Supplementary Information

Tri-State Logic Computation by Activating DNA Origami Chain

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1. Additional AFM images of logic gate “AND”

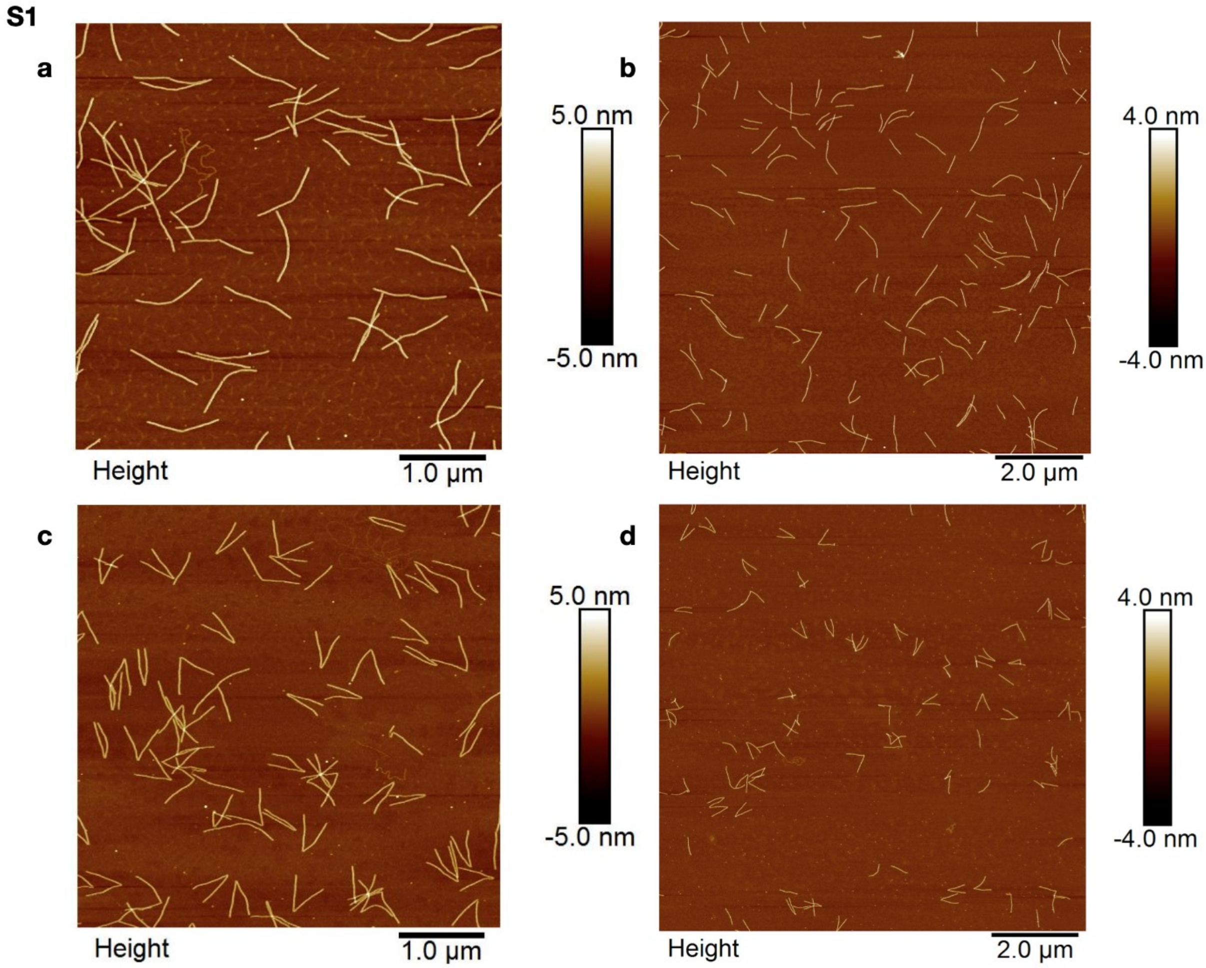

Figure S1. AFM images of logic gate “AND”. (a) and (b) are open geometry with output “0”. (c) and (d) are folded geometry with output “1”.

2. Additional AFM images of one-folding geometry in tri-state buffer logic gate

S2

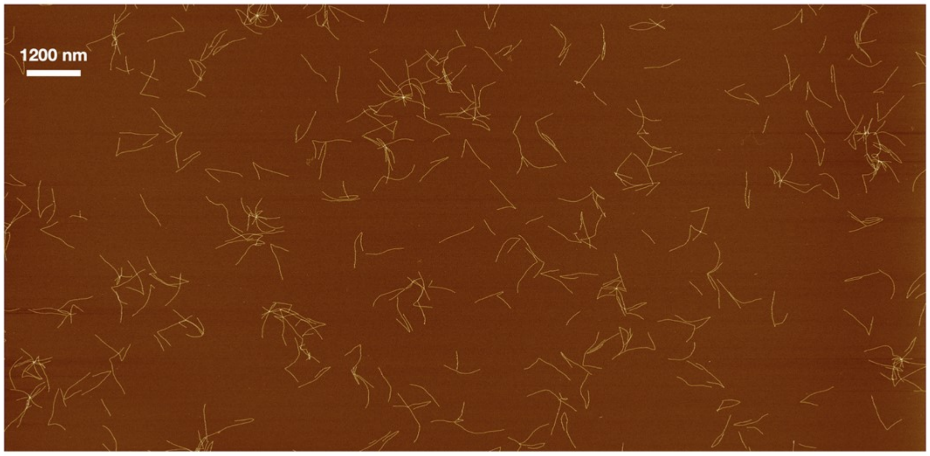

Figure S2. AFM images of one-folding geometry. Excluding non-desired monomer, dimer and non-specific aggregations, the percentage of trimer with one-folding geometry is at least 70% (Statistics was obtained from over 500 DNA origami, the AFM image in the figure is only a representative one). It is safe to set the threshold to be 50% to read the output to be “0”.

3. Additional AFM images of two-folding geometry in tri-state buffer logic gate

S3

Figure S3. AFM images of two-folding geometry. Excluding non-desired monomer, dimer, and non-specific aggregations, the percentage of trimer with two-folding geometry is at least 70% (Statistics was obtained from over 500 DNA origami, the AFM image in the figure is only a representative one). It is safe to set the threshold to be 50% to read the output to be “1”. The entangled origami is ignored in statistics because it does not provide any clear view on individual’s geometry.

4. Additional AFM images of one-folding geometry in tri-state inverter logic gate

S4

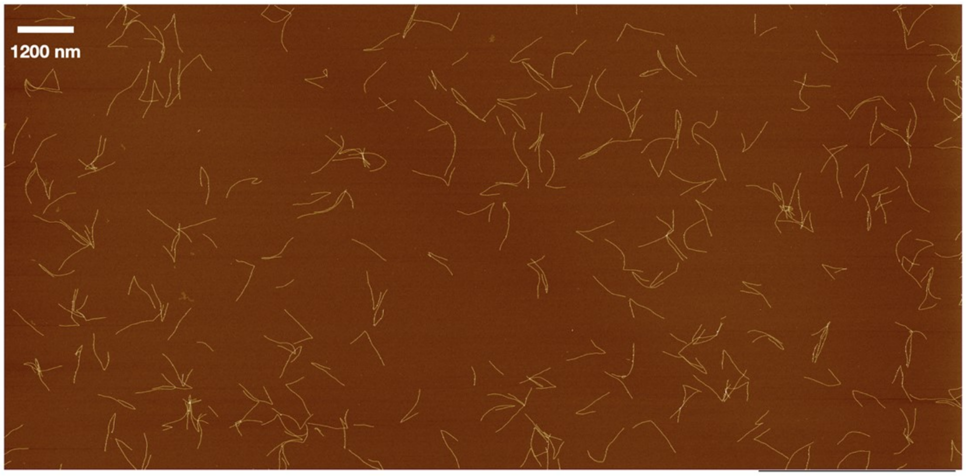

Figure S4. AFM images of one-folding geometry. Excluding non-desired monomer, dimer, and non-specific aggregations, the percentage of trimer with one-folding geometry is at least 70% (Statistics was obtained from over 500 DNA origami, the AFM image in the figure is only a representative one). It is safe to set the threshold to be 50% to read the output to be "0".

5. Additional AFM images of two-folding geometry in tri-state inverter logic gate

S5

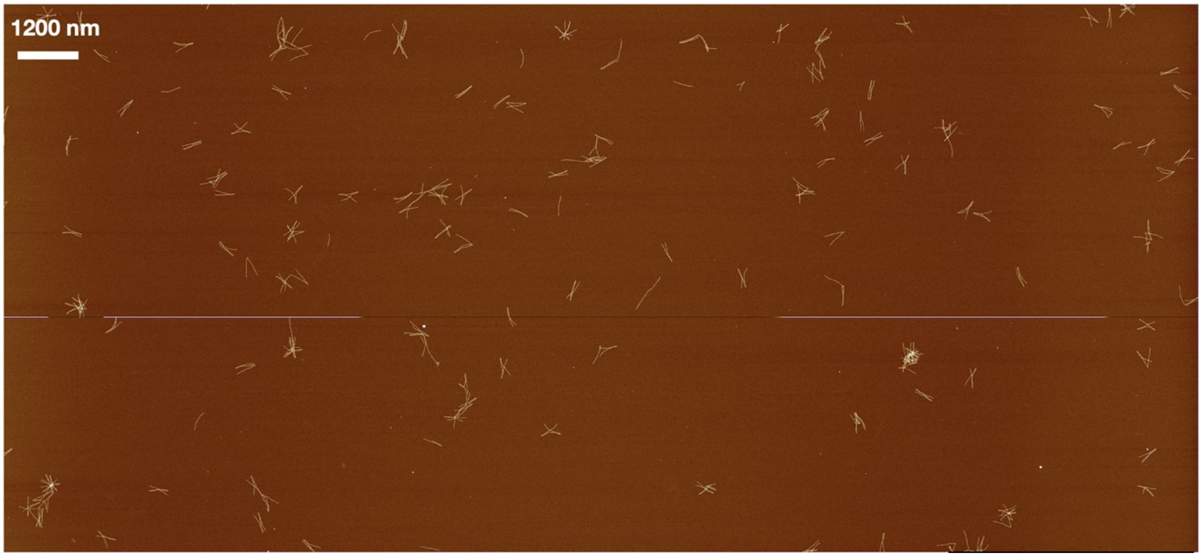

Figure S5. AFM images of two-folding geometry. Excluding non-desired monomer, dimer, and non-specific aggregations, the percentage of trimer with two-folding geometry is at least 70% (Statistics was obtained from over 500 DNA origami, the AFM image in the figure is only a representative one). It is safe to set the threshold to be 50% to read the output to be “1”.

6. Entropy Gain in Folding Left Hinge in Tri-state Buffer Design

In the presence of both enable and input strands in the free solutions, a partial duplex stem with green-green* would form, as the concentration of enable/input (50 nM) is 100 times more than that of the sticky ends on origami hinge (0.5 nM). Then the red* on this partial duplex stem may hybridize with the red on the left hinge, seemingly impeding the folding of left hinge. Let's call this is scenario 1(Fig. S6). However, the folding on the left hinge still forms because of lower Gibbs Free Energy in the folded state due to significantly higher local concentration of the hinge-sticky ends.

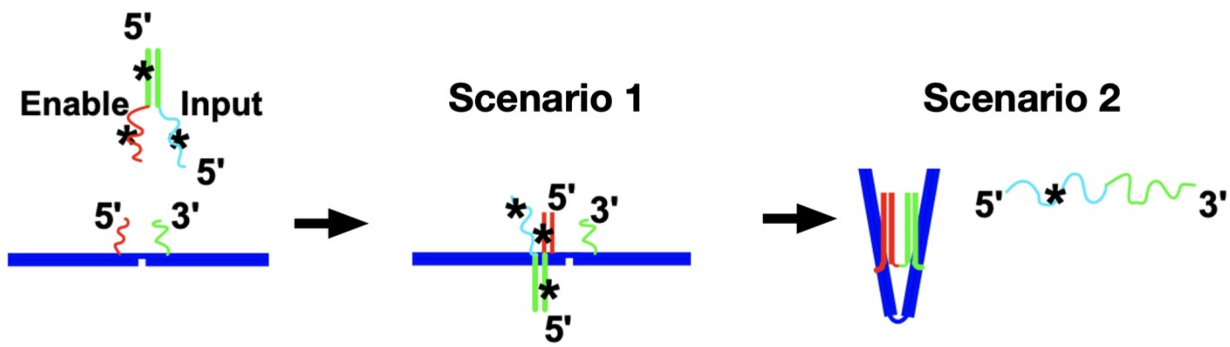

Fig. S6 Schematics of folding process by Enable/Input duplex.

In scenario 2 the folded state, a free enable strand hybridizes with the red and green sticky ends on the left hinge (Fig. S6). It was true that from the enthalpy-hybridization energy point of view, there was no reason for scenario 2 to displace scenario 1, if scenario 1 had taken placed first. However, the local concentration of sticky ends on the hinge is many orders of magnitude higher than that of the input/enable in free solutions, resulting in a great entropy gain to fold the hinge. The concentration of input strand is ~ 50 nM. Notably, one sticky end on the hinge is locally confined within ~ 5 nm^3 after folded, giving a local concentration of ~ 0.01 M. Hence, the concentration ratio of the local sticky ends to free input in solution is ~ $5*10^5$. The entropy linearly depends on the natural logarithm of relative concentrations. In our case, entropy change for transition from scenario 1 to scenario 2 is $\Delta S_{12} = k_B ln(5 * 10^5) = 13\ k_B$. Then $\Delta G_{12} = \Delta H - T\Delta S = - 13 k_B T$.

With Boltzmann distribution, Probability ~ $e^{-energy/kT}$, 13 k_BT lower in free energy give a factor of $5*10^5$ higher in probability for it to be in scenario 2 rather than in scenario 1.

The same reasoning also applies to the inverter logic gate in Figure 4 when both enable and input strands are present.

7. Factors Affecting Folding Angles

The folding angles in the two folding mechanisms(Fig.1c, d) by design might be a bit different, because the location of the sticky ends connected with the staple strands are different. It was also different that the left hinge was folded by one input strand, while the right hinge was folded by two input/enable strands. For 2-folding state, the angle of right hinge might tend to be more compact than the left hinge. There were many factors to vary the angles we've explored, such as changing the location design of the sticky ends on the hinge (longer or shorter distance away from the hinges vertex), different Mg^{2+} concentrations, the length of sticky ends, the concentration ratios of enable/input to origami, etc. The folding angles indeed seemed to be relevant to all these controlled factors. However, there were also some other not so easy to control factors involving in deposition of origami on the mica surfaces that as well slightly varied the folding angles more randomly, such as mica surface difference in different area, humidity or air flow speed when drying mica, AFM tips properties, etc. While these would be interesting, we have decided not to include the study of angles in this article. Because our major aim is to demonstrate the idea of tri-state logic using DNA origami. As long as the clear difference between folding and not-folding can be clearly told apart, the output signal is unambiguously generated.

8. Control Experiment for Folding Mechanisms

We designed control experiments with poly-T non-specific strands to substitute enable and input strands in the two folding mechanisms. When the substitute enable and input strands were added in the DNA origami dimer, no statistically meaningful number of hinges was found to be folded revealed by AFM imaging.

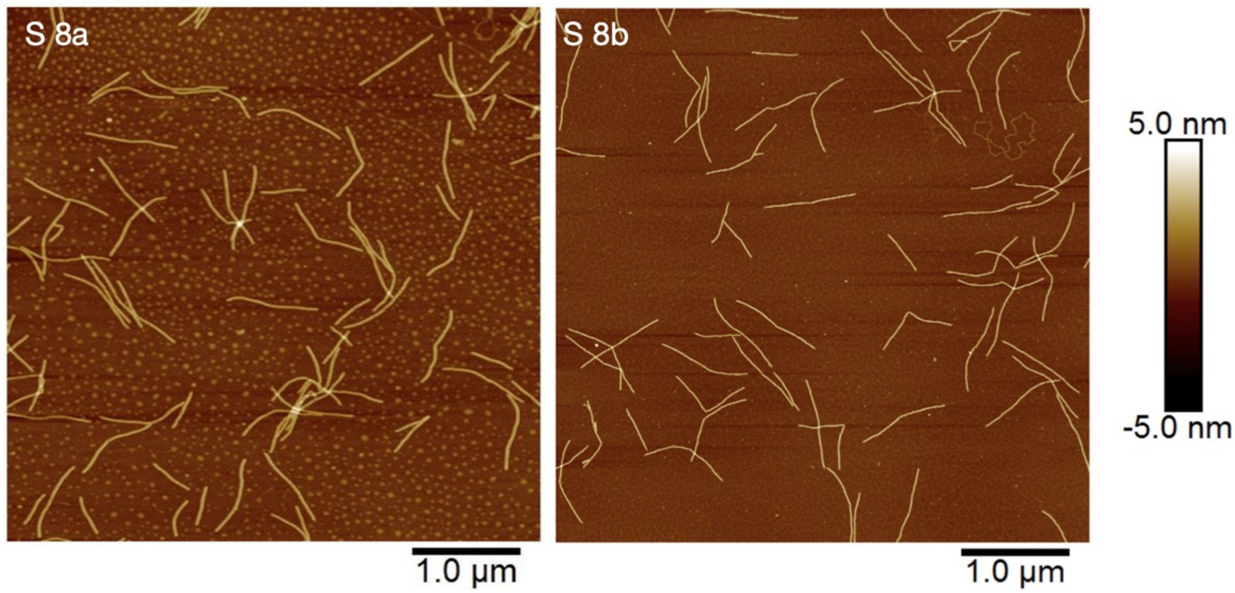

Figure S7. AFM images of control experiments. a) DNA origami dimer platform of folding mechanism 1 (as shown in Fig. 1c) was added with non-specific Poly-T strands as control to substitute the input to find no folding at the hinge. **b)** DNA origami dimer platform of folding mechanism 21 (as shown in Fig. 1d) was added with non-specific Poly-T strands as control to substitute the input to find no folding at the hinge.

9. DNA Sequences of 6HB DNA Origami and sticky ends

6HB DNA Origami uses scaffold DNA M13.

Staple strands:

6HBM13-001	TTATCCGCTCACAATTCCACACAACA
6HBM13-002	TACGAGCCGGAAGCTCGAATTCGTAA
6HBM13-003	CGGGTACCGAGCATAAAGTGTAAAGCCTGG
6HBM13-004	GGTGCCTAATGAGTGCCAAGCTTGCATGCC
6HBM13-005	TAAAACGACGGCCAGTGAGCTAA
6HBM13-006	CTCACATTAATTGCGTTGCGCTC
6HBM13-007	CCTGTGTGCTTTCCCAGTCACGACGTTGTGCAGGTCGACTTA
6HBM13-008	ACTGCCCGAAATTGTCATGGTCATAGCTATCTAGAGGATCCC
6HBM13-009	AGTTGGGTAACGCATGTGCTGCAAGGCGGTGCTGGCGAAAGG
6HBM13-	CGCCAGGGTTTTCCAGTCGGGAAACCTGGCTATTACGCCATT

010	
6HBM13-011	GGGCCATTCGCCATGTGCGGGCCTCTTCTCGTGCCGGAAGAT
6HBM13-012	ACCAGGCAAAGCGACTCCAGCCAGCTTTGGCCTCAAGCTGCA
6HBM13-013	GGGAAGGATCGGCCACGACGACAGTATCCCGGCACCGCTTAA
6HBM13-014	TTAATGAGCGATCGTCAGGCTGCGCAACGTCTGGTGCCGGAA
6HBM13-015	CCGTGCATCTGCACTAGATGGGCGCATCTGATAGGTCACGTT
6HBM13-016	GACAGTTTGAGGGGAACGCGCGGGGAGAGACCGTAATGGGTT
6HBM13-017	GGCATTAAATGTGAACAAACGGCGGATTGGCGGTTCCAATAG
6HBM13-018	AGCTTTCATCAATGGCCATCAAAAATAATTTTTAATGCGTAT
6HBM13-019	GATTCTCCAGGGTGTTAAATCAGCTCATTTCGCGTCTGGCTT
6HBM13-020	TGGGCGCCGTGGGAGCGAGTAACAACCCTTCTTCCTGTAGCC
6HBM13-021	GTTAAAATTCGCGTTGTAAACGTTAATAGTAAGCAAATATTT

6HBM13-022	AGATTAAATTTTTGGTTTTTCTTTTCACGGAAGATTGTATCG
6HBM13-023	AAAAAACTAGCATGAAGCCCCAAAAACACAGTGAGGGCTATC
6HBM13-024	AACGGTAATCGTATCATTGCCTGAGAGTCTACAAAACGGGCA
6HBM13-025	GTTGATAATTGCCCTATTTTTGAGAGATCTGGAGCAAACAGA
6HBM13-026	ACAGCTGATCAGAATCAATCATATGTACCTAGAGAATCGATG
6HBM13-027	TAAATTAATGCCAGTTCAACCGTTCTAGCCCACCATCAATAT
6HBM13-028	GGGGAGAGGGTAGCTTCACCGCCTGGCCAGACAGTCAAATCG
6HBM13-029	GATTAAATGCAATGGTGAGAAAGGCCGGCTGAGAGTTTTGCG
6HBM13-030	CCCTCATATATTTAAAGCCTTTATTTCAGTAATACAGTTGCA
6HBM13-031	AAAGATTGTCCACGAACATTATGACCCTACGCAAGGATAACA
6HBM13-032	GCAAGCGCAAAAGGCCTGAGTAATGTGTAGAAATTTTTAGAA
6HBM13-	TAAAGCTAAATCTCCAATAAAGCCTCAGAGAATTAGCAAAAT

033

6HBM13-

034 TTGGTTGTACCAAACTGGTTTGCCCCAGGGCAAGGCAAAGGT

6HBM13-

035 TAGAAAAGGTGGCACAATAAATCATACACAGGCGAAGATACA

6HBM13-

036 GGGGCGCGAGCTAGGCAAATGGTCAATAGACCATTAAATCCT

6HBM13-

037 GTAGCATGGTGGTTAGTAGATTTAGTTTACCTGTTTAGCTAC

6HBM13-

038 GTTTGATTAACATCTCAATTCTACTAATTAATATTTTCATTT

6HBM13-

039 AGTTGATTCCCACAAGTTTCATTCCATAAGAAGTACGGTGTC

6HBM13-

040 AAATTCTGCGAACGCCGAAATCGGCAAAAATATGCAACTATA

6HBM13-

041 TGTTTGCGGATGGCCTCAACATGTTTTAATCCCTTAAACTCC

6HBM13-

042 TAAGAGGTCATTGAGGTCAGGATTAGAGCGGAAGCATAAATC

6HBM13-

043 ATATAATTAGCCCGAAAGCGAACCAGACAGTACCTTTAATAA

6HBM13-

044 AAAAGAAGCTGTAGTTAGAGCTTAATTGTCTGCTCCTTTTGA

6HBM13-045	ATATCGCGTTTTGTAAGCCCGAAAGACTCTCAAAAAGATTAA
6HBM13-046	TCAATTCGAGCTTCAGATAGGGTTGAGTAGCGGATTGCATGA
6HBM13-047	GAGAGAATGACCATATAGTCAGAAGCAAGTTGTTCTGCGGAA
6HBM13-048	AGTTCAGAAAACGGCATAAATATTCATTCCAATACCAGTTTG
6HBM13-049	TTACCCTAGTCCACAGACTGGATAGCGTGAATCCCCCTCACC
6HBM13-050	GAACAAGGACTATTAAATCAAAAATCAGTGAATGCTTTAAAC
6HBM13-051	AGAGGGGGTAATCATGCAAAAGAAGTTTGTAATAGCGAGAGG
6HBM13-052	ATAGTAAAATGTTTTATTAAAGAACGTGGATAAAAACCAACT
6HBM13-053	CTAAGGAATTACGAGTTTACCAGACGACGACTCCAAAGATTC
6HBM13-054	ACATAACGCCAATTGTTGAGATTTAGGAAGGTAGAACGTCAA
6HBM13-055	CTATCATAAAACCGAACAACATTATTACATACCACATTCATC
6HBM13-	AGGGCGAAACCCTCGGCATAGTAAGAGCAAACTAATGCAGAT

056	
6HBM13-057	TACGTTAATAAACAACGTTGGGAAGAAAAACATTATACCAGT
6HBM13-058	CTACGAACTAACGGTCTATCACTAAATCTAAGAACTGGCTCA
6HBM13-059	CATTGGGCTTGAGAACCTTATGCGATTTGGAACCCAAAGCTG
6HBM13-060	ACGAGTAGTAAAGGTTCAGTGAATAAGGACGTAACTAAAGGG
6HBM13-061	AATCATTGATTTAGCATTACCCAAATCACTTGCCCTGACGAG
6HBM13-062	AGCCCCCGTGAATTTGGTTTAATTTCAAAGAGAAACACCAGA
6HBM13-063	TAATCTTGACAAATGCTGACCTTCATCACTCCAGGCGCATAG
6HBM13-064	TGGAACCGGATATTAGCTTGACGGGGAAACGGTGTACAGATT
6HBM13-065	GCGCGCAGACGGTCAAGAGGACAGATGAAGCCGGCCATCGCC
6HBM13-066	AGCCGGAACGAGTGAAATTGTGTCGAAATTTGTATGAACGTG
6HBM13-067	CTGACCAAGGAAGGAAGTACAACGGAGATCCGCGACCTGCCC

6HBM13-068	GCGAGAAACTTTGAAATCATAAGGGAACCCTCCATGTTACTT
6HBM13-069	AGCGATTATACCACCACTCATCTTTGACCGAAAGAATACACT
6HBM13-070	GAAAGCGCGAAACAGAAGAAAGCGAAAGACGAAAGAGGCAAA
6HBM13-071	AAGGAAGTTTCCATGGCACCAACCTAAAGAGCGGGAGCATCG
6HBM13-072	ACTTTTTCATGAAAGAGGGTAGCAACGGGAAAGACCGCTAGG
6HBM13-073	AATGCCACAAGTGTTCACCCTCAGCAGCCTACAGAGGCTTAG
6HBM13-074	GCGCTGGCTACGAATAAACGGGTAAAATGGTGAGGACTAAAG
6HBM13-075	TTAAAGGCCGCTAAGCTGAGGCTTGCAGACACCGATATATTC
6HBM13-076	AATTTGCGGGATCGAGCGGTCACGCTGCCGCCCACGCATAGT
6HBM13-077	GGAGGTGAATTTCTATGACAACAACCATGCGTAACTCTCCAA
6HBM13-078	AGCTTGCTTTCGTCAAGGCTCCAAAAGGTTGAAAACACCACA
6HBM13-	TAGTTGCCGCTTAAATAATTTTTTCACGAGCCTTTAATTGAG

079	
6HBM13-080	CCCGCCGGCCGACATAAACAGCTTGATAAATATCGGTTTATC
6HBM13-081	GAACAACTAAAGTACGGAGTGAGAATAGCCCTTTCAACAGTT
6HBM13-082	AGGAATTGCGAATATGCGCCGCTACAGGTTTGCTAAACAAGA
6HBM13-083	TCACGATCTAAAGTTTTCTGTATGGGATGCGCGTACGTCACC
6HBM13-084	ATAGTTAGCGTAAGCAAACTACAACGCCTGAGTTTCTATGGT
6HBM13-085	GTTAGTAACGAGCAATGTACCGTAACACTGTAGCATTCCAAG
6HBM13-086	TGCTTTGAATGAATTTTGTCGTCTTTCCTCCAGACAGCCCTC
6HBM13-087	GGATAGCAAGCCTTCACCACCCTCATTTAGCCGCCACCCTCA
6HBM13-088	GTCAATAGGAACCCCGTATAACGTGCTTCCACCCTCAGAAAC
6HBM13-089	GAGCCCGGAATAGGCACCCTCAGAACCGTCCTCGTTAGCGGG
6HBM13-090	GATATAAGTATAGCTGCTCAGTACCAGGTTAGGATTAGAATC

6HBM13-091	AGGTTTAGAGCTAACCTCAAGAGAAGGACGGATAAGTGCCCA
6HBM13-092	AGAGCGGGTACCGCTGTATCACCGTACTAAGTCGAGAGGGTT
6HBM13-093	TGAAAGTATTAACTACCTATTATTCTGACACCCTGCCTATTT
6HBM13-094	GTGAGGCTGAGACTACAGGAGGCCGATTACAGTTAATGCCGG
6HBM13-095	CGAGTGTACTGGTACAGTGCCCGTATAAAAAGGGAAAGCGCA
6HBM13-096	TGATGATACAGGGACTGAATTTACCGTTGAATGGATTTTAGA
6HBM13-097	AGTGCCTGGTACGCCCTCATTAAAGCCACCAGTAAGCGTCGC
6HBM13-098	CAGGAACTGAGTAAATAAGTTTTAACGGTGATACATGGCTTT
6HBM13-099	CTTGATATTCACCAGCAGGTCAGACGATGGTTGACAGGAGGT
6HBM13-100	ATAAACAAATAAATCAGAATCCTGAGAACCGCCGCCAGCATC
6HBM13-101	TGAGAACCGCCACCAACCACCACCAGAGGTGTTTTAATCAAA
6HBM13-	GCCGCCACCCTCAGCCGGAACCAGAGCCTTTTCATTATAATC

102

6HBM13-

103 AGAGCCGCCACCGATAGCGTTTGCCATCACCACCGGAACCGG

6HBM13-

104 AGTGAGGCCACCAGCTCAGAGCCACCACTCGCCTCCCTCAGA

6HBM13-

105 CATTTTCGGTCACCGTAGCGCGTTTTCACCCCTTTAGCGTCA

6HBM13-

106 AGTAGCCCCCTTATGTAAAAGAGTCTGTGAATCAAGTTTGTC

6HBM13-

107 GAAAGGCCGGAAACAATCAGTAGCGACACCATCACCGACTTG

6HBM13-

108 ATTACCATTAGCCTATTTGGGAATTAGACCGTCACGCAAATT

6HBM13-

109 GATAGCAGTAGCAAAAGGTGAATTATCAGCCAGCAAAATCTA

6HBM13-

110 AACCGTTGCACCGTGTCACCAATGAAACGGACCAGTAGCACC

6HBM13-

111 AATATTGACGGAACATTGAGGGAGGGAACAGGGCGACATTCA

6HBM13-

112 AAAATTATTCATTATACTTCTTTGATTACCAAAGACAAAATC

6HBM13-

113 ACACCACGGAATAAATGGTTTACCAGCGGTAATAATGTTAGC

6HBM13-

114 AAACGCAAAGACCGGTAGAAAATACATACGCAGTACATCACT

6HBM13-

115 AATAGAAGTAGAAGAAGACTCCTTATTACATAAAGGTGGCGA

6HBM13-

116 TGCCTGAAATTCATGTTTATTTTGTCACCGAACATATAAAAG

6HBM13-

117 ATACCCAAAAGAGAAAACGCAATAATAAAACAGAAGGAAACC

6HBM13-

118 CAACTGGCATGATTAACTCAAACTATCGGAACAAAGTTACTC

6HBM13-

119 GAATGAAATAGCAAGTAAGCAGATAGCCGCCTTGCCTAATAT

6HBM13-

120 GAGCAAGAAACAGGGAGATAACCCACAATTGAGCGTGGTAAT

6HBM13-

121 CCTTTTTACAATATAAGTCAGAGGGTAAGAATTGAGTTAAGG

6HBM13-

122 ATCCAGAAAGAAAATAGCTATCTTACCGCGGCCCAATAATAA

6HBM13-

123 AGAATTAACTGAGCGGAAGCGCATTAGAAAAATAACATAAAA

6HBM13-

124 GAACACCCTGAACATACCGCCAGCCATTCTTTACAGAGAGGC

6HBM13- ACTATCCCAATCCAATGAAAATAGCAGCGCAACAGCGCTAAC

125	
6HBM13-126	AGCCATATTATTAGGTCTTTCCAGAGCCTTACCAAGAAAAAC
6HBM13-127	GTTTAACGAAATACTTTTATCCTGAATCTAATTTGCCAGTAG
6HBM13-128	GCTCATGGTCAAAAAATAAGAAACGATTTTTACAAAATAAAC
6HBM13-129	TTGCTATTTTGCCAGCCTTAAATCAAGATTTGCGGGAGGTTT
6HBM13-130	AAACCCAGCTACAACTACATTTTGACGCAACCTCCCGACTTT
6HBM13-131	TGAAGCAAATCAGAGAGGCGTTTTAGCGTCAATCGCATCGAG
6HBM13-132	GCGCCCAATAGCAAAGCAAGCCGTTTTTCCGCACTTCTGAAA
6HBM13-133	TATTCTATTTACATTATTAAACCAAGTAATTTTCATCGTATC
6HBM13-134	TGGATTAAGAACGCTATAGAAGGCTTATTGGGAATCATTACC
6HBM13-135	TTTCCTTATCATAAAATCAATAATCGGCCCCGAGCATGTAGA
6HBM13-136	AATCCAAGAACGGGTGGCAGATTCACCACATCCTAATTTAGG

6HBM13-137	AATGCAGAACGCGCGAAAAATAATATCCGTCACACTACCGAC
6HBM13-138	ATGTTCAGCTAACCGGTAAAGTAATTCTTATAAAGGACCAGT
6HBM13-139	TAAGTCCGGGACATCAGTAATAAGAGAAGTCCAGACGACGTA
6HBM13-140	AATAAAATGAACAACTGTTTATCAACAATGACAATAAACAAC
6HBM13-141	ATTTAGGCAGAGAATAACAACGCCAACATATGAGAATCGCCA
6HBM13-142	TAGCATTTTCGAGCTCTGGCCAACAGAGGTAGGGCTTAATGA
6HBM13-143	TACTGTTTAGTATCGCCAACGCTCAACAATAGAACCGTGTGA
6HBM13-144	ACTAGAAAAAGCTTTAAGGCGTTAAATATACCGACCCTTCTG
6HBM13-145	CTTACCAAGCGTAATTAATGGTTTGAAAAGAATAAACACCAG
6HBM13-146	ACCTGAAGTATAAAATATGCGTTATACATTGGAATCATAATT
6HBM13-147	TTAATTTCATCTGATTTTCAAATATATTAAAGAACGCGAGAA
6HBM13-	CTTCTGACCTAAATGAATACGTGGCACAATCGCAAGACAATT

148	
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6HBM13-150	AGAGACTACCTTCTGAAGAGTCAATAGTCTTAGATTTTTTGA
6HBM13-151	ACTATATTTAGTCTAAACATAGCGATAGGAATTTATCAAAAA
6HBM13-152	ATGGCTAGTAAATGCTTAGGTTGGGTTATTATCATAGGTCTG
6HBM13-153	TTAATTTTCCCTAAGTAAATCGTCGCTATAGAATAACCTTGC
6HBM13-154	TCTAGAATCCTTGATTAATGCGCGAACTATATATGTGAGTTA
6HBM13-155	TTATTACATTTAACCAGTACATAAATCAGATAGCCATTCATT
6HBM13-156	AAAACAAAATTACTTTACCTGAGCAAAAGCGAATTCTAAAAC
6HBM13-157	TTTTTTATTAAAAAAAAATCGCGCAGAGGAAGATGATGAACC
6HBM13-158	ATCGCCAATGGAAAAATTTCATTTGAATCGACAAACATCAAG
6HBM13-159	TGATTGCTTTGAATAACAATAACGGATTTACTTTTACATCGG

6HBM13-160	TTATACCAAGTTACTACCGAACGAACCACAGTAACAGTACCC
6HBM13-161	GACGTAAAACAGAAGTCAGATGAATATACCAGCAGGTTTGGA
6HBM13-162	AAATTATTTGCAGAACTTCTGAATAATGCCTGATTAAGATAA
6HBM13-163	TTTTCAGGTGAGGCTTCATCAATATAATGAAGGGTTAGAATA
6HBM13-164	AACAGAGGTTTAACATAAAGAAATTGCGCACCTACCATATCA
6HBM13-165	TTCCTGATTATCTAAGCGGAATTATCATTAAGAAACCACCAG
6HBM13-166	GAAGATGATGGCAAGGTCAGTATTAACATTTGCGGAACAAGA
6HBM13-167	AACGTATTAAATCCAGTAACATTATCATCCGCCTGGTCAATA
6HBM13-168	AATTCGACAACTGGATACATTTGAGGATTAGAGCCCAACAGTGCCACGCAAGTTTG
6HBM13-169	CAATCAATATCTGGTCAGTTGTAATTTTAATGAGAGCAACAACTAATAGAT
6HBM13-170	TTTGCCCGAACGTTATGCAAATCAACAGTTAAACCCT
6HBM13-	ATCGAAAGGAATTGAGGAAGGGACTTTACAAAC

171	
6HBM13-172	TTAGAAGTATTATTATCTAAAATATCCTCAAAT
6HBM13-173	TCACCTTGCTGAACTTTAGGAGCACTCAGCAGCAAATGAAAAATCTAAAGCA

Sequences Design of Sticky Ends, input and enable strands:

6H-D3-169-4T

TTTT CAATCAATATCTGGTCAGTTGTAATTTTAAAAGTTTG

6H-D3-168

AATTCGACAACTGGATACATTTGAGGAT

Ci-CN0-168+

CTCGTCCTATGTCCAGATTAA T

TAGATTAGAGCCCAACAGTGCCACGCTGAGAGCAACAACTAA

6H-CN0-3T-173

GGTAAGGTGGTCGATACTCCTC TTT TCACCTTGCTGAACTTTAGGAGCACT

6H-CN0-3T-174

CAGCAGCAAATGAAAAATCTAAAGCA TTT GGTATTGTTCCAGACGGT

6H-CN1-002

GAGGAGTATCGACCACCTTACC TACGAGCCGGAAGCTCGAATTCGTAA

6H-CN1-003

CATAAAGTGTAAAGCCTGG ACCGTCTGGAACAATACC

Ci-CN2-008 (also CN1)

ACTGCCCGAAATTGTCATGGTCATAGCTATCTAGAGGATCCC CGGGTACCGAG T

GAGCTGGAGAGTCTAATCTAA

Cir-Enable (strand 2*1*)

TTAGATTAGACTCTCCAGCTC TT TTAATCTGGACATAGGACGAG

6H-CN1-3T-173

TGCTGCTCCTAAATTCTCGTAT TTT TCACCTTGCTGAACTTTAGGAGCACT

6H-CN1-3T-174

CAGCAGCAAATGAAAAATCTAAAGCA TTT AATTAAGCAATTTGGTAT

6H-CN2-002

ATACGAGAATTTAGGAGCAGCA TACGAGCCGGAAGCTCGAATTCGTAA

6H-CN2-003

CATAAAGTGTAAAGCCTGG ATACCAAATTGCTTAATT

Buf-CN2-008 (strand 3)

ACTGCCCGAAATTGTCATGGTCATAGCTATCTAGAGGATCCC CGGGTACCGAG T

GAGCTAAAGTCGTGTGTTAAG

Cir-inp-Buf (strand 3*2)

CTTAACACACGACTTTAGCTC TT GAGCTGGAGAGTCTAATCTAA

Inv-CN1-168+ (strand 41)

CCTAACTATCTTTAGCCAATG CTCGTCCTATGTCCAGATTAA T

TAGATTAGAGCCCAACAGTGCCACGCTGAGAGCAACAACTAA

Ci-inp-Inv (strand 1*4*)

TTAATCTGGACATAGGACGAG AA CATTGGCTAAAGATAGTTAGG

Cir-inp-Inv (strand 1*4*)

TTAATCTGGACATAGGACGAG CATTGGCTAAAGATAGTTAGG