

Template sequence

GACGAAAGGCCTCGTGATACGCCTATTTTATAGGTTAATGTCATGATAATAATGGTTTCTTAGACGTCAGGTGGCAGTTTTCGGGGAAATGTGCGCGGAACCCCTATTTGTTT
ATTTTCTAAATACATTCAAATATGTATCCGCTCATGAGACAATAACCCTGATAAATGCTTCAATAATATTGAAAAAGGAAGATGAGTATTCAACATTTCCGTCGCGCTT
ATTCCTTTTTCGCGCATTTTGCCTTCCCTGTTTGTCTCACCAGAAACGCTGGTGAAAGTAAAGATGCTGAAGATCAGTTGGGTGCACGAGTGGTTACATCGAACTGGATC
TCAACAGCGGTAAGATCCTTGAGAGTTTTCGCCCCGAGAAGCTTTTCCAATGATGAGCACTTTTAAAGTTCTGCTATGTGGCGCGGTATTATCCCGTATTGACGCGCGGCAAGA
GCAACTCGGTCGCCGATACACTATTCTCAGAATGACTTGGTTGAGTACTCACCAGTCACAGAAAAGCATCTTACGGATGGCATGACAGTAAGAGAATTATGCACTGCTGCCATA
ACCATGAGTGATAACACTGCGGCCAACTTACTTCTGACAACGATCGGAGGACCGAAGGAGCTAACCGCTTTTTCGACAAACATGGGGGATCATGTAACTCGCTTGTATCGTTGGG
AACCGGAGCTGAATGAAGCATACCAAACGACGAGCGTGACACCCAGATGCCTGTAGCAATGGCAACAAGTTGCGCAAACTATTAACCTGGCGAACTACTTACTCTAGCTTCCCG
GCAACAATTAATAGACTGGATGGAGGCGGATAAAGTTGCAAGGACCACTTCTGCGCTCGGCCCTTCCGGCTGGCTGGTTTATTGTGATAAATCTGGAGCCGGTGAGCGTGGGTCT
CGCGGTATCATTGCAGCACTGGGGCCAGATGGTAAGCCCTCCCGTATCGTAGTTATCTACACGACGGGGAGTCAGGCAACTATGGATGAACGAAATAGACAGATCGCTGAGATAG
GTGCTCACTGATTAAAGCATTTGGTAACGTGTCAGACCAAGTTTACTCATATATACTTTAGATTGATTTAAACTTCATTTTAAATTTAAAGGATCTAGGTGAAGATCCTTTTGA
TAATCTCATGACCAAAATCCCTTAACGTGAGTTTTCGTTCCACTGAGCGTCAGACCCCGTAGAAAAGATCAAAGGATCTTCTTGAGATCCTTTTTTCTGCGCGTAATCTGCTGC
TTGCAACAAAAAACACCGCTACCAGCGGTGGTTTGTTCGCGGATCAAGAGCTACCAACTCTTTTCCGAAGGTAACCTGGCTTCAGCAGAGCGCAGATACCAAACTACTGTTC
TTCTAGTGTAGCCGTAGTTAGGCCACCACTTCAAGAACTCTGTAGCACCGCTACATACCTCGCTCTGCTAATCCTGTTACCAAGTGGCTGCTGCCAGTGGCGATAAGTCGTGCT
TACCGGGTTGACTCAAGACGATAGTTACCGGATAAGGCGCAGCGGTGCGGTGAACGGGGGTTCTGTGCACACAGCCAGCTTGGAGCGAACGACCTACACCGAACTGAGATAC
CTACAGCGTGAGCTATGAGAAAGCGCCACGCTTCCCGAAGGGAGAAAGGCGGACAGGTATCCGGTAAGCGGCAGGGTCGGAACAGGAGAGCGCACGAGGGAGCTTCCAGGGGGAA
ACGCTCGGTATCTTTATAGTCTGTGCGGTTTCGCCACCTCTGACTTGAGCGTCGATTTTGTGTATGCTCGTCAGGGGGCGGAGCCATGGAAGAAACGCCAGCAACCGCGCTT
TTTACGCTTCCGCGCTTTTGTGCGCTTTTGTCTACATGTTCTTCTCGCTTATCCCTGATTTCTGTGGATAACCGTATTACCGCTTTGAGTGAGCTGATACCGCTCGCGC
AGCCGAACGACCGAGCGCAGCGAGTCACTGAGCGAGGAAGCGGAAGAGCGCCCAATACGCAAAACCGCTCTCCCGCGCGTTGGCCGATTCAATTAATGAGCTGGCAGCAGAGGT
TTCCCGACTGGAAGCGGGCAGTGAGCGCAACGCAATTAATGTGAGTTAGCTCACTCATTAGGCACCCAGGCTTACACTTTATGCTTCCGGCTCGTATGTTGTGTGGAATTGT
GAGCGGATAACAATTTACACAGGAACAGCTATGACCATGATTACGCCAAGCTCCTCAGCAATTCACTGGCCGTCGTTTTACACGTCGTGACTGGGAAACCCCTGGCGTTACC
CAACTTAATCGCCTTGAGCACATCCCCCTTTCGCCAGCTGGCGTAATAGCGAAGAGGCCCGCACCAGTGCCTTCCCAACAGTTGCGCAGCTGAATGGCGAATGGCGCCTGA
TGCGGTATTTCTCCTTACGCATCTGTGCGGTATTTACACCGCATATGGTGCACTCTCAGTACAATCTGCTCTGATGCCGCATAGTTAAGCCAGCCCGACACCCGCAACACC
CGCTGACGCGCCTGACGGGCTTGTCTGCTCCCGCATCCGCTTACAGACAAGCTGTGACCGTCTCCGGGAGCTGCATGTGTCAGAGGTTTTACCGCTCATACCGAAACGCGCG
A

Staple sequences (coloured to match Fig. 1 of the manuscript).

Staple names indicate the position of the 5' and 3' end of each staple within the tile (the helices are labeled 1 to 12 top to bottom and the bases are labeled 0 to 223 left to right). This is labeling is consistent with the names generated by caDNAno.²⁷ For example, the staple in the top left of Fig. 1a is labeled 1[0]-2[0] while staple in the top right is labeled 2[223]-1[223]. Staples on the left and right hand edges in Fig. 1a have T₄ extensions at both ends (marked in bold below). This modification is designed to suppress aggregation of tiles.¹

Standard Staple Set

Seam Staples

```
2[127]-2[96]      GGCGCGTCAGCGGGTGGTGCACCCAACTGAT
3[96]-3[127]      TCGATGTAACCCACTCTTGGCGGGTGTCCGG
4[127]-4[96]      GTGCTGCAAGCGGATTGCCATCCGTAAAGATGC
5[96]-5[127]      ATTCTCTTACTGTCTATAAGTTGGGTAACGCCA
6[127]-6[96]      TTGCGCTCACTGCCCGACGTTGTTGCCATTG
7[96]-7[127]      GTTAATAGTTTGGCGCACTTCCAGTCGGGAA
8[127]-8[96]      ACATGTGAGCAAAAGCGGTGTAGATAACTACG
9[96]-9[127]      TTGCCTGACTCCCGGTCCAGCAAAAGGCCAGG
10[127]-10[96]    GCCTTTCTCCCTTCGGGTGACGCTCAGTGGGA
11[96]-11[127]    ATCTTTTCTACGGGGTGAAGCGTGGCGCTTT
```

Body Staples

```
1[0]-2[0]          TTTTTGAATACTCATACTCTGGCGACACGGAAATTTTTT
1[32]-2[32]        ATTGAAGCATTTATCAGAAGGCAAAATGCCG
1[64]-2[64]        AGCGGATACATATTTGTTTACCAGCGTTTCT
2[143]-3[143]      CAGACAAGCCCGTCAGGCTGGCTTAACATATGC
2[159]-1[159]      AAGCGGATGCCGGAGACGCTTAAGAAACCA
2[175]-3[175]      TCACAGCTTGCTGTGTACTGTAGAGTGCACC
2[191]-1[191]      CAGCTCCCGGAGACGGAACCTATAAAATAGG
2[207]-3[207]      AAACCTCTGACACATGTACCGCACAGATGCGT
2[223]-1[223]      TTTTTCGGTGATGACGGTGATTGCTCTCGCGCTTTTTT
3[0]-4[0]          TTTTTCCGCGCCACATAGCAGCAATACGGGATAATTTTTT
3[16]-2[16]        AACTTTAAAGTGCTCCAAAAAAGGGAATAG
3[32]-4[32]        ATCATTTGGAACGTTTATGCGGCGACCGAGT
3[48]-2[48]        CTTCCGGGCGAAAAACGGGTGAGCAAAACAG
3[64]-4[64]        TCTCAAGGATCTTACCAGTACTCAACCAAGT
3[80]-2[80]        GCTGTGAGATCCAGCTCTCAGCATCTTTAC
4[143]-5[143]      TGGCGAAAGGGGATGGGTTTCCCACTCAC
4[159]-3[159]      TCGCTATTACGCCAGCGCATCAGAGCAGATT
4[175]-5[175]      ATCGGTGCGGGCCTCTCGGCCAGTGAATTGCT
4[191]-3[191]      ACTGTTGGGAAGGGCGATATGCGGTGTGAAA
4[207]-5[207]      CATTCAGGCTGCGCATCATGGTCATAGCTGT
4[223]-3[223]      TTTTTATCAGGCGCCATTTCGCAAGGAGAAAAATACCGTTTTT
5[0]-6[0]          TTTTTTGCAAAAAAGCGGTTAATGATCCCCCATGTTTTTTT
5[16]-4[16]        GCTCCTTCGGTCTCTGCTCTTGCCCGCGT
5[32]-6[32]        CGATCGTTGTGAGAGGCTCCGGTTCCCAAC
5[48]-4[48]        TAAGTTGGCCGCAAGTGCATTCTGAGAATAGTG
5[64]-6[64]        TTATCACTCATGGTTAGTACAGCTCGTCGTTT
5[80]-4[80]        TGGCAGCACTGCATATTTCTGTGACTGGTG
6[143]-7[143]      ACTCACATTAATTGCGACCTGTCTGCCAGCT
6[159]-5[159]      CCTAATGAGTGAGCTAGACGTTGTAACACGA
6[175]-7[175]      GTAAAGCCTGGGGTGCAACGCGCGGGAGAG
6[191]-5[191]      GCCGGAAGCATAAAGTGAGGAGCTTGGCGTAA
6[207]-7[207]      TCCACACACATACGAGGCGCTCTCCGCTTC
6[223]-5[223]      TTTTTGTTATCCGCTCACAAATTCCTGTGTAAATTTTTT
7[0]-8[0]          TTTTTCCGGAAGGGCCGAGCGCAATAAACCCAGTTTTT
7[16]-6[16]        CAGAAGTGGTCTCTGCAGATCAAGGCGAGTTAC
7[32]-8[32]        ACTTTATCCGCTTCCAAGACCCAGCTCACC
7[48]-6[48]        TCCAGTCTATTAATTGGTATGGCTTCATTCA
7[64]-8[64]        GTTGCCGGGAAGCTAGCATCTGGCCCCAGTG
7[80]-6[80]        AGTAAGTAGTTGCGCACTACAGGCATCGTGGT
8[143]-9[143]      ATAACGCAAGGAAAGAAACCGTAAAGGCGC
8[159]-7[159]      TCCACAGAATCAGGGGGCATTAAATGAATCGGC
8[175]-9[175]      GGCGGTAATACGGTTATCCATAGGCTCCGCCC
8[191]-8[191]      TATCAGCTCACTCAAAGCGGTTTGGCTATTG
8[207]-9[207]      GGCTGCGGCGAGCGGAAAAATCGACGCTCAA
8[223]-7[223]      TTTTTCTGCGCTCGGTCTGCTTCTCGCTCACTGACTCGTTTTT
9[0]-10[0]         TTTTTTAAAGTATATATGAGTAAGTTTAAATCAATTTTTT
9[16]-8[16]        AAACCTGGTCTGACAGCTCCAGATTATACAG
9[32]-10[32]       GTTACCAATGCTTAATCTTCACTAGATCC
9[48]-8[48]        CAGTGAGGCACCTATCCTGCAATGATACCGCG
9[64]-10[64]       TCAGCGATCTGCTATAGGGATTTTGGTTCATG
9[80]-8[80]        TTCGTTCATCCATAGATACGGGAGGGCTTAC
10[143]-11[143]    TACCGGATACCTGTCCCTCATAGCTCACGCTG
10[159]-9[159]     TTCCGACCTCGCCGCTCGTTGCTGGCGTTT
10[175]-11[175]    TCGTGGCTCTCCTGGTGTAGGTCGTTGCT
10[191]-9[191]     CCCCCTGGAAGCTCCCCCTGACGAGCATCAC
10[207]-11[207]    AAGATACCAGGCTTTTGCACGAACCCCGT
10[223]-9[223]     TTTTTACCGCAGGACTATAGTCAGAGTGGCGAATTTTTT
11[0]-12[0]        TTTTTGATCCGGCAACAAACGAGTTGGTAGCTCTTTTTT
11[16]-10[16]     CACCGCTGGTAGCGGTTTTTAAATTAAAAATG
11[32]-12[32]     GGTTTTTTTGTTTGCACGCTCTGCTGAAGCCA
11[48]-10[48]     AGCAGCAGATTACGCAAGATTATCAAAAGGA
11[64]-12[64]     GCAGAAAAAAGGATCGCTACACTAGAAGAA
11[80]-10[80]     TCAAGAAGATCCTTTGACGAAAACCTCAGTTA
12[159]-11[159]    GCAGCCACTGGTAACATAGGTATCTCAGTTCCG
12[191]-11[191]    ACCCGGTAAGACACGACCAAGCTGGGCTGTG
12[223]-11[223]    TTTTGCCTTATCCGGTAACCTCAGCCCGACCGCTGCTTTTT
```

Edge Staples

1[16]-1[31]	TCCTTTTCAATATT
1[48]-1[63]	GGGTTATTGTCTCATG
1[80]-1[95]	AATGTATTAGAAAA
1[96]-1[127]	ATAAACAAATAGGGTTCCGCGCACATTCC
1[128]-1[143]	CGAAAAGTGCCACCTG
1[160]-1[175]	TTATTATCATGACATT
1[192]-1[207]	CGTATCACGAGGCCCT
12[31]-12[16]	GTTACCTTCGGAAAAA
12[63]-12[48]	CAGTATTTGGTATCTG
12[95]-12[80]	TGGTGGCCTAACTACG
12[127]-12[96]	GGTATGTAGGCGGTGCTACAGAGTTCTTGAAG
12[143]-12[128]	GGATTAGCAGAGCGA
12[175]-12[160]	CTTATCGCCACTGGCA
12[207]-12[192]	ATCGTCTTGTAGTCCA

Half seam modification (Fig. 4b of the manuscript)**Replace:**

2[127]-2[96]	GGCGCGTCAGCGGGTGGTGCACCCAACTGAT
4[127]-4[96]	GTGCTGCAAGCGGATTGCCATCCGTAAGATCG
6[127]-6[96]	TTGCGCTCACTGCCCGACGTTGTTGCCATTG
8[127]-8[96]	ACATGTAGCAAAAGGCGGTAGATAAATACG
10[127]-10[96]	GCCTTTCTCCCTTCGGCTGACGCTCAGTGA

With:

2[111]-2[96]	GTGCACCCAACTGAT
2[127]-2[112]	GGCGCGTCAGCGGGTG
4[111]-4[96]	GCCATCCGTAAGATGC
4[127]-4[112]	GTGCTGCAAGCGGATT
6[111]-6[96]	ACGTTGTTGCCATTG
6[127]-6[112]	TTGCGCTCACTGCCCG
8[111]-8[96]	CGTGTAGATAAATACG
8[127]-8[112]	ACATGTAGCAAAAGG
10[111]-10[96]	CTGACGCTCAGTGA
10[127]-10[112]	GCCTTTCTCCCTTCGG

A short hairpin was introduced into staple 9[32]-10[32]:

9[32]-10[32]	GTTACCAATGCTTAATtcctcttttgaggacaagtcttctgtTCTTACCTAGATCC
--------------	--

Extended staples modification (Fig. 4c of the manuscript)**Replace:**

7[96]-7[127]	GTTAATAGTTTGCACACTTCCAGTCGGGAA
1[48]-1[63]	GGGTTATTGTCTCATG
1[64]-2[64]	AGCGGATACATATTGTTTCACAGCGTTCT
1[128]-1[143]	CGAAAAGTGCCACCTG
2[143]-3[143]	CAGACAAGCCCGTCAGGCTGGCTTAACTATGC
2[159]-1[159]	AAGCGGATGCCGGGAGACGCTAAGAAACCA
3[48]-2[48]	CTTCGGGGCGAAAAACGGGTGAGCAAAAACAG
3[64]-4[64]	TCTCAAGGATCTTACCAGTACTCAACCAAGT
4[143]-5[143]	TGGCGAAAGGGGGATGGGTTTCCCAGTCAC
4[159]-3[159]	TCGCTATTACGCCAGCGGCATCAGAGCAGATT
5[48]-4[48]	TAAGTTGGCCGAGTGCATTCTGAGAAATAGTG
8[143]-9[143]	ATAACGCAGGAAAGAAACCGTAAAAAGGCCG
9[48]-8[48]	CAGTGAGGCACCTATCCTGCAATGATACCGCG
9[64]-10[64]	TCAGCGATCTGTCTATAGGGATTTTGGTCATG
10[143]-11[143]	TACCGGATACCTGTCCCTCATAGCTCAGCTG
10[159]-9[159]	TTCCGACCTGCCGCTCGTTGCTGGCGTTTT
11[48]-10[48]	AGCAGCAGATTACGCAGATTATCAAAAAGGA
11[64]-12[64]	GCAGAAAAAAGGATCGCTACACTAGAAGAA
12[63]-12[48]	CAGTATTTGGTATCTG
12[143]-12[128]	GGATTAGCAGAGCGA
12[159]-11[159]	GCAGCCACTGGTAACATAGGTATCTCAGTTCC

With:

7[96]-7[111]	GTTAATAGTTTGCACA
7[112]-7[127]	CTTTCAGTCGGGAA
1[48]-2[48]	GGGTTATTGTCTCATGAGCGGATACATATTGTTTCACAGCGTTCTGGGTGAGCAAAAACAG
2[159]-1[159]	AAGCGGATGCCGGGAGCAGACAAGCCCGTCAGCGAAAAAGTGCCACCTGACGTCTAAGAAACCA
3[48]-4[48]	CTTCGGGGCGAAAACTCTCAAGGATCTTACCAGTACTCAACCAAGTCACTCTGAGAATAGTG
4[159]-3[159]	TCGCTATTACGCCAGCTGGCGAAAGGGGATGCTGGCTTAACTATGCGGCATCAGAGCAGATT
5[48]-5[63]	TAAGTTGGCCGCACTG
5[128]-5[143]	GGGTTTCCAGTCACTG
8[63]-8[48]	CTGCAATGATACCGCG
8[143]-8[128]	ATAACGCAGGAAAGA
9[48]-10[48]	CAGTGAGGCACCTATCTCAGCGATCTGTCTATAGGGATTTTGGTCATGAGATTATCAAAAAGGA
10[159]-9[159]	TTCCGACCTGCCGCTTACCGGATACCTGTCCAACCGTAAAAAGGCCGCTGCTGGCGTTTT
11[48]-12[48]	AGCAGCAGATTACGCGCAGAAAAAAGGATCGCTACACTAGAAGAACAGTATTGTTGTTATCTG
12[159]-11[159]	GCAGCCACTGGTAACAGGATTAGCAGAGCGACTCATAGCTCAGCTGTAGGTATCTCAGTTCC

Alternate seam modification (Fig. 4d of the manuscript)**Replace:**

3[96]-3[127]	TCGATGTAACCCACTCTTGGCGGGTGTCTGGG
5[96]-5[127]	ATTCTCTTACTGTCATAAGTTGGGTAACGCCA
7[96]-7[127]	GTTAATAGTTTGGCGCACTTTCAGTCGGGAA
9[96]-9[127]	TTGCCCTGACTCCCGTCCAGCAAAAGGCCAGG
11[96]-11[127]	ATCTTTTCTACGGGGTGAAAGCGTGGCGCTTT

8[223]-7[223]	CTGCGCTCGGTCGTTCCCTCGCTCACTGACTCG
6[223]-5[223]	GTTATCCGCTCACAATTTCTGTGTGAAATF
10[223]-9[223]	ACCCGACAGGACTATAGTCAGAGGTGGCGAA

With:

3[96]-3[111]	TCGATGTAACCCACTC
3[112]-3[127]	TTGGCGGGTGTCTGGG
5[96]-5[111]	ATTCTCTTACTGTCAT
5[112]-5[127]	AAGTTGGGTAACGCCA
7[96]-7[111]	GTTAATAGTTTGGCGCA
7[112]-7[127]	CTTCCAGTCGGGAA
9[96]-9[111]	TTGCCCTGACTCCCGT
9[112]-9[127]	CCAGCAAAAGGCCAGG
11[96]-11[111]	ATCTTTTCTACGGGGT
11[112]-11[127]	GAAGCGTGGCGCTTT
5[208]-10[208]	TTCCCTGTGTGAAATTACCCGACAGGACTATA
7[208]-8[208]	CTCGCTCACTGACTCGCTGCGCTCGGTCTTC
9[208]-6[208]	GTCAGAGGTGGCGAAGTTATCCGCTCACAAT

Long staple modification (Extended Data Fig. 4)**Replace:**

10[207]-11[207]	AAGATACCAGGCGTTTTGCACGAACCCCCGT
12[223]-11[223]	GCCTTATCCGGTAACCTCAGCCCGACCGCTGC
12[207]-12[192]	ATCGTCTTGAGTCCA

With:

10[207]-10[192]	AAGATACCAGGCGTTT
11[192]-12[192]	TGCACGAACCCCCGTTTCAGCCCGACCGCTGCGCCTTATCCGGTAACCTATCGTCTTGAGTCCA