTGAAATTGTTGGCGATTA
15[200]	17[207]	GTTTGCGTCACGCTGGTTTGCCCCAAGTGTAGCGGTCACG
15[216]	13[215]	CCAGGGTGGCTCGAATTCGTAATCCAGTCACG
15[232]	17[239]	TTTCACCAGCCTGGCCCTGAGAGACACCCGCCGCGCTTAA
15[264]	16[248]	CGACCAGTACATTGGCAGATTCACCTGATTGC
15[280]	13[279]	GGACATTCACCTCAAATATCAAACACAGTTGA
15[296]	17[303]	AGAGATAGTTTGACGCTCAATCGTACGTGCTTTCCTCGTT
15[312]	13[311]	TGACCTGACAAATGAAAAATCTAAAATATCTT
15[328]	17[335]	GAATACGTAACAGGAAAAACGCTCCTAAACAGGAGGCCGA
15[344]	13[343]	CAATATTTGCCTGCAACAGTGCCATAGAGCCG
15[360]	17[367]	CTATTAGTATATCCAGAACAATATCAGGAACGGTACGCCA
15[376]	13[378]	CGCGAACTAAAACAGAGGTGAGGCTTAGAAGTATT
15[392]	17[399]	TAAAACATTAGAAGAACTCAAACTTTTTATAATCAGTGAG
16[79]	16[69]	ACTATTAAAGA
16[247]	15[263]	CCTTCACCGTGAGACGGGCAACAGCAGTCACA
16[431]	17[442]	TCTTTGATTAGTAATAGTCTGTCCATCACGCAAATTAACCGTT
16[442]	16[432]	GTAGCAATACT
17[69]	16[80]	ACGTGGACTCCAACGTCAAAGGGCGAATTTGGAACAAGAGTCC
17[112]	15[119]	AGAGCTTGACGGGGAAATAGCCCGAGATAGGGATTGCGTT
17[144]	15[151]	GAGAAAGGAAGGGAAGGAAATCGGCAAAATCCGGGAAACC
17[176]	15[183]	GCGCTAGGGCGCTGGCAGCAGGCGAAAATCCTTCGGCCAA
17[208]	15[215]	CTGCGCGTAACCACCAGTTGCAGCAAGCGGTCATTGGGCG
17[240]	17[271]	TGCGCCGCTACAGGGCGCGTACTATGGTTGCT
17[272]	15[279]	TTGACGAGCACGTATACTGAAATGGATTATTTAATAAAAG
17[304]	15[311]	AGAATCAGAGCGGGAGATGGAAATACCTACATAACCCTTC
17[336]	15[343]	TTAAAGGGATTTTAGATACCGCCAGCCATTGCGGCACAGA
17[368]	15[375]	GAATCCTGAGAAGTGTATCGGCCTTGCTGGTACTTTAATG
17[400]	15[410]	GCCACCGAGTAAAAGAACATCACTTGCCTGAGCGCCATTAAAA
27[192]	19[199]	GAGCAAAAGAAGATGAGTGAATAACCTTGCTTATAGCTTA
27[224]	19[231]	AAAACAAAATTAATTAAATGGAAACAGTACATTAGTGAAT
27[264]	18[248]	CGGGGTTTCCTCAAGAGAAGGATTTTGAATTA
27[288]	19[295]	GATAAGTGCCGTCGAGCTGAAACATGAAAGTATACAGGAG
27[320]	19[327]	TAGCCCGGAATAGGTGAATGCCCCCTGCCTATGGTCAGTG
18[175]	18[165]	TTAATTAATTT
18[247]	27[263]	CCTTTTTTCATTTAACAATTTCATAGGATTAG
18[346]	18[336]	TATAAACAGTT
19[165]	21[167]	TCCCTTAGAATAACGCGAGAAAACTTTTACCGACC
19[184]	27[191]	ACATAGCGCTGTAAATCGTCGCTATTCATTTCAATTACCT
19[200]	21[199]	GATTAAGAAATGCTGATGCAAATCAGAATAAA

19[216]	27[223]	AGAGTCAAAAATCAATATATGTGATGAAACAAACATCAAG
19[232]	21[231]	TTATCAAACCGGCTTAGGTTGGGTAAGCCTGT
19[264]	20[248]	AGCGTCATGTCTCTGAATTTACCGACTACCTT
19[280]	27[287]	TTTGATGATTAAGAGGCTGAGACTTGCTCAGTACCAGGCG
19[296]	21[295]	TGTACTGGAAATCCTCATTAAAGCAGAGCCAC
19[312]	27[319]	TTTAACGGTTCGGAACCTATTATTAGGGTTGATATAAGTA
19[328]	21[327]	CCTTGAGTCAGACGATTGGCCTTGCGCCACCC
20[143]	20[133]	TTAATTTCATC
20[247]	19[263]	TTTAACCTATCATAGGTCTGAGAGTTCCAGTA
20[367]	21[359]	GCCGCCAGCATTGACACCACCCTC
20[378]	20[368]	CCACCAGAGCC
21[133]	23[135]	TTCTGACCTAAAATATAAAGTACCGACTGCAGAAC
21[152]	20[144]	GTTTGAAATTCAAATATATTTTAG
21[168]	23[167]	GTGTGATAAGGCAGAGGCATTTTCAGTCCTGA
21[184]	19[183]	GTTAAATACAATCGCAAGACAAAGCCTTGAAA
21[200]	23[199]	CACCGGAATCGCCATATTTAACAAAATTTACG
21[216]	19[215]	ACTAGAAATATATAACTATATGTACGCTGAGA
21[232]	23[231]	TTAGTATCGCCAACGCTCAACAGTCGGCTGTC
21[264]	22[248]	TTCATAATCCCCTTATTAGCGTTTTTCTTACC
21[280]	19[279]	CCGGAACCCAGAATGGAAAGCGCAACATGGCT
21[296]	23[295]	CACCGGAAAGCGCGTTTTCATCGGAAGGGCGA
21[312]	19[311]	CTCAGAGCATATTCACAAACAAATTAATAAGT
21[328]	23[327]	TCAGAACCCAGAATCAAGTTTGCCGGTAAATA
21[344]	19[346]	CAGAGCCAGGAGGTTGAGGCAGGTAACAGTGCCCG
21[360]	23[359]	AGAGCCGCACCATCGATAGCAGCATGAATTAT
22[111]	22[101]	CTGTCCAGACG
22[247]	21[263]	AGTATAAAATATGCGTTATACAAAGCCATCTT
22[399]	23[391]	CCATTAGCAAGGCCGGGGGAATTA
22[410]	22[400]	TAGCACCATTA
23[101]	25[111]	ACGACAATAAATCCCGACTTGCGGGAGATCCTGAATCTTACCA
23[120]	22[112]	TCAGCTAAAAAAGGTAAAGTAATT
23[136]	25[143]	GCGCCTGTTATTCTAAGAACGCGATTCCAGAGCCTAATTT
23[152]	21[151]	AATAGATAGAGCCAGTAATAAGAGATTTAATG
23[168]	25[175]	ACAAGAAAGCAAGCAAATCAGATAACAGCCATATTATTTA
23[184]	21[183]	CCCATCCTCGCCAACATGTAATTTAATAAGGC
23[200]	25[207]	AGCATGTATTTCATCGTAGGAATCAAACGATTTTTTGTTT
23[216]	21[215]	TCAATAATAGGGCTTAATTGAGAATCATAATT
23[232]	25[239]	TTTCCTTAGCACTCATCGAGAACAATAGCAGCCTTTACAG
23[264]	24[248]	ATGGTTTATGTCACAATCAATAGATATTAAAC
23[280]	21[279]	AAAGACAACATTTTCGGTCATAGCCAAAATCA
23[296]	25[303]	CATTCAACAAACGCAAAGACACCAGAACACCCTGAACAAA
23[312]	21[311]	GGAGGGAATTTAGCGTCAGACTGTCCGCCTCC
23[328]	25[335]	TTGACGGAAATACATACATAAAGGGCGCTAATATCAGAGA
23[344]	21[343]	ATTAAAGGCCGTAATCAGTAGCGAGCCACCCT
23[360]	25[367]	CACCGTCACCTTATTACGCAGTATTGAGTTAAGCCCAATA
23[376]	21[378]	AGCCATTTAAACGTCACCAATGAACACCAGAACCA

23[392]	25[399]	GAGCCAGCGAATACCCAAAAGAACATGAAATAGCAATAGC
24[79]	24[69]	TCAAGATTAGT
24[247]	23[263]	CAAGTACCTCATTCCAAGAACGGGAAATTCAT
24[431]	25[442]	CAGAAGGAAACCGAGGTTTTTAAGAAAAGTAAGCAGATAGCCG
24[442]	24[432]	AACAAAGTTAC
25[69]	24[80]	TGCTATTTTGCACCCAGCTACAATTTTGTTTTGAAGCCTTAAA
25[112]	23[119]	ACGCTAACGAGCGTCTGGCGTTTTAGCGAACCCAACATGT
25[144]	23[151]	GCCAGTTACAAAATAATAGAAGGCTTATCCGGTTATCAAC
25[176]	23[183]	TCCCAATCCAAATAAGATTACCGCGCCCAATAAATAATAT
25[208]	23[215]	AACGTCAAAAATGAAAAGCAAGCCGTTTTTATGAAACCAA
25[240]	25[271]	AGAGAATAACATAAAAACAGGGAAGCGCATTA
25[272]	23[279]	GACGGGAGAATTAACTCGGAATAAGTTTATTTCCAGCGCC
25[304]	23[311]	GTCAGAGGGTAATTGATGGCAACATATAAAAGCGATTGAG
25[336]	23[343]	GATAACCCACAAGAATGTTAGCAAACGTAGAAAATTATTC
25[368]	23[375]	ATAAGAGCAAGAAACATGGCATGATTAAGACTCCGACTTG
25[400]	23[410]	TATCTTACCGAAGCCCAAACGCAATAATAACGAAAATCACCAG