Supporting Information

DNA-Corralled Nanodiscs for the Structural and Functional Characterization of Membrane Proteins and Viral Entry

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Supporting Experimental Procedures

Expression and Purification of triple cysteine NW11 (3C-NW11)

3C-NW11 construct in pET-28a containing a tobacco etch virus (TEV) protease-cleavable N-terminal His6 tag and a C-terminal sortase-cleavable His6 tag was transformed into BL21-Gold (DE3) competent *Escherichia coli* cells (Agilent). 3L cell cultures were grown at 37 °C with agitation at 200 r.p.m. in Luria broth (LB) medium supplemented with 50 µg/ml kanamycin. Expression was induced at an OD600 of 0.6 with 1 mM IPTG, and cells were grown for another 3h at 37°C. Cells were harvested by centrifugation (7,000 x *g*, 15 min, 4 °C), and cell pellets were stored at −80 °C.
3C NW11 was purified as follows; Pellets of cells were resuspended in Buffer A (50 mM Tris–HCl, pH 8.0, 500 mM NaCl, 8 mM BME) plus 1% Triton X-100 and lysed by sonication on ice. Lysate was centrifuged (35,000 × *g*, 50 min, 4 °C), and the supernatant was loaded onto a Ni^{2+}-NTA column. Resin was washed with 10 CV of the following buffers: buffer A + 1% Triton X-100, buffer A + 50 mM sodium cholate, buffer A, and buffer A + 30 mM imidazole. Protein was eluted with buffer A + 500 mM imidazole.

Reconstitution of 3C-NW11 nanodiscs

We used ratio of 1:75 3C-NW11: lipid to assemble nanodiscs. Lipids (POPC:POPG, 3:2; solubilized in sodium cholate) and 3C-NW11 were incubated on ice for 1 h. After incubation, sodium cholate was removed by incubation with Bio-beads SM-2 (Bio-Rad) for 1 h on ice followed by incubation overnight at 4 °C. The nanodisc preparations were filtered through 0.22 µm nitrocellulose-filter tubes to remove the Bio-beads. The nanodisc preparations were further purified by size-exclusion chromatography while monitoring the absorbance at 280 nm on a Superdex 200 10 × 300 column equilibrated with 20 mM Tris–HCl, pH 7.5, 100 mM NaCl, 8 mM BME, 0.5 mM EDTA. Fractions corresponding to the size of nanodisc were collected and concentrated. The purity of nanodisc preparations was assessed using SDS–PAGE.

Nanodisc-DNA conjugation and purification

The bifunctional cross-linker Sulfo-SMCC (Thermo Scientific) was dissolved in anhydrous dimethylsulfoxide (DMSO) to give a final concentration of 100 mM. 10 nmoles of DNA oligo (with primary amine modification, /5AmMC6/TAGATGGAGTGTGGTGTGAAG) was incubated with a 100 times molar excess of the crosslinker in buffer B (100 mM NaPi, pH 8.0, 150 mM NaCl and 7.5% DMSO) for 1 h at 23°C. The reaction mix was applied to Amicon filter (Millipore, 3kD) and centrifuged at 7000 rpm for 50 min (repeat 3 times), and then went through a disposable Bio-rad P-6 spin column to remove excess cross-linker.
Next, 50 uL of 5 uM nanodisc was incubated with purified DNA oligo-SMCC from the first step at 23°C in buffer C (containing 100 mM NaPi, pH 7.4, 150 mM NaCl) for 2 h (DNA:nanodisc ratio 12:1). We removed the BME from the nanodisc sample right before the incubation with DNA oligo-SMCC by applying it to Bio-rad P-6 spin column. The oligo-conjugated nanodisc was then purified by size

exclusion chromatography (preferred, **Figure S9**) or by using Centricon concentrators (30 kDa MW cutoff, Millipore) and centrifuging at 4000 g for 10 min (repeat 5 times).

Design and assembly of DNA origami structures

The DNA origami/crystal nanostructures were designed using the software caDNAno.[1] DNA origami was folded by mixing p7308 scaffold at 10 nM with 10-fold excess of staples in folding buffer (containing 5 mM Tris-HCl, 1 mM EDTA, 12 mM $MgCl_2$, pH 8) and subjected to a thermal annealing ramp (from 65°C to 25°C over 20 h). Well-folded DNA origami was purified by a rate-zonal centrifugation procedure using a 15-45% (v/v) glycerol gradient.

Assembly of oligo-conjugated nanodisc with DNA Origami

Excess of oligonucleotide-conjugated nanodisc was incubated with the DNA corrals containing handle strands (5'-CTTCACACCACACTCCATCTA-3'). Nanodisc assembly was performed in buffer containing 5mM Tris-HCl, 1mM EDTA, 10 mM $MgCl_2$, using an annealing protocol, in which the temperature was gradually decreased from 37 °C to 4 °C over 2 h.

Large lipid nanodisc reconstitution

DNA corrals containing small nanodiscs were mixed with 9X amount liposomes (POPC:POPG:cholesterol:DGS-NTA(Ni) ratio of 51:34:10:5, for the poliovirus experiment) then diluted with tris buffer containing octyl glucoside (5 mM Tris, 1 mM EDTA, 12 mM $MgCl_2$, pH 8, 0.7% OG). Next, this solution was incubated on a Thermomixer at 300 rpm at room temperature for 1 h. The entire solution was then transferred into a 7K MWCO Slide-a-Lyzer dialysis cassette (Thermo Scientific). The cassette was dialyzed against 2 L of Tris buffer for 48 h at 4°C. After dialysis, the sample was recovered from the dialysis cassette and concentrated using an Amicon filter (50 KD). Reconstituted nanostructures were separated from excess lipids by equilibrium centrifugation using sucrose gradient (30, 25, 20, 15, 10 from bottom to top). The gradient solutions were layered into ultracentrifuge tubes and centrifuged at 48,000 rpm for 5 h at 4°C. The gradient was fractionated, and aliquot of each fraction was checked for the presence of assembled DCND.

VDAC-1 production

Human VDAC1 was expressed, purified and refolded as detailed previously.[2-3] Briefly, the plasmid containing pET21d:hVDAC1 (VDAC1(1–283)-Leu-Glu-His_6) construct was transformed to BL21 (DE3) competent cells. Expression of hVDAC1 was carried out in LB medium and induced by 1mM IPTG at 37 °C for 3~5 hours. Cells were lysed and the inclusion bodies containing hVDAC1 were collected and solubilized in denaturing buffer (8 M urea, 50 mM Tris-HCl, pH 8.0, 250 mM NaCl, 20 mM imidazole). hVDAC1 was subsequently purified with Ni-NTA resin and precipitated through dialysis against dialysis buffer (50 mM Tris-HCl, pH 8.0, 50 mM NaCl, 1 mM EDTA, 5 mM DTT). The precipitate was collected and dissolved in 6M guanidine hydrochloride buffer. Refolding of hVDAC1 was carried out at 4 °C by very slow, dropwise dilution into 10x volume of refolding buffer (50 mL; 50 mM NaPi, pH 6.8, 100 mM NaCl, 1 mM EDTA, 5 mM DTT, 1% (43 mM) lauryldimethylamine oxide (LDAO)). The refolded hVDAC1 was further purified through cation exchange chromatography, from which the fractions containing properly folded hVDAC1 were pooled and concentrated for nanodisc reconstitution.

Transmission electron microscopy

For imaging, particles were adsorbed onto glow discharged carbon-coated TEM grids (Ted Pella) and then stained using a 0.7% (for the poliovirus samples) or 2% aqueous uranyl formate solution. The samples were visualized with a JEOL JEM-1400 TEM, operated at 80 kV in the bright-field mode.

Cryo electron microscopy

Gatan CP3 system was used to plunge-freeze a glow-discharged Quantifoil grids (EMS, Hatfield, PA) after the application of 3 µl of the poliovirus-DCND solution (blot time set to 3s). Grids were transferred into an FEI F20 electron microscope operating at an acceleration voltage of 200 kV. Micrographs were acquired on a K2 Summit camera (Gatan, Pleasanton, California) in super-resolution mode.

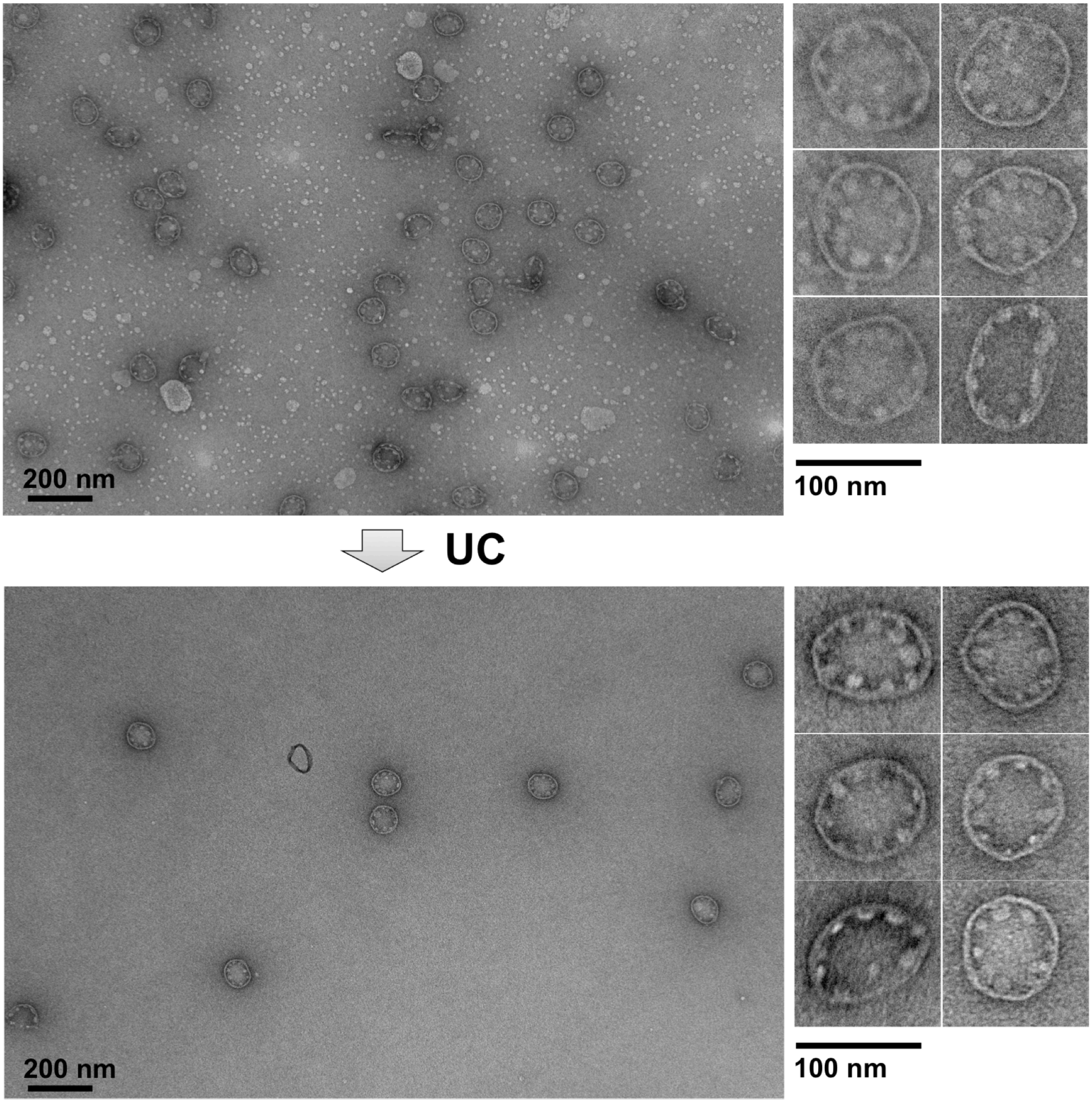


Figure S1. TEM analysis of 90 nm DNA-origami barrel after assembly with small nanodiscs. (top) TEM image of DNA-origami barrel after assembly with small nanodiscs. (**bottom**) TEM image after the ultracentrifugation (UC) step to remove uncoupled, free nanodiscs.

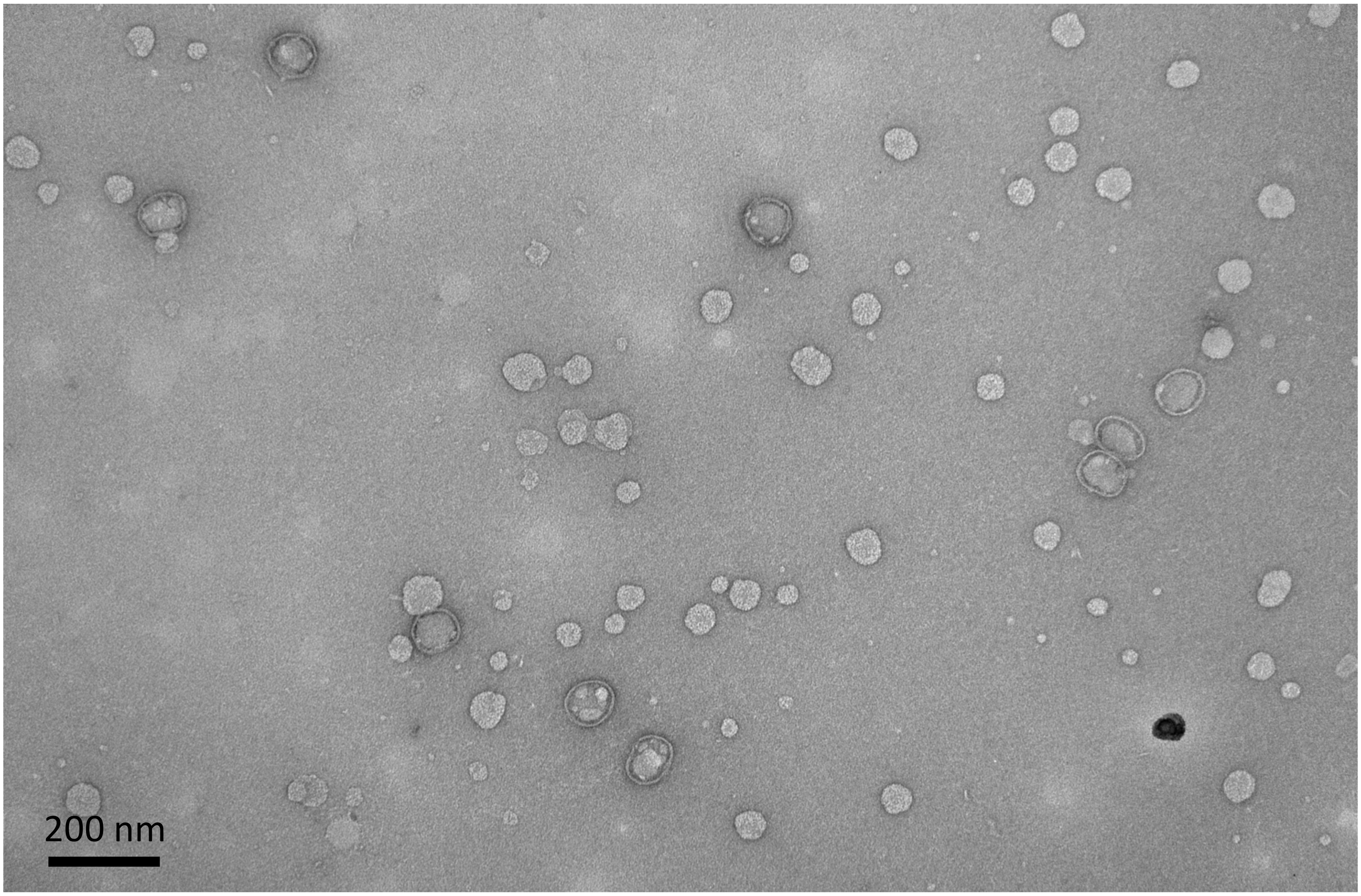


Figure S2. **TEM of DCND reconstituted inside 90-nm barrel**. Negative-stain images show the formation of integrated large sized nanodiscs inside the DNA barrel. The image also shows the formation of free lipid vesicles outside the DNA barrels. Reconstituted DNA nanostructures were separated from excess lipid vesicles by sucrose gradient at a later step. The POPC/POPG lipid mixture was used in the reconstitution of DCND.

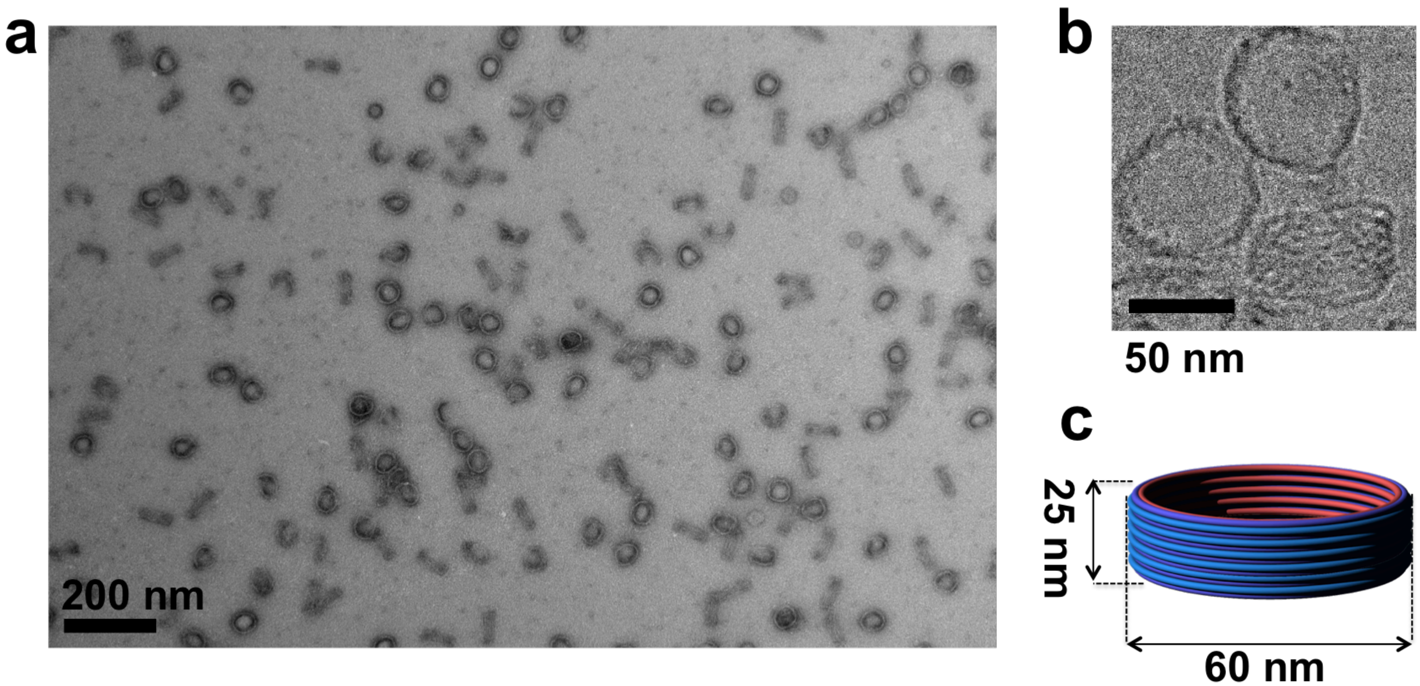


Figure S3. **TEM characterization of 60-nm DNA-origami-barrel without a bilayer.** (**a**) Negative-stain EM for the 60 nm barrel. **(b)** Cryo-EM of empty 60 nm DCND particles (lacking membranes). The Image shows the side and top views side by side. **(c)** The dimensions of DNA origami barrel**.**

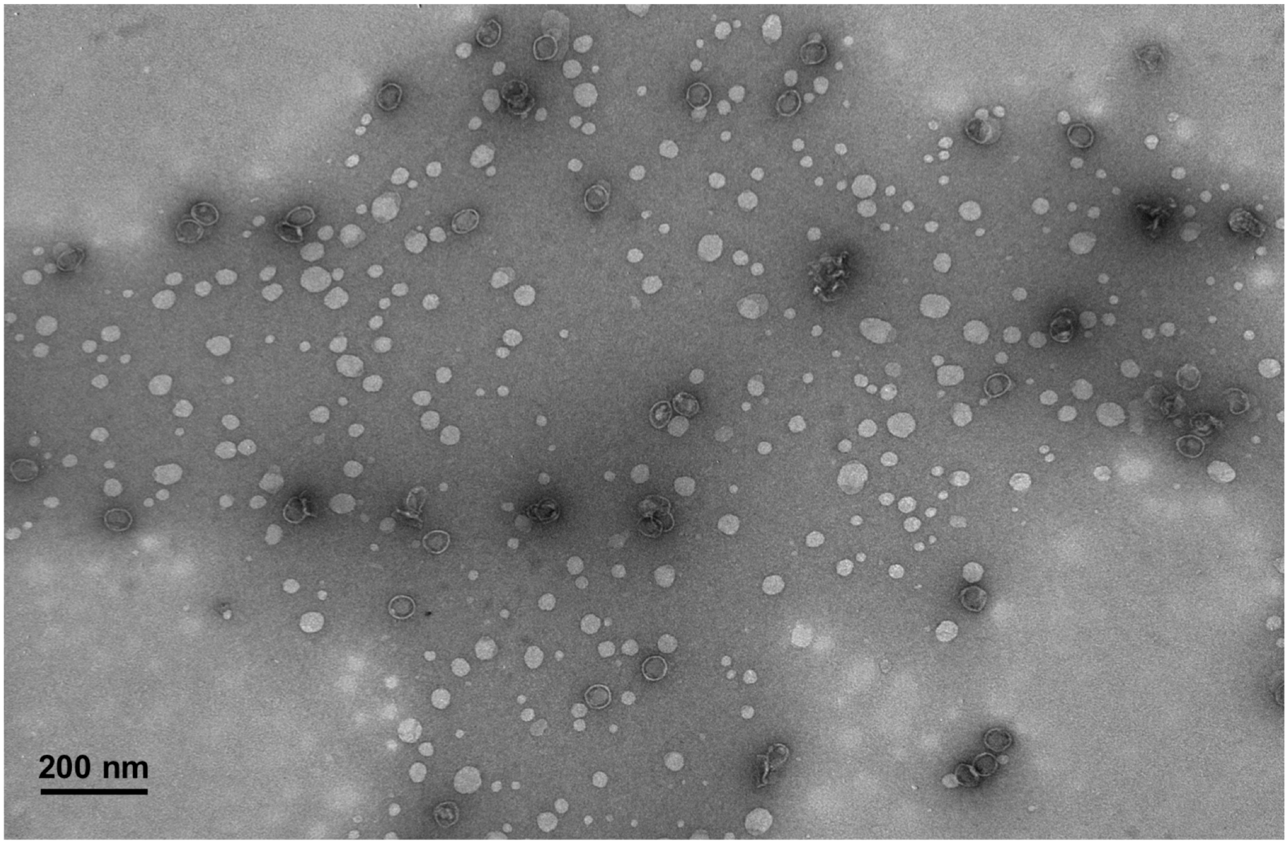


Figure S4. **TEM analysis of DCND reconstituted inside 60-nm barrel**. The image also shows the formation of free lipid vesicles outside the DNA barrels. The free lipid vesicles can be removed at a later step by sucrose gradient.

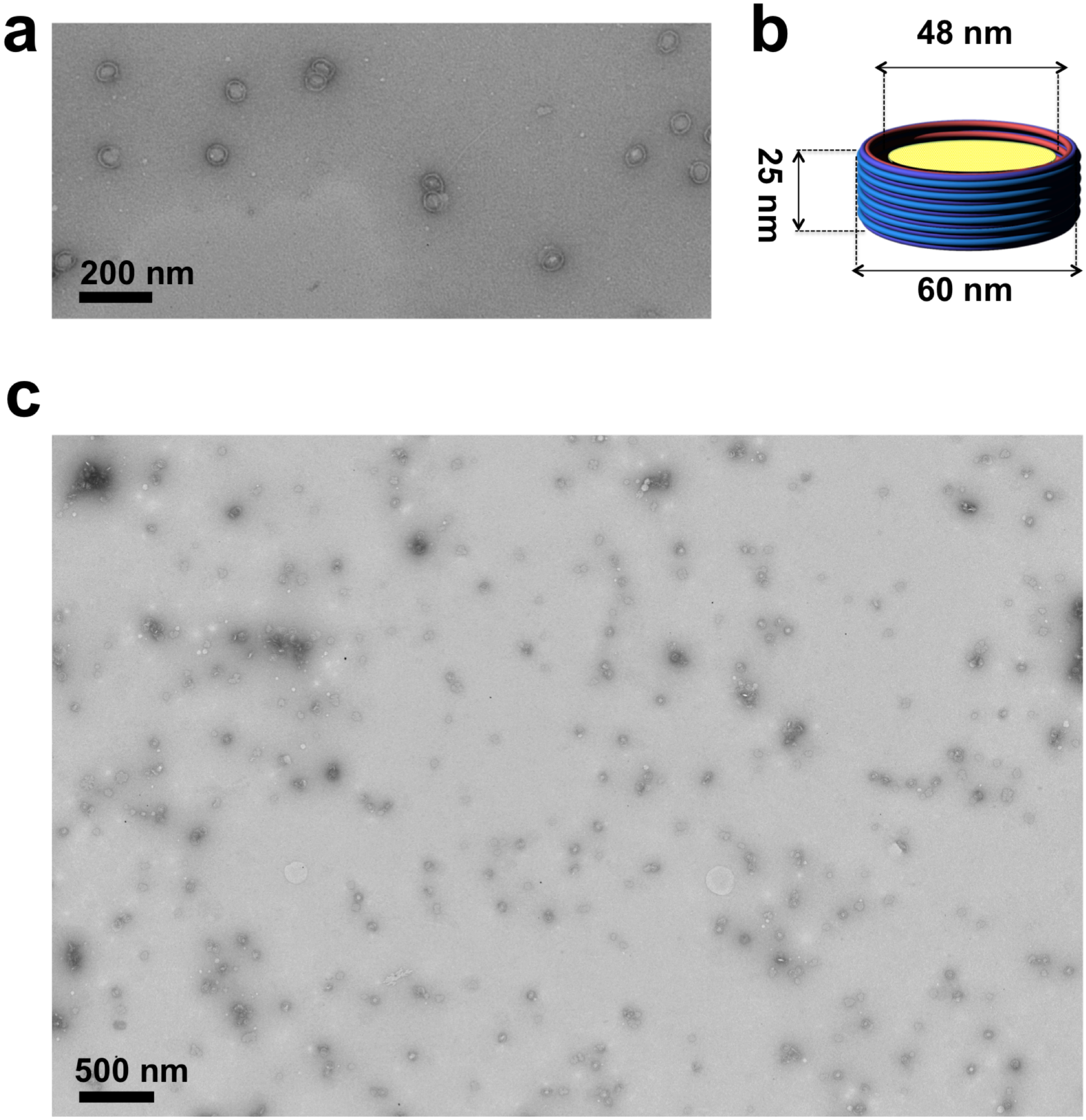


Figure S5. TEM analysis of 60 nm DCND after the sucrose gradient step. (a) Negative-stain image for the 60 nm DCND **(b)** The dimensions of the 60 nm DCND. **(c)** Zoom-out view of 60-nm DCND.

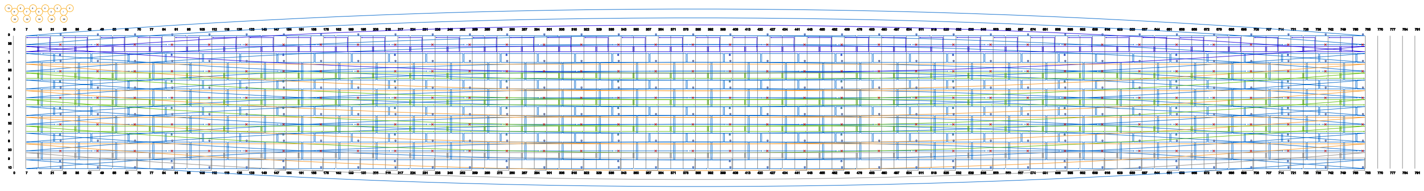


Figure S6. caDNAno design of 90 nm DNA barrels.

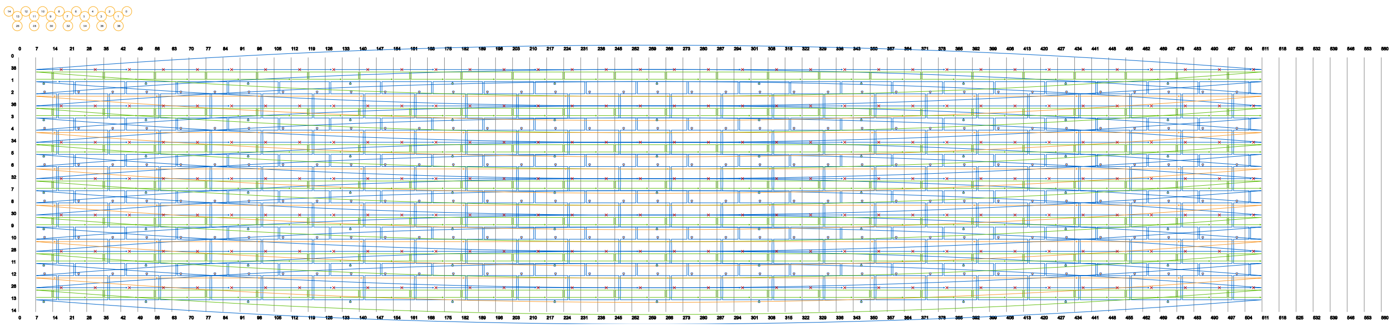


Figure S7. caDNAno design of 60 nm DNA barrels.

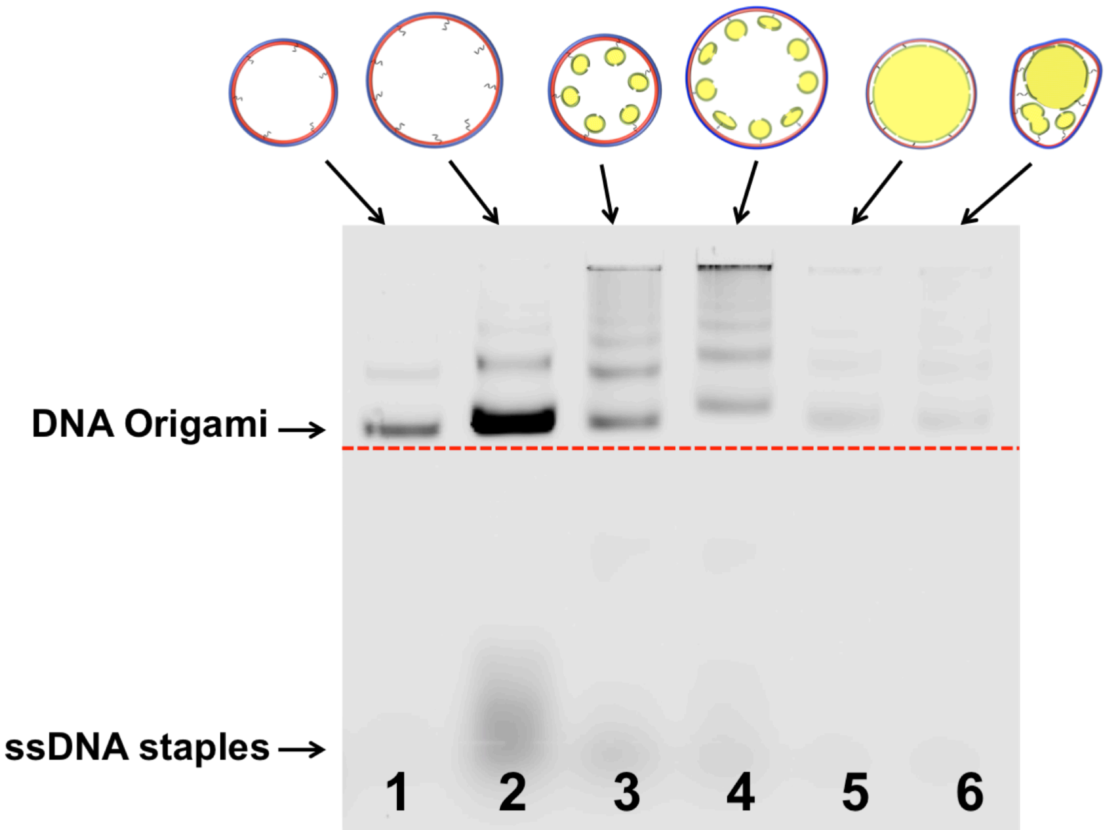


Figure S8. Native Agarose gel electrophoresis for DCND. Lane 1: folded 60-nm DNA barrel only, lane 2: folded 90-nm DNA barrel only, lane 3: folded 60-nm DNA barrel containing small nanodiscs, lane 4: folded 90-nm DNA barrel containing small nanodiscs, lane 5, 6: 60 nm DCND reconstituted with different amount of lipids.

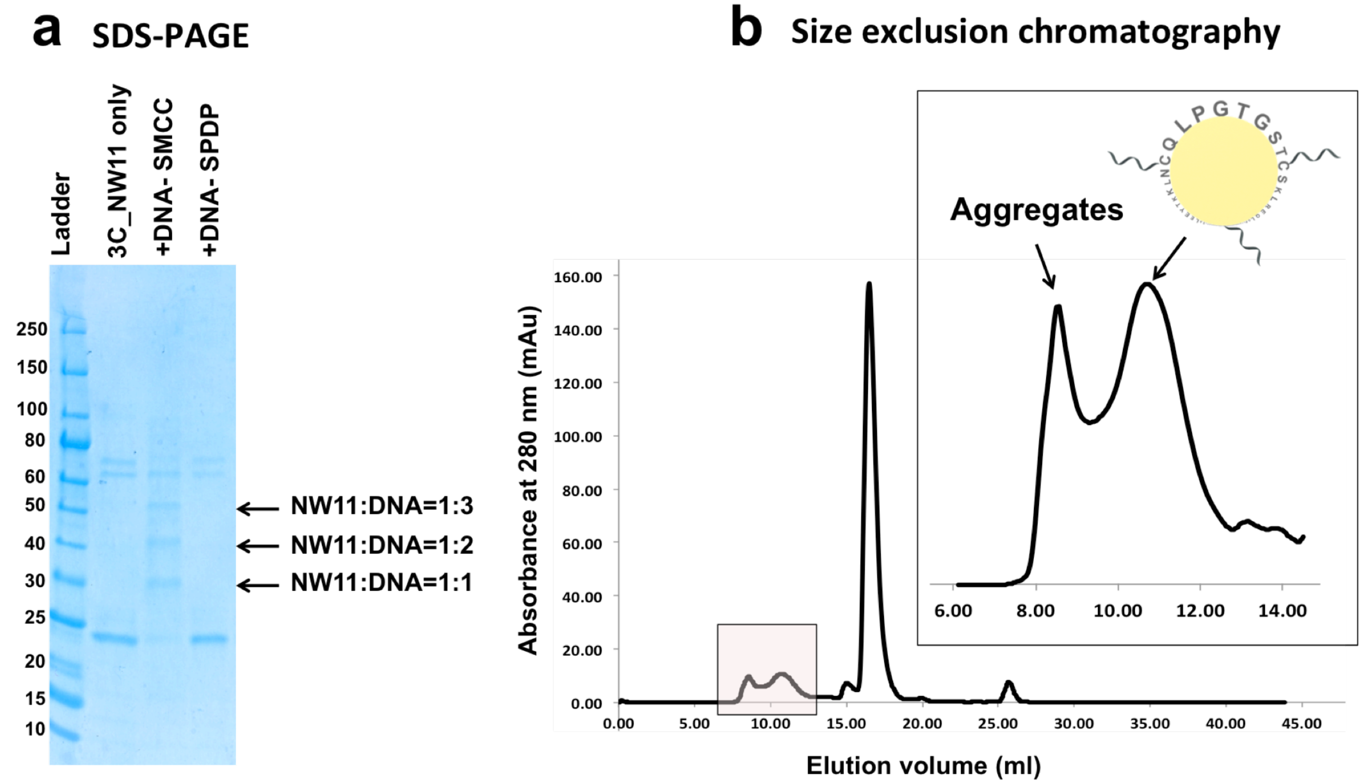


Figure S9. Coupling of DNA oligos to nanodisc. (**a**) SDS-PAGE of SMCC and SPDP coupling. SMCC coupling resulted in better yield. **(b)** Size exclusion chromatography was performed to purify oligo-nanodiscs from free oligos and aggregates.

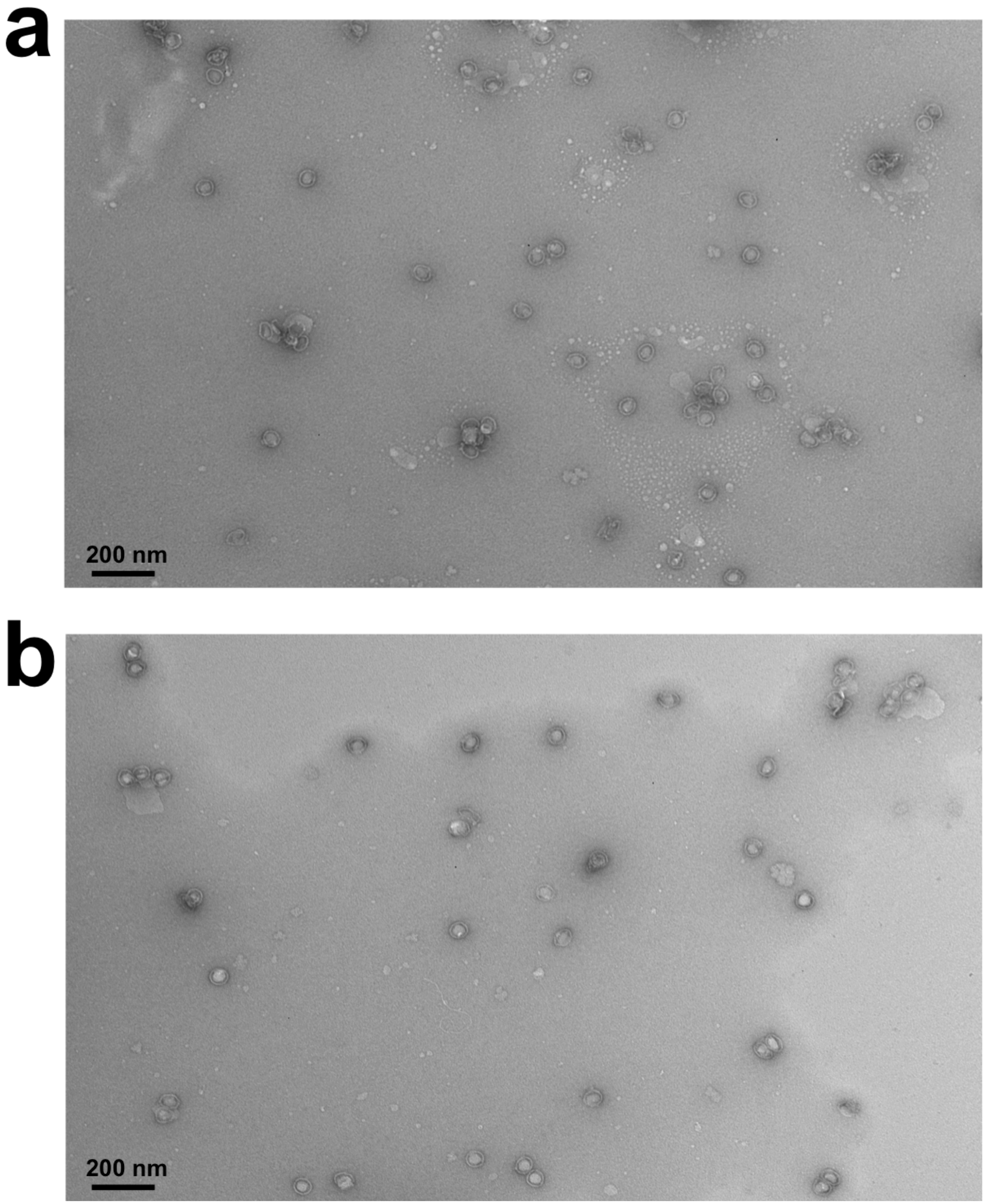


Figure S10. TEM analysis of 60 nm DCND before and after storage for 7 days at 4°C. (a) TEM image for the 60 nm DCND taken on day 1 after assembly. **(b)** TEM image for the 60 nm DCND after storage for 7 days at 4°C.

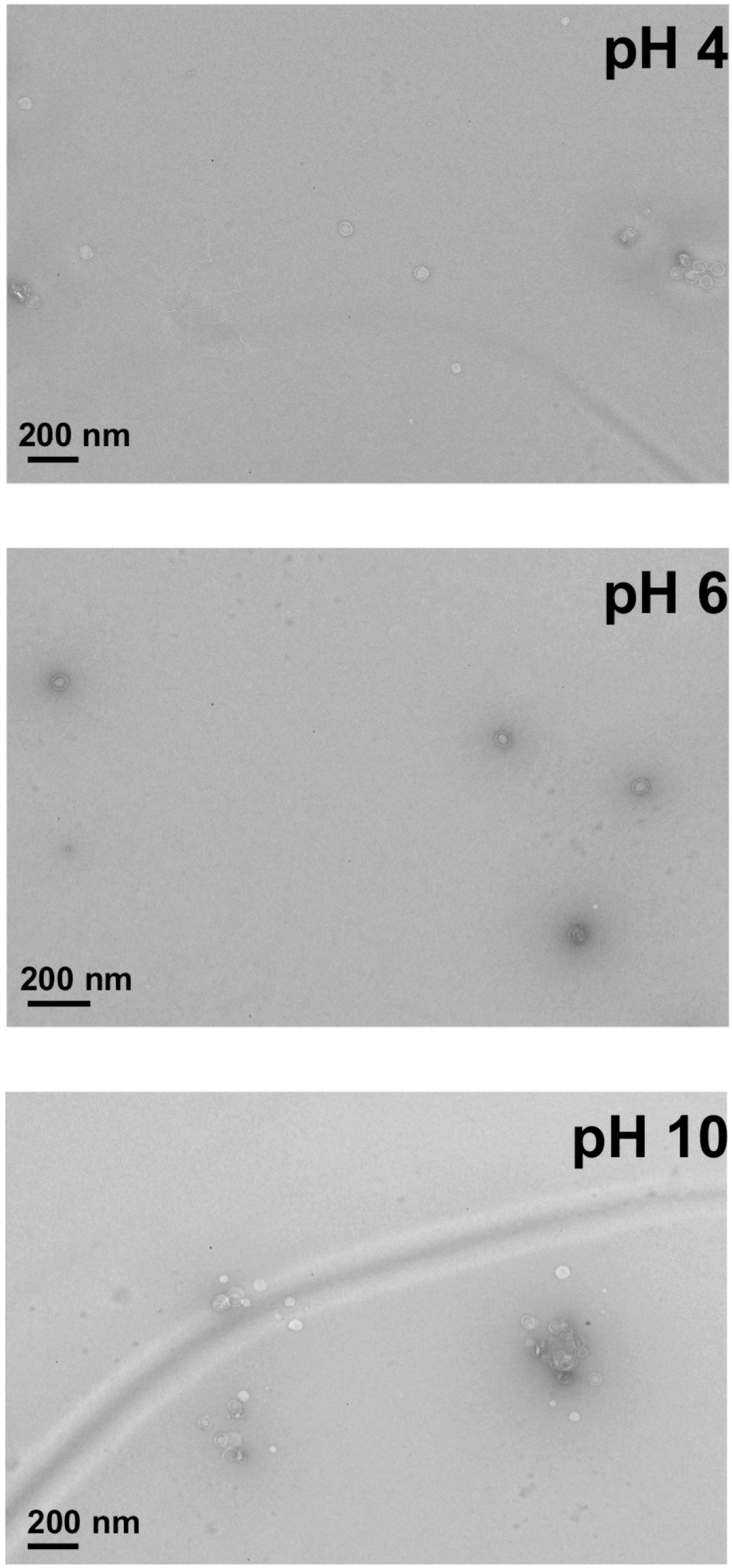


Figure S11. TEM characterization of 60-nm DCND samples in 1X TE-Mg^{2+} buffer at different pH.

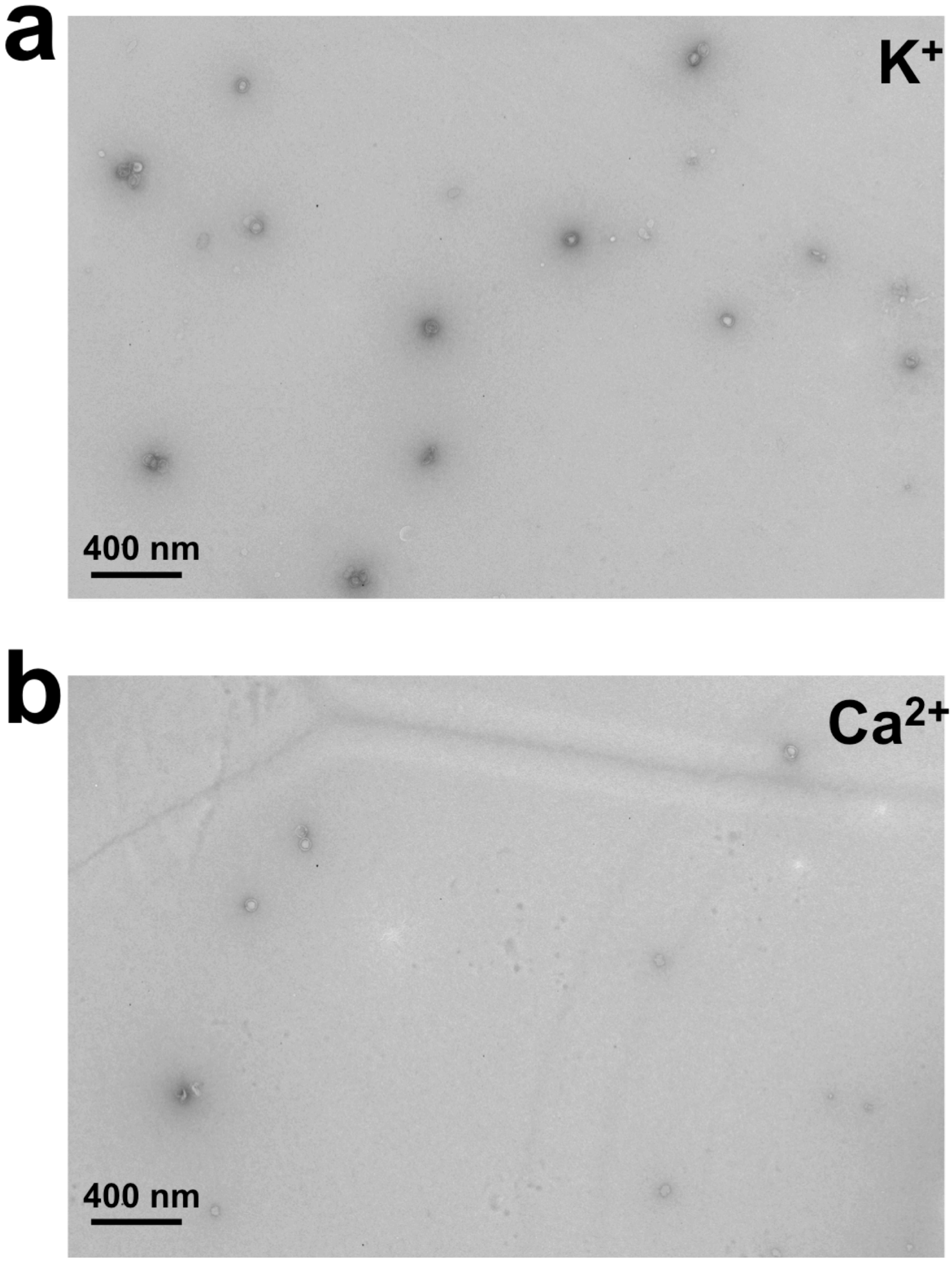


Figure S12. TEM characterization of 60-nm DCND in presence of 50 mM K^+ (a) and 10 mM Ca^{2+} (b) buffers.

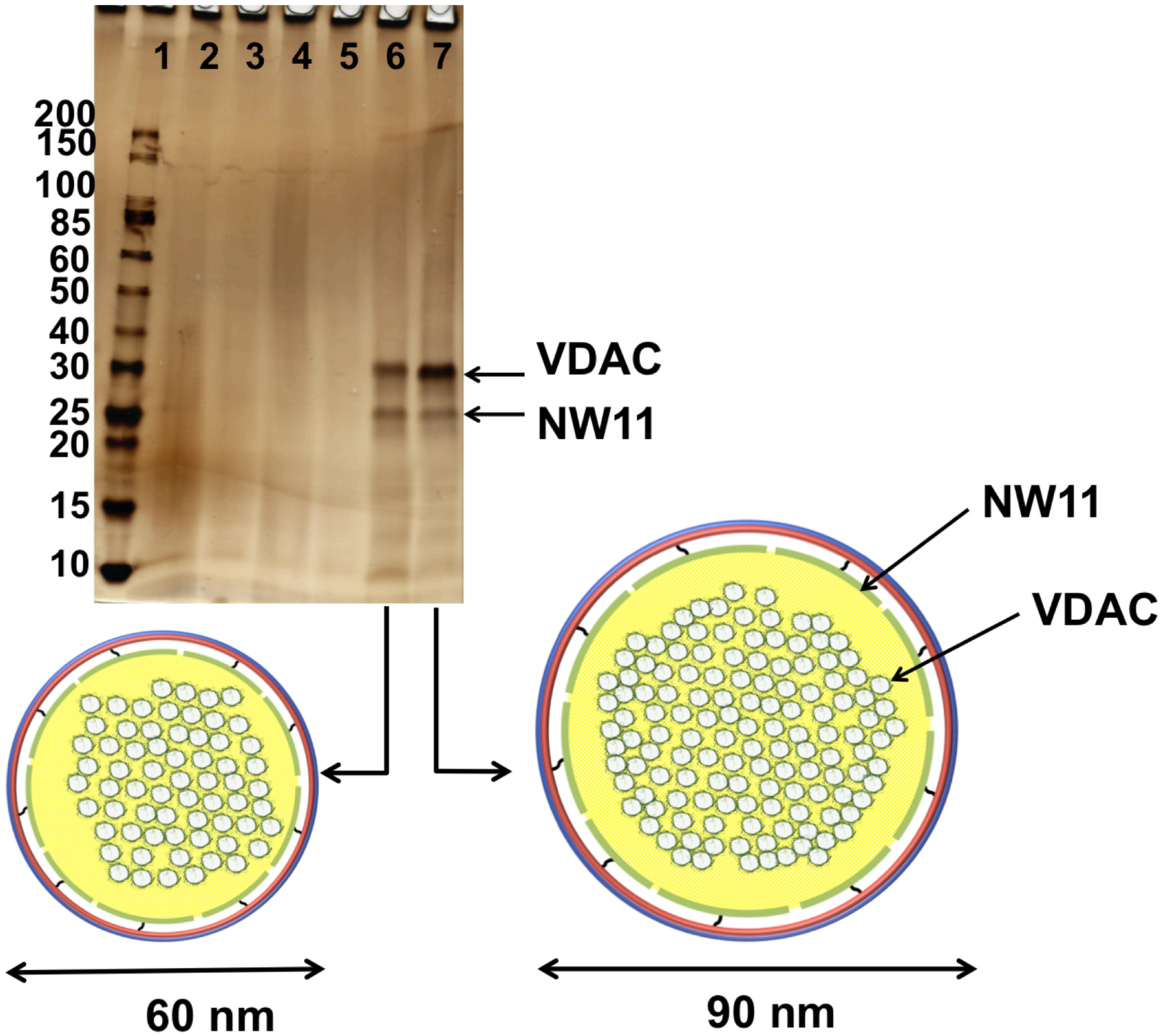
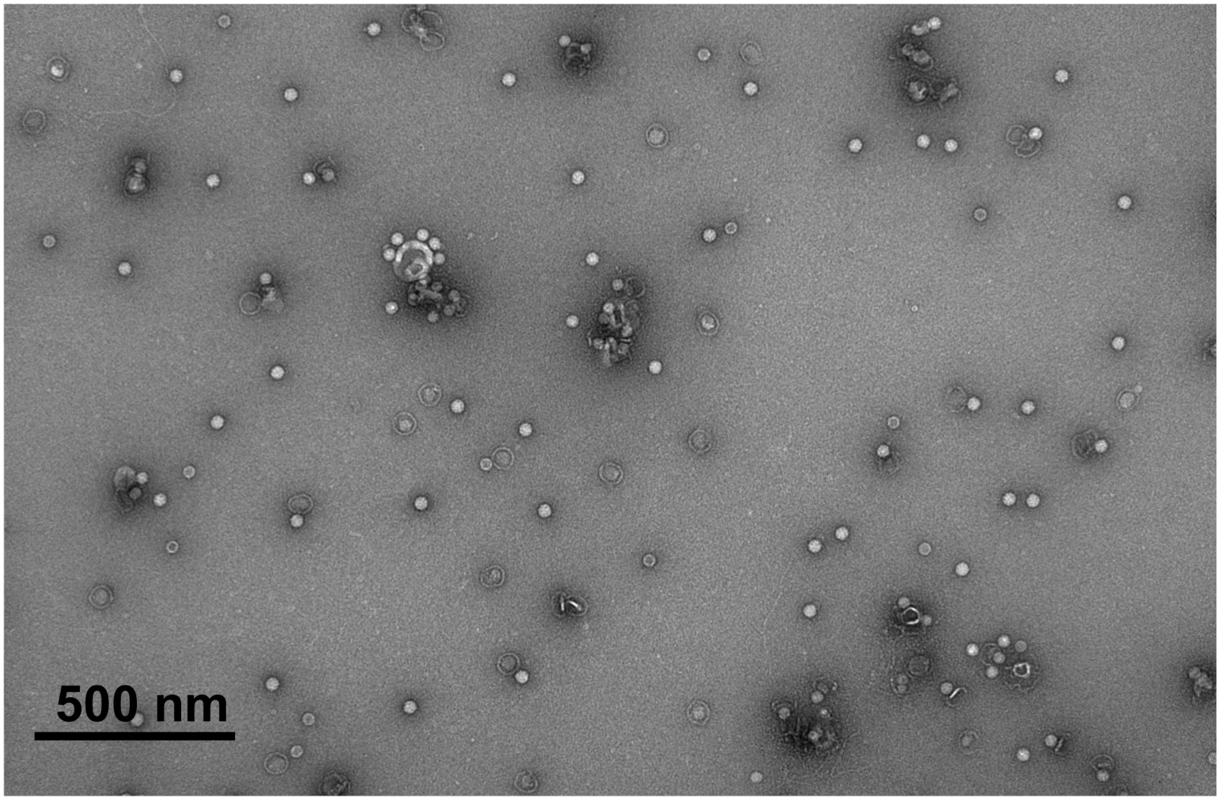


Figure S13. SDS-PAGE analysis for purified 60 and 90 nm DCND. Samples were visualized by silver stain. Lane 6: 60 nm DCND containing VDAC. Lane 7: 90 nm DCND containing VDAC. The analysis confirms the incorporation of VDAC into both 60 and 90 nm DCND. Samples were boiled before loading into gel.



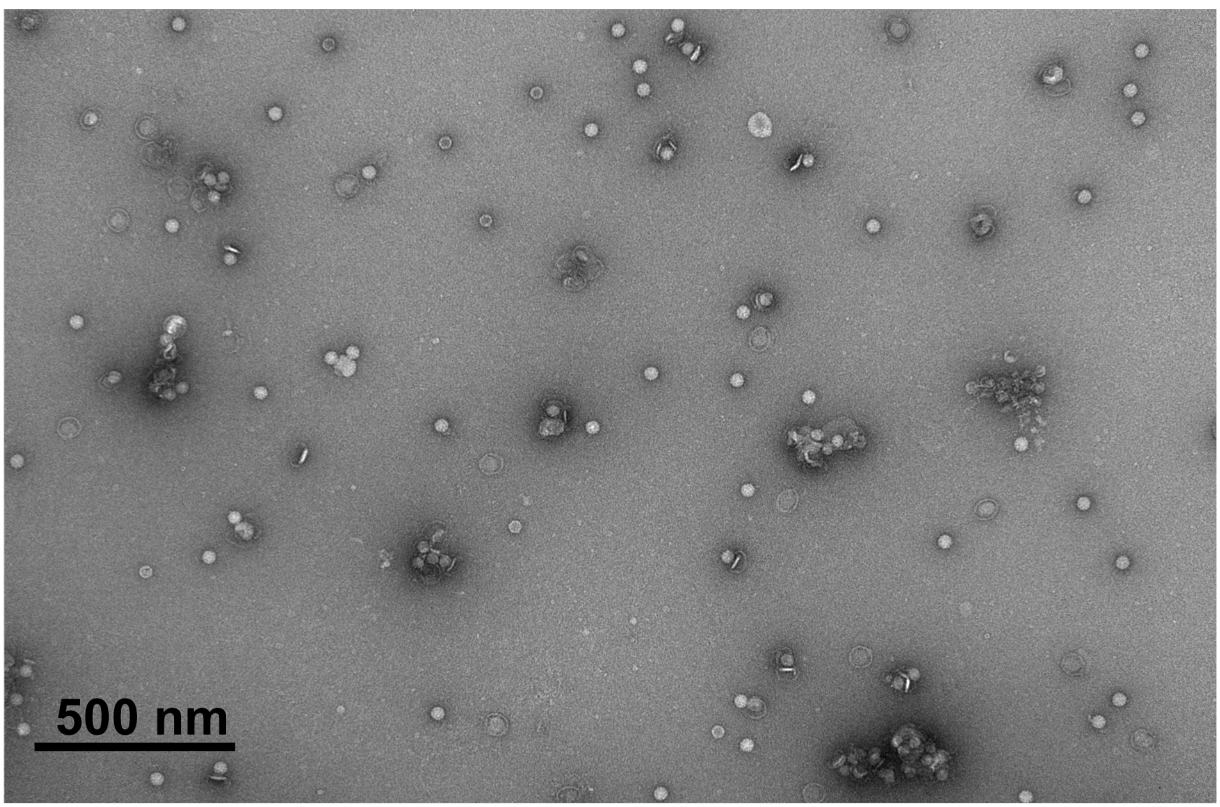


Figure S14. TEM images showing individual viral particles tethered to 60 nm DCND. The 60 nm DCND were prepared and stored for 6 weeks at 4°C before the incubation with the poliovirus.

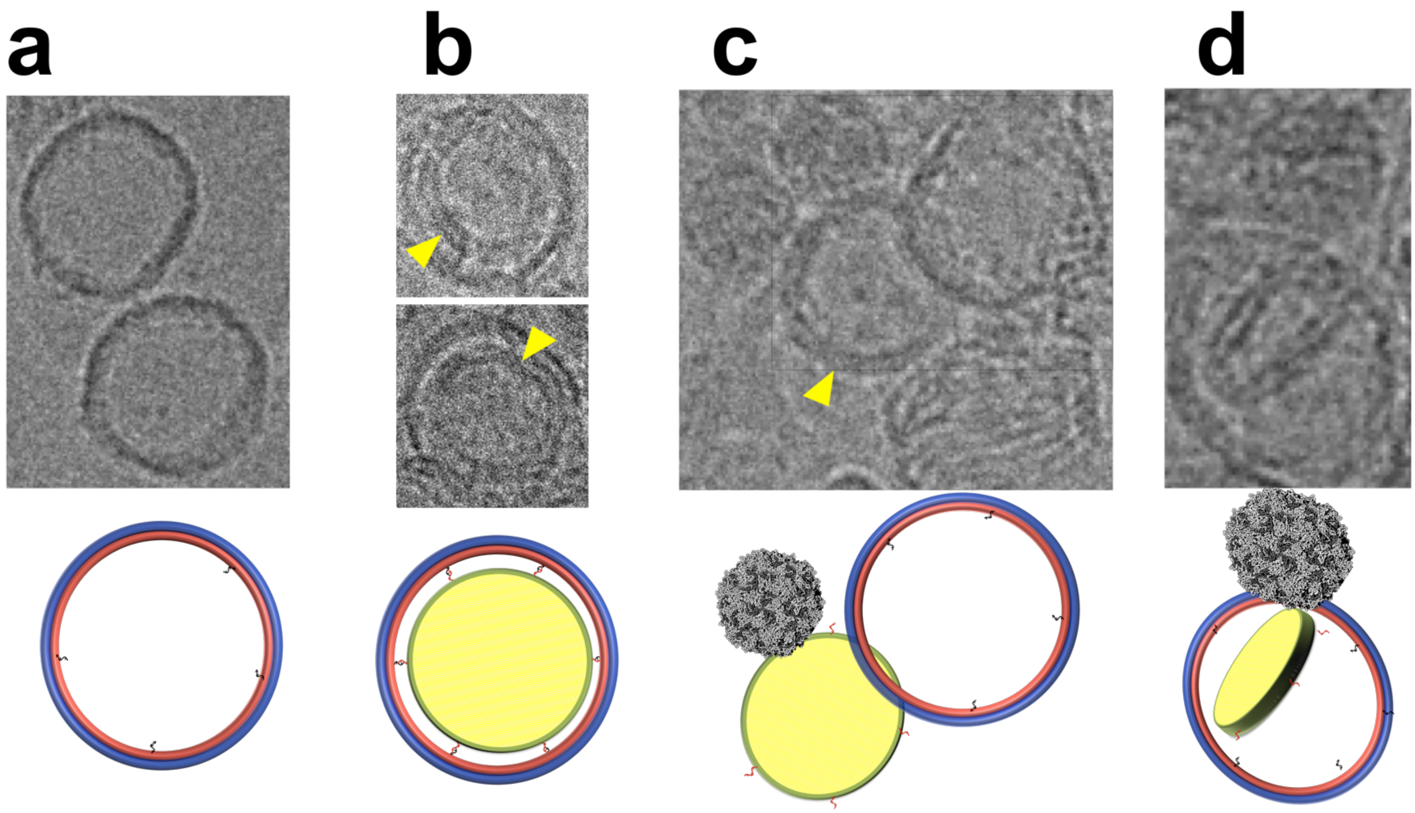


Figure S15. Cryo-EM analysis of the 60 nm DCND with and without poliovirus. (a) Membrane-free DNA barrel**. (b)** DCND particles. The yellow arrows point to the lipid bilayer boundaries. **(c)** Poliovirus plus DCND. The bilayer is partially separated from the DNA. **(d)** The bilayer is tilted within the DNA barrel.

3C-NW11 sequence

MGSSHHHHHHENLYFQGSTFSKLREQLGPVTQEFWCNLEKETEGLRQEMSKDLEEVKAKVQPYLD
DFQKKWQEEMELYRQKVEPLRAELQEGARQKLHELQEKLSPLGECMRDRARAHVDALRTHLAPYS
DELRQRLAARLEALKENGGARLAEYHAKATEHLSTLSEKAKPALCDLRQGLLPVLESFKVSFLSALEE
YTKKLNTQLPGTGAAALEHHHHHH

DNA Origami sequences

90 nm DNA-origami-barrel

Core staples

Oligo0 CGTGGACCGACCAGCAGTCCTCCGTCTGATTGCCCTAAGAA
Oligo1 CATCACTGGAGGCGAACTACGATGCGATCCGTATAATAATAA
Oligo2 GCCAACAACCCGCTCGGTTGCCCACCATGCCTGAGTTTCTG
Oligo3 CCACGCTGAAGCGCCCTTGAGCCATCAGAGATAGAACAGTG
Oligo4 GAAGTATTACGGTTAACCCCTTGACTTGAGAGCCAGGATTTA
Oligo5 ACTTCTGCCGCCTCGTCACTGGGCACATAGACTTTAATTAT
Oligo6 CGAATTAGTGGTTGAGCCGCAGTACGGAATAATGGAAGAGG
Oligo7 CATAGCGTGCCCAGATTCCGTGCGGTATTCATTTCATGAAAA
Oligo8 CTTCTGACCGAGTCTGTCGTAGCACCGATAGCTTAGTTCAT
Oligo9 ACATGTAGCGCACATGGAGCACAGAAGCCTAAATTTCGCCA
Oligo10 CAATCAACAACCCGCCGACGCGTGTCAATTTAGGCAAGAAAC
Oligo11 CTTGCGGTGCCGGTATTTGCTGCCAATTAATCGGCTCCCGA
Oligo12 TAGCAGCGCGCTCGCCTCATGTGCCAGGAGGTTTTGGAAAA
Oligo13 GAAAAGTCTGGATGGGCTCAGTTCGCACTTTACAGATTTTAA
Oligo14 TCACAATAGTGCCGGAGTCCTAGCTCTAAGCAGATATTTTG
Oligo15 CGGAAACCAGCAGACACAACGCCGCGCCAATAGAAAAAGGC
Oligo16 CACCCTCTAGGTAGTCCTCAAAAGAGAGTCACCAATAGCCGC
Oligo17 ATACATGTCGCGGCGGGACAGGTCACCAGAACCGCCGCGTC
Oligo18 CCAGGCGTGCAGCGACACAAGCCTTCGGCTTTTGATCAGTA
Oligo19 GTACAAAGCGATTGGAAGCTCGTACTGGATAAGTGCTCACCA
Oligo20 CGTTGAACGTGCCGGGCGGTTGTCCCGCTACAACGCTTTCA
Oligo21 GATCGTCTCCTGAAAAATGGGCGCTCAAATCTCCAATGCGG
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Oligo26 TCAGAAGCATCGGGCCACAATGTCCAGTAGCGAGAGTATAG
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Oligo40 CCGTCAAGCTCTCGGCAGTCGGCGTTTATTGAAAAATTAGAG
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Oligo47 AACGCGATGTCTCCTGCATAGGTCGTGCTCTTATCACTAAG
Oligo48 GATTTTTGGGTTTGTGGGTATGGGTCCGGAAATCAAGAAAC
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Oligo50 CAAAGACGTGAGACCGGGCCTTGCGCGTAAAAGTTAAAACG
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Oligo135 CCAACAGGCTGGTCACCGTCGAGCGGACCTTCAAATAAACT
Oligo136 TTTGACCTAACGGCCGGCCTGGTTAGCGTTGGAAGTATTTAG
Oligo137 AAAAACAATACCGGGTCCCAAATCCCAATAATTAGCGTACC
Oligo138 TTAATGCTCCTGTCCGACGTCTGTTGCTTGCCGGAGATAAA
Oligo139 GTTAATAACGAATCCGCCGGGTGGGACCGAATCAGAGTAAAC
Oligo140 GTTGGTGTACCTGGCATGACGCAGGCCTTCCGTCGGGTCAC
Oligo141 TTACGCCACGGTGGCGTTCCCTGGACATAGCCATTCCGCTA
Oligo142 CGGGTACCTAGGTACGGTCGGCCTTGAAGGCGAGGCGATCCC
Oligo143 TGCATTAGCACAGAGACCCGCTATGGACGTTAATTGCCAGC
Oligo144 AAAATCCCGCAGTTGGGGCTCCTTCCGTCCCCCAGCAGGCG
Oligo145 ACAGGAACTTGTTACCTCGGCACGTCCTGAAAGGGATTTTAG
Oligo146 GCAACAGCGCCCGGCCCGACGGATTGCCGCCGCCAGCCATT
Oligo147 TCTTTAAGAGCGCTTTACGAGTTGGCTGAAATGGCTATTAG
Oligo148 ATCTGGTGCATTGGGCAGCCAAGTATATGACCCTCAATCAAT
Oligo149 AGTAACAGCGGTTGCCTGGAGGCCTGGCATTTAAAAGTTTG
Oligo150 AGATTTTGACACCACATTAAGAGCTTTTTAAGAAATTGCGT
Oligo151 CAATTTCCGCCTGACCCGCGAGATCCGCATAATTACATTTAA
Oligo152 TTTTTAATGAGCTCGGGGCTACATGGAATTGAGAGACTACC
Oligo153 CATAATTGGATCGGGCGGTGCACTGTCCCAAACACCGGAAT
Oligo154 TCCAGACCCGGTGCGCACACCCAATAGACTAAAGTAATTCTG
Oligo155 CAAGCCGATGGACCAGGCCGAGCTAGTGAATCGAGAACAAG
Oligo156 CCAACGCCATGGCCACTGCTAAGTGAGTTTCCTGAATCTTA
Oligo157 AGTCAGATAGCCATCCGGCGTACGTTTTAACACCCTGAACAA
Oligo158 ACTGGCACTATGTCGGATCCCGCGAGGGGATACCCAAAAGA
Oligo159 AGGTAAATGCTGGGTTAGCTCAGCGGGTGTTGAGGGAGGGA
Oligo160 ACTGTAGTCAGACGCCTCACCTGGACGTACCTTTAGCGTCAG
Oligo161 TTGACAGGATTGTCAGGGCACCGCTAGCGCCGCCGCCAGCA
Oligo162 TATAAACACGTGGGACCCCTTCGGACCGATAACAGTGCCCG
Oligo163 GTACCGCCCACGAGCACTACCGACGTCAGCTCAGGAGGTTTA
Oligo164 CCAGACGCTGGATACCCACATGTGCAGCATTTGTCGTCTTT
Oligo165 TTTCTTAATCCAACACAGGCGCGGAGGTTTTTCGAGGTGAA
Oligo166 TTTTCATGGACAAACGTGCAACAGCAGAAAGGACTAAAGACT
Oligo167 CATGTTAATGTGCGCCTGTCGGTGTATGACGCGACCTGCTC
Oligo168 AGGCTTGAGCGCAGACACGCCTCCACGCTATTCAGTGAATA
Oligo169 CATCAGTACGCGATTAACAGGCAAGAGCCAGGTAGAAAGATT
Oligo170 CCAATACGTCGTGTCGTGTCCGCCGACTGACTGGATAGCGT
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Oligo180 GAGTCCACTATTATCACCGCTTTTCACCAGTGAGAAAGCCTGAT
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Oligo184 TATTTTAGTTAATATTAAGATTCCCTTAGAATCCTATTACCTGT
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Oligo188 CCGCCTCCCTCAGGAAACCAACCATTACCATTAGCATTCATACA
Oligo189 GCGGGGTTTTGCTGATACAGTTACCGTTCCAGTAAACCCTCAAA
Oligo190 CGAATAATAATTTCTGTAGCTAACACTGAGTTTCGCGTCGAGTA
Oligo191 TCTTTGACCCCCAAGCGAAAGTTAAAGGCCGCTTTAAAAAAGTG
Oligo192 AAGAACTGGCTCATGACAAGGCGCATAGGCTGGCTAAAGTACCA
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Oligo195 GAGCAAACAAGAGTAATGTGTTAGAACCCTCATATATTAACACT
Oligo196 AGGAAGATCGCACGCTTTCACATCAAAAATAATTCAAACTAGTG
Oligo197 TCCACACAACATATTGCATGAGTCACGACGTTGTAGCTTCTGTC
Oligo198 CCATCACGCAAATTAGAATCTAGGGTTGAGTGTTGTGAGAGATT
Oligo199 ATAAAACAGAGGTAAGCGTACATTGGCAGATTCACTATCGGCGT
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Oligo203 CTTATCCGGTATTTTCCAAGTCCTGAACAAGAAAACCAGTAAAC
Oligo204 GCAAGAAACAATGAACAGGGTCCCAATCCAAATAAGATTAGTGG
Oligo205 ATTAGAGCCAGCACCAGCGCGGCAACATATAAAAGCCAGAAGGA
Oligo206 CCAGAATGGAAAGCACCCTCCAAAATCACCGGAACCAGCACCGA
Oligo207 AGCAAGCCCAATAATATAAGCTGAGACTCCTCAAGCTGGTAAAG
Oligo208 ATATTCGGTCGCTAAGGAGCTGAGAATAGAAAGGAAGACAGCAT
Oligo209 AGGACAGATGAACATTTGTAGAAAGAGGCAAAAGATCGGAACAT
Oligo210 TAGTAAGAGCAACGTTAATATTAATCATTGTGAATTATTCATAG
Oligo211 TTGATAAGAGGTCTTAAGAGCGAGAATGACCATAAAGTTTTGCA
Oligo212 TTTATTTCAACGCAATCATAGTTTAGCTATATTTTATGCAACTT
Oligo213 CAGCTCATTTTTTATCATATAAAGGCTATCAGGTCAGATTCACC
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Oligo221 ACGCGCCTGTTTAATATAAATTATACAAATTCTTAAATAAGGTG
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Oligo226 AAACAACTTTCAAGTTAGCGCCCTCAGAGCCACCACGGAATATT
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Oligo229 CTCAAATGCTTTAGGGTAATAGATACATAACGCCACTAACGGAT
Oligo230 GATACATTTCGCACGGTGTCCAGGATTAGAGAGTAGAAAGACCC
Oligo231 GAGGGTAGCTATTGAGAAAGATGACCCTGTAATACGGCAAAGTA
Oligo232 TGGGCGCATCGTATAACAACTTGTTAAAATTCGCAGGTTGATGA
Oligo233 CTCGAATTCGTAATTTGATACTGGCGAAAGGGGGAGCCATTCGA
Oligo234 ACGCCAGAATCCTGCCGATTTTTGATGGTGGTTCCTGGTTTGGG
Oligo235 CGAACTGATAGCCATTTTTGAAAACGCTCATGGAAAATATTAGT
Oligo236 CATTTTGCGGAACTATTAATGTTGGCAAATCAACAATATCAACG
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Oligo238 GAAAAAGCCTGTTTAAGAATTCCGGCTTAGGTTGGATAGGTCTT
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Oligo240 AATTGAGCGCTAATAACTGAACGAGCGTCTTTCCAAATTTTATT
Oligo241 GACGGAAATTATTCAACCGAATTAAGACTCCTTATTAACGGAGT
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Oligo243 CTCAGAACCGCCACACCGTATTAATGCCCCCTGCCCCTTGAGGG
Oligo244 GCTTGATACCGATAGCTTGCAGTAAATGAATTTTCCTAAAGTCC
Oligo245 GCCGGAACGAGGCCGAAATCGGAAGTTTCCATTAAGGCTTTGCA
Oligo246 ATTTAGGAATACCTTATTACCTGACGAGAAACACCGCTGCTCTA
Oligo247 CCAGACCGGAAGCATCGCGTCGGAATCGTCATAAATGTTTAGAG
Oligo248 AGCTAAATCGGTTAAAATTATCTGCGAACGAGTAGTTCATTCAA
Oligo249 AAATATTTAAATTAAAGCCCCAACCGTTCTAGCTGACAGTCAAA
Oligo250 GTGCGGGCCTCTTAGGCTGCACCGTAATGGGATAGATTCTCCGC
Oligo251 GAAACCTGTCGTGCGTTGCGTAGTACCCGTATAAGAAGTCCGCG

Short inner scaffolds

Oligo252 TTGTGGGTCTGTTCGCCTCAACTCTGCTGCGTCGGTGCGA
Oligo253 TGTGTAGGCTACAGACGCTTACTGTCCGGCCGGCAGCTCC
Oligo254 TGAGGAGTCCCTCGAAAGCCGAGCCAACGTCCTCGCACTC
Oligo255 AGGAAATATCCGGCACCGGGTGGCCCAATCCAGCGCAACA
Oligo256 CTCGATGTCGGGATGGTGACGCGCGGACACGCTTGAGAAG
Oligo257 CGCGACCAGGGTTGGGACGGGATACTTGCGGCTAACGAAC
Oligo258 TGTCATGAAACGAACTCCGCGTCACGACTGGGACCGCCGA
Oligo259 CGGCGTTTCCGGTTGCATGTGTTCACATCGCTGGACGGAC
Oligo260 GTCGCAGCGATCGCACCTGTGAAACCATGCCAAGATGGCG
Oligo261 TCCATGACAGGCGCTAGAAATAACCCGGGTCGCGCGAACG
Oligo262 GGGTTCCACCGTGCTCGAGGGCGCTTGTCTCTAGCTGCAA
Oligo263 CACGTCAAGCGCAACTGGATGCAGACACCCGCAGCCCTTT
Oligo264 CCCATGCCACCCATCACCGTCCGCCCTCTAACGAACCTCC
Oligo265 CGCCACACCCAGGAGTATGCTCGCCTTAGCCTACTGGCCG
Oligo266 TGGCCGCCTCATGGGAAGCCTAAGACGTACGTGACCCACG
Oligo267 TGTACTATGGAGTGTCCTTGGGTGCATGGTGGGCCGCCCG
Oligo268 GCAGTAAGGCAGCTGAACAGTGATACCGGTGCGGGCCTGG
Oligo269 GGCGGAGAATACACAGGCTCGCTCAGGCTTCGCGTGGGAT
Oligo270 CTGCCCATGTCGGCGGTCGCAAGAGACTCAGGTTCCACGA
Oligo271 ACGTTGGCATGAACGCCGACTGACGAGCTGCTGATTTGCG
Oligo272 ACACTTCGCTTAGCCGCCGCTTCTCAGCAGTCTTGCCTCC
Oligo273 TTCTCCGCATAAGCCGCCCACCTCTCCGGATCGCACCAGA
Oligo274 CATTGTCACCGCGCGTCAAGCAGCCACCAGAACTCGCACT
Oligo275 CAGCTCGAGGAGCGCGGATGCAGCCATTCGTACGTCCTGA
Oligo276 GGGAAAGTGTCGGTCGTTCGGCATGGCTGCGCTATCCTGG
Oligo277 AGCCATGGAGCTAATCCGCCAAGCCCGCCGCATACGAAGT
Oligo278 GGTGGGACACGGACGCGGTGGCTACTTTGTCGCCTTCAGA
Oligo279 CCGGGACTTGGTCGTAGGAATTCCTCGCCATCCCTGCCGG
Oligo280 GGTGGCGGGATAGGTCTTGTCGACACGCGCCTCATCACAC
Oligo281 TGCTGGCCTCGCTTTCTGGTATCGCTCGGTCGGTCCTGAG
Oligo282 CGCGGCCATCAGAAGCGCCATTGTTAAGTGTCCGCTCGAC
Oligo283 GGTGACCAGCGCTAACCAGGCCGGCCGTTATGGGATTTGG
Oligo284 GACCCGGTATGCAACAGACGTCGGACAGGAGTCCCACCCG
Oligo285 GCGGATTCGTGGCCTGCGTCATGCCAGGTATGTCCAGGGA
Oligo286 ACGCCACCGTTCAAGGCCGACCGTACCTAGTCCATAGCGG
Oligo287 GTCTCTGTGCTGGGCTTCATAACCTAGGCGCAGGCACCGC
Oligo288 GGGCCGGGCGAGCCAACTCGTAAAGCGCTCTATACTTGGC
Oligo289 TGCCCAATGCCCAGGCCTCCAGGCAACCGCAAAGCTCTTA
Oligo290 ATGTGGTGTCCGGATCTCGCGGGTCAGGCGTCCATGTAGC
Oligo291 CCCGAGCTCAGACAGTGCACCGCCCGATCCCTATTGGGTG
Oligo292 TGCGCACCGGACTAGCTCGGCCTGGTCCATCTCACTTAGC
Oligo293 AGTGGCCATGAAACGTACGCCGGATGGCTACCTCGCGGGA
Oligo294 TCCGACATAGCCCGCTGAGCTAACCCAGCACGTCCAGGTG
Oligo295 AGGCGTCTGACTAGCGGTGCCCTGACAATCGGTCCGAAGG
Oligo296 GGTCCCACGTGACGTCGGTAGTGCTCGTGGCTGCACATGT
Oligo297 GGGTATCCAGCCTCCGCGCCTGTGTTGGATCTGCTGTTGC
Oligo298 ACGTTTGTCCATACACCGACAGGCGCACATCGTGGAGGCG
Oligo299 TGTCTGCGCTCTCTTGCCTGTTAATCGCGTGTCGGCGGAC
Oligo300 ACGACACGACCCAGAACATACGGCGCACTCAGTCACGTGC
Oligo301 CCGGGCAACGCCTATGGCACCAAGACCTGACGGATGTTCG
Oligo302 TTTTGCCTGAACCGGGACGCCTCTCAGAGCGCGGCAAAGT
Oligo303 GTGTCCGAAAAACTGCTCGCCGGGCTAGCCACAGGAGACG
Oligo304 GTGGCAATAGCAATACGGGAGCCGCCGACACGGAAGGAGC
Oligo305 CCCAACTGCGGGACGTGCCGAGGTAACAAGGCAATCCGTC

Handles to hybridize with nanodisc-DNA conjugates

Oligo306 CCGAGCGGGTTGATGGCTCAAGGGCGCTTCAAGTCAAGGGTTTTTCTTCACACCACACTCCATCTA
Oligo307 GTTAACCGTATGTGCCCAGTGACGAGGCGGCCGTACTGCGTTTTTCTTCACACCACACTCCATCTA
Oligo308 GCTCAACCACTACCGCACGGAATCTGGGCACGGTGCTACGTTTTTCTTCACACCACACTCCATCTA
Oligo309 ACAGACTCGGCTTCTGTGCTCCATGTGCGCTGACACGCGTTTTTTCTTCACACCACACTCCATCTA
Oligo310 CGGCGGGTTGATTGGCAGCAAATACCGGCACTGGCACATGTTTTTCTTCACACCACACTCCATCTA
Oligo311 AGGCGAGCGCTGCGAACTGAGCCCATCCAGAGAGCTAGGATTTTTCTTCACACCACACTCCATCTA
Oligo312 CTCCGGCACTGCGCGGCGTTGTGTCTGCTGTCTCTTTTGATTTTTCTTCACACCACACTCCATCTA
Oligo313 GGACTACCTAGGTGACCTGTCCCGCCGCGACGAAGGCTTGTTTTTCTTCACACCACACTCCATCTA
Oligo314 TGTCGCTGCACAGTACGAGCTTCCAATCGCCGGGACAACCTTTTTCTTCACACCACACTCCATCTA
Oligo315 GCCCGGCACGTGAGCGCCCATTTTTCAGGACCCTACACCTTTTTTCTTCACACCACACTCCATCTA
Oligo316 TCGATCCTGAGCGAACTCACCTCCTCGGGCATGGTCGACGTTTTTCTTCACACCACACTCCATCTA
Oligo317 CTGCCGTTCACGAGGTACGCGCCGGAAGACCTGGACATTGTTTTTCTTCACACCACACTCCATCTA

Oligo318 TGGCCCGATGCTGGAGAGGATTGACGCGATGCAATACGCCTTTTTTCTTCACACCACACTCCATCTA
Oligo319 GTCCTCCGTACCGGGCTGGCGGGTTGGAGCTGACGTCTATTTTTTTCTTCACACCACACTCCATCTA
Oligo320 CGAGCAACCTACGCATCCAAACCCTAGTGTGGCCGGCCCATTTTTTCTTCACACCACACTCCATCTA
Oligo321 ACGACGTTTGTGCGCCTCGTGCCTCCTCCAGACAAAGTGCTTTTTTCTTCACACCACACTCCATCTA
Oligo322 GTCTTCTGAGGGCGCGCGGCTACCGGTACTAGACGGAGGATTTTTTCTTCACACCACACTCCATCTA
Oligo323 CTGCTGGTCGTCGCATCGTAGTTCGCCTCCTGGTGGGCAATTTTTTCTTCACACCACACTCCATCTA
Oligo324 GCCTACCACCTCCCGTCGACCCATCTCGCCCGTAGCTCAATTTTTTCTTCACACCACACTCCATCTA
Oligo325 GAGAACAAGGAAACGCCGACTGCCGAGAGCCTGGCCCAACTTTTTTCTTCACACCACACTCCATCTA
Oligo326 CCGTGCCCACCCACCCAGCGCTGATGAACCTTATGCAGACTTTTTTCTTCACACCACACTCCATCTA
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Oligo331 GTCGGCCACGGCAGACTCCCGCTGGATCAGGTAGACAAGGTTTTTTCTTCACACCACACTCCATCTA
Oligo332 GGCACGCTCCCAGGCCGCAGACGACTTCGAACGTTTGAAGTTTTTTCTTCACACCACACTCCATCTA
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Oligo334 CACTGGGAGGTCGGTTGGTAGCGTGCTCGCGTGCCACTTATTTTTTCTTCACACCACACTCCATCTA
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60 nm DNA-origami-barrel

Core staples

Oligo0 ACGTGGACGGGACTGCGCGAGGGTAGGACCAGCTGCAAAAGA
Oligo1 GTGGCACAGTGGGCACACTCGAGAACTCCCGTTGTAATAC
Oligo2 GAGCACTAACGGGCCCGAATTGAGGGCAAGACAATATTTTAG
Oligo3 CATATCACTGAGGATATGAGACGATGACAACTAATCCTAC
Oligo4 ATGTGAGTCCAGTCGCCCCCCGCAGTTGAAATTATTTAATAT
Oligo5 TGGTTTGATCTGGGTAGCAGCGGTAGGAATAACCTTTTAA
Oligo6 AGAACGCGTTGCCCACGAGTGCGGTGATAAATACCGAAATGC
Oligo7 GGGAGGTATCCCGGACCACATATATCCCTGTTTATCTTGC
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Oligo16 AACAACATGCTCTAGTCGGACGTCGACTATGAACGGTAACGG
Oligo17 AGTTCAGCGCAACGGGACGCACAGCATATTACAGGTAAAC
Oligo18 AAAGTACGCGAGGGTAGGGCCTAACTCAAAAACGAGACAACT
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Oligo20 TGTCAATCGCGGTGGCCGTACTGGCCCATACTTTTGCTAGCA
Oligo21 TTGGTGTTAATCTGTGGATAATCCGAATATGTACCTCACG
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Oligo23 TGTCGTGGGCCAAGACGTAGCGCATGATGCCTGCAAAACC
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Oligo36 AATAGGTGGAGGCCGGTCACCCTAGCTGAACATGGCTCCCGG

Oligo37	CAGTTTCTGGCAAGGGCTGAGGGCAGTAACCCTCATTCAA
Oligo38	AACGAGGGGAACTCGCTGTGCGGGTCTGAGAATTTTTATCGG
Oligo39	AAGGGAACACGTTGCGCATGAAGCCATAGAAGTTTATCAT
Oligo40	AAAATCTAGGTGACCGTTGGCGTACCGTCCCAGGCGCGAAGA
Oligo41	TCATTGAAGGTTGGCCGCTGACTTCTCGATTCATCAATAT
Oligo42	TGTAGCTCATTCGCCGTGGACGCCTTTGATAAATCAAAATGC
Oligo43	TAAATCGCCTATGCGCGTAGACGCAGAATTCCATAAAAGC
Oligo44	AATCGATGCGCAGCCCGCCAGCACACTCGTCCTTTATAAGAG
Oligo45	GCGGATTGCTTCCTGAGATTCTTACTAAATAATCAAAACG
Oligo46	TCACGACGCGGCCAAGGATTTACTGCTCGACCGTGCACCCAG
Oligo47	CTCACTGTGCTCTGCTCCGCTGCGGTTTTCTAGACTTGCG
Oligo48	AATAGCCCAAACGACGAGGGGCACGAAAAAGGAGAGGAAAAG
Oligo49	AAAGGGAGGCAGCACTGCAAGAACGGGAAATAACATAATA
Oligo50	GGTCAGTTATCAGGGAGTCACCGCCTCTCAATGCGCGTATCT
Oligo51	CAATATAGCCCGCCTGAAAGACGCCTGGAATACATTTCAT
Oligo52	TACATTTACTGGCGTCCCCCTGAGTCCCATATTGCGTTTAAT
Oligo53	CGCGAGATATCACTCGTGAGCCCAGTACTTAATTAAAGAA
Oligo54	GACAAAAGCTAAGCCGAAGCGGAAAGCCAAATAAGAAGTACC
Oligo55	AGAAGGCGGCACCACACGAGAAGGACGTCAAGAAAGATAT
Oligo56	ATTAGACGCGTGGCTCGCAAGGGCAGCGTTTTGCACCAGCGC
Oligo57	AATACATTGCTGTTGGTTACACGCCGGGTAATAAGTAGAA
Oligo58	CAGCACCGTGCTGCCGCAAGCGAGAAAAACCAGCGCCGATAG
Oligo59	GATATTCCAAGATGGTAGGTCCTTGATATTTGCCAGCCTT
Oligo60	GTCGAGAGCAACTGGAGTGGCGACCGGTACTACAGGAGTGCC
Oligo61	TGTATGGGTGCGCGAGACCGTTCTAGGGCACCCTCTTTTC
Oligo62	GTCACCCTTCAAAGCACGCCCACCGTGTGAAAAATCTGGATC
Oligo63	GCCGGAACCACGCAGTGTCAGTCGGACAACGGGTAACTTA
Oligo64	CTCATTATCAACGGGCACAGCCCATCGGCGGCTGACCACTGG
Oligo65	GTCCAATCGCAAGGTTCTCCGACTCAACATTTAGGATAGC
Oligo66	GGCTTAGACGTCCCTGCGCAATAGGCCGACTCTTTACCGGAT
Oligo67	TTAAGCAGAGTGCTGTGTTTCGACGGGCTGATTCCCAAAA
Oligo68	CATTGCCTGAGAGTCGTGGTACGATGTGATAAGGATACAGGT
Oligo69	ACCCGTCAGATAGGCTGGCTCCGTGTGACCCAAAATAACA
Oligo70	TTAAGTTGCAAGGCTGTTCCGCAACGGGGGTTTGAGGGGCGA
Oligo71	GTGAGCTGGACTGTGAGCGACCGGTCGGAGCGAGGAATGA
Oligo72	AAATCGGCCAGCATTCCCTAGCCTCCCGTAGTATTGGTTCCG
Oligo73	CAGATTCGGGAACACCACCACTGATGAACCTGAGTATTGG
Oligo74	CCTCAAATGGACTTGCAAGGCGGCGAAAACGCCCTAACTGAA
Oligo75	TTCCTGAGGCTTCTTGCGGCATGATGATTTTAGAATCATA
Oligo76	TGAAACAAGGTCCCGACAGCTTCGCGTATTAGGTTTAGATGA
Oligo77	TGATGCAAAGCACGGAGCATTGCCGTACCTTAGAAAATGC
Oligo78	CGAGCCAGTGCCGCGACTCGAAGGTAACAAGGAATCAATTTT
Oligo79	CCGCGCCCGGGAGCAGACGTGTGGTGTATCCCATCCATTA
Oligo80	AGAGAGAAGAACGAACGAGCGGGATTCACAATTTTATTTTAC
Oligo81	TATTACGACATTCCCATTAGCCGGGATAAACAATGCTCCT
Oligo82	CGGAAACGCGACGATTTGCAGCGCTTCTCAAAGGGCGAAGGC
Oligo83	AGGTTGAACGAGCAGACCGGCACGGGTCATAATCAACAGG
Oligo84	GTTTTGCTGTGCGTCGAGGCGACTAACTGGGTAATAAGCGGG
Oligo85	TCTTTCCTAGTTGGGCCGGTCCCGTCCACCACCCTTGTCG
Oligo86	CAGGGAGTCGGGATGCCTTCTGCTTCTCAGAAGGCTCGCTTG
Oligo87	GAAATCCGGTGCGAACTGTGGCCGACTATAATGCCGTGTC
Oligo88	TGAATTACGGGAGTCTGCCGAGAATGGCGCGAGTAATCATTG
Oligo89	GTAATAGCGTGCTTTTCCATGTCGGTCTCATTCAAAGGGG
Oligo75	TCCTTTTGCTACCTGGGCCACTGCACGCTATTATAGTATTGC
Oligo91	CATACAGACGCATTACCTGGAACGACATGCGAACGTAAAT
Oligo92	TTTTTGAGCTCACACCGCAGTAGCCCGAGCTAGAACCAGCTA
Oligo93	TCATCAACCTACGTAGACCGCACGATAGGATTGTAAGCTT
Oligo94	CTGGCGAAGTAGTGCCGCGACGCTGATGCAACAGTATGCCAG
Oligo95	TAAAGTGCGTCCCTTCGGACCCACGTAGGCTAGCGAAGCA
Oligo96	AGGCGAAAACGGTGGTCACCGGTGCGTGCAGTGGTTTCCAGC
Oligo97	AATCGTCCCGACTGCCGGATGGTTCGATCTCAAACCGCTC
Oligo98	ATGAAAAACTTTCCTTCTAGCTTATGGCTGCATTAAAAGCAA
Oligo99	CCACCAGCCTAGGGCGCCCGGTGAGATCACTTTACAGAAA
Oligo100	CATTTCAAGCATTGAGGCCCTCGGAAGGAATGAATATTTATT
Oligo101	GGTTGGGGCATGGACCCAGGTGAAGATTAAACATAGCTTA
Oligo102	GCCAACATGTCAGCTGCTCTCCGTCCGGTTAGAAAAAACAAC
Oligo103	CGTTTTTCGAGGCACACGTCTAGGTTGTACGAGCACAAGC
Oligo104	AACGTCAACGCTCTGTTCGCGCACTACCATTTACCAATGTTT

Oligo105 CCAAAAGCCGCGTTCGGCGAAACGGGAAAATAGCTAATAC
Oligo106 CACCAGTAGGCCGGAAGTTGTTTATCCAAACCGATTGAAAAT
Oligo107 CCACCAGTACAGGCATGAGTGCGGCGGCCGGAACCAACCA
Oligo108 CTCCTCAAGACGTAAATGACTAAACCCGAGGGGGTCATGAGA
Oligo109 AGTTAGCATGGATACCGGCGGCTGGCGAAGGGATACTCAT
Oligo110 ATAACCGATGCCGCTGCTGTGCTCGCAGGTGCCTTTACACGC
Oligo111 ATTTGTACCTGGCCCAAAACTGGAGATAAGGCACCCGGAG
Oligo112 GAGATGGTTCGCATATGCGGATCCCAACTCGAACCGGGGCTT
Oligo113 CTTTTGCTTCGCGCGTTGGAGTCGATTTAGATACAAGAGG
Oligo114 AGGTCAGGGGCTAGTGCCAGCCCGTCCTAAAAGCGGACCAAC
Oligo115 AATAGTAGCCTACAGTTTGTGGCCGAATTTAGTTTCTACT
Oligo116 CTGATAAAGCGCGAGCAGTCGATAGCGCGTTTTTAAATCTAG
Oligo117 TTCGCGTACTCGAGGCTAGGTTCAACTTATATTTAAATAA
Oligo118 TCGGTGCGGCGGAATTGACGTCAATGCCCTGGAAGATGGCGA
Oligo119 AATTCCAGTTGTTGTTCTCTCTCCGCGGACGCATGCTCAC
Oligo120 AGCAAGCGCTTCACGTTAAGCACTGCGCTGACCAGTGGTTGC
Oligo121 CTCATGGACCCTGTAGGCCTCCCTCGGTCTTGCTGAAACG
Oligo122 CAACAGTGCGGACCCGGCTGTGGAGCTAAAACGAACCGCCTG
Oligo123 TAACATTGGAGGCCTCTGCATCTGCACCTCGACAATTGAG
Oligo124 AGTTACAAAGACCGCGTAGGACCGCTGAATAGTACCTTACCA
Oligo125 GAGAGACGATGAGTACGCATCGTCCAAACTTAGATGGTCT
Oligo126 GCTTAATTGTAGGCCGGCACTGGCACGGTAAGTATCAGTAGG
Oligo127 AGTACCGTGTCGCAGGCCACAGGTGAGAACCAATCAACCA
Oligo128 CCAATCCACAAACCGTTCCAGCCCACATCAAGCGTCTTTATC
Oligo129 ACCGAGGACATCGGGTGGTGCCCTAGAACGAAGCCAGGAA
Oligo130 GAGCCATTAGGGCGACGCACGTCATAACAAAAGGTAAGACTT
Oligo131 CACCACCTCTGTATGCTAGGTGCTCGTGCCACCGGAGAGC
Oligo132 CTGAAACAGCGGCCCTGCCAAGCTGCCCCTAGTAACATTATT
Oligo133 GCCTGTAATCGGGCGTCCCTAACTTCTGCAATAGGACAAC
Oligo134 GCCGACAACGGCATGGCGAACAAGGACAGCGGTTTATGTTGC
Oligo135 TACCAAGTCTCGCCACCCTCACCTTGTGAACGAAAGATTA
Oligo136 AAACACCACACCTTCTGCACTGTCGTCACGTACCCAAACGAG
Oligo137 ACGACGAGCTTCACAGACCCTACCGCGAAAAAGGAACCAG
Oligo138 AAGCGAACAACACCTCCGTACTCCACCCTAAAAAGATCTTCA
Oligo139 CGAGCTGTTGCGCAAAAGGCGCGAAGCAAGATACAGGGCG
Oligo140 CACCATCATGTTGAGTCCGCTGCCATGAAACTGAGTACAAAT
Oligo141 TTAACCACTCCGAGGTCGCCGGAGGGATAACGTTAATTTT
Oligo142 TTCAGGCTCACGCAACACTCCCGTCTAGATAGCCAGCCGCCA
Oligo143 TTTCCTGACTCGAACCGCACCCTGCAGCCCCGTATAGCTG
Oligo144 CCCTTCACTGTGCACCGCCCGGATGGTGTTAACAGCTGATTG
Oligo145 TACCGCCAAGACAACAGCGCCAGGCTCGCCAGAACAATAT
Oligo146 AGGTGAGGGTATAGCGCCATCGGGCATAAGAAGATAAAACAG
Oligo147 CCGAACGGGACCCAGCCGAGAGCCGACGTAAATCCTTTGC
Oligo148 AACGGATTAACTGCGTGAGTGAAGGAACTTGGGAGAAACAAT
Oligo149 AATAGTGACAGGTGTAGGATCGGGCGCGCTGAGAAGAGTC
Oligo150 ACCAGTATGGCATCAACTGTGGTGACGGAAATACAAATTCTT
Oligo151 TTATCATAGACCTCTGCTTGTGCCACAAGGCTGTCTTTCC
Oligo152 GTTACAAAGCGCCAGCGACTGGGCGTCCTCCCTAATTTGCCA
Oligo153 AGATAGCTCTGCTCAACACTCACCGCATAGAAAAGTAAGC
Oligo154 TTAAAGGTAGTCCGCCCTACAGAAGTTCCGGGAAATTATTCA
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Oligo156 TGCCCCCTAGCAGCCCGTCCGTGATGAGTCATAAACAGTTAA
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Oligo158 TTTCTTAAATCCGGGCATTTGGGAAGCCCGTTTCGAGGTGAA
Oligo159 AAACACTGGCCGGCGTCTTAGTTACGACAAGAATACACTA
Oligo160 CATTCAGTCCGGGCCGCGCATACGGACCCAAACAAAGCTGCT
Oligo161 GCAACACTGACTGGGCAGTGGTTGCTGAGGCATAGTAAGA
Oligo162 TTCAAATATCGTCGCGCGTGTAGCATATTAAGCCCGAAAGAC
Oligo163 CCTGTTTGTTCGTTCGATGATTGTCGTCAATGGTCAATAA
Oligo164 AAGGGTGAACCCTGTCGGGCCACATGGTAGGTAAAGATTCAA
Oligo165 ATTAAATCTTACGTGGGCGTCGAGAAGAGTTAAAATTCGC
Oligo166 GCCGGAAACTTGTTGTGTCACCTCGGAGTTACCGCTTCTGGT
Oligo167 GCTCGAAGCCCGAAGAGGACGTGTGCCCCCCGGGTACCGA
Oligo168 AGAGTCCACTATTTTAATGAACGCTTTCCAGTCGGGGGTCGACGT
Oligo169 TATCTAAAATATCTTTTGAATACCTGAAAGCGTAAGAGCAATACA
Oligo170 CAGTACATAAATCGCACGTAAATGGAAGGGTTAGAAAGATTAGGT
Oligo171 AACATGTTCAGCTCCGTGTGAATCTTCTGACCTAAATGCTTCTAA
Oligo172 GGGTAATTGAGCGTTAAATCATAGCGAACCTCCCGACAACAATAC

Oligo173 CGTCAGACTGTAGAATAGAAAAAAGACACCACGGAACAAGAATGA
Oligo174 ACCGTACTCAGGAGCGTCATATGGAAAGCGCAGTCTGTCATAGAG
Oligo175 AACGGCTACAGAGCGAATAATCGGAGTGAGAATAGAAACCGCCTC
Oligo176 AATAAAACGAACTGTACAGACGAACTGACCAACTTTTCATGAGGC
Oligo177 TGTTTTAAATATGATGACCATCCCCCTCAAATGCTTTAGAAAGTT
Oligo178 GTAATCGTAAAACGGGAGAAGTGTACCAAAAACATTAGTTTCACA
Oligo179 AAAACGACGGCCACATCGTAACCGTAATGGGATAGGCCGGTTGCG
Oligo180 TCCCTTATAAATCCGGTTTGCAAGCCTGGGGTGCCTCAAGTCCGG
Oligo181 AACCCTCAATCAAAACTGATACAGTCACACGACCAGTCACTTGAA
Oligo182 CAAGAAAACAAAAAGATTTTCATCAGATGATGGCAATTGAGGACA
Oligo183 AAGAGAATATAAATAAACACCTCCAATCGCAAGACAATTTTCCAT
Oligo184 ATAAAAACAGGGACAGCTACAATAGCAAGCAAATCAAATAATAAT
Oligo185 CAATGAAACCATCAAAGACAAGTATGTTAGCAAACGAGCAAGAAC
Oligo186 ACCAGGCGGATAAGTGTACTGCAGGTCAGACGATTGTCTTTTCAC
Oligo187 GGCCGCTTTTGCGCCAAAAAAACGTTAGTAAATGAAAGAGCCAGT
Oligo188 TGCGATTTTAAGATTCATCAAGACCTGCTCCATGTTAAATACGAA
Oligo189 GAGGTCATTTTTGCCTGACTAAAATGTTTAGACTGGAATACCATA
Oligo175 CTACAAAGGCTATAAAATTTTAAGGCAAAGAATTAGCAATTCTAA
Oligo191 GGATGTGCTGCAAGGACGACGTTAAATGTGAGCGAGACAGGAAAT
Oligo192 ACGCTGGTTTGCCTTCTTTTCTGAAATTGTTATCCGGCTAGTAGC
Oligo193 GCTGAGAGCCAGCAATACCGAATACCTACATTTTGATATCGGCCC
Oligo194 GCGCAGAGGCGAAACAGTAACCATTTTGCGGAACAAAAACAATAC
Oligo195 ATCGCCATATTTAGCCTGTTTCCTTTTTAACCTCCGGCGATAGTC
Oligo196 AGAAACGATTTTTCGCTAACGCTCATCGAGAACAAGTGTAGAAGA
Oligo197 AATTAGAGCCAGCAGGGAGGGACGCAATAATAACGGATCTTACTA
Oligo198 AGTATTAAGAGGCGTGCCTTGCAGAGCCGCCACCAGAGAGCCAGG
Oligo199 AACAACCATCGCCATTGTATCATTCCACAGACAGCCGCAAGCCAA
Oligo200 GAGTAGTAAATTGATATTCATCGAAACAAAGTACAAAACCTAAAC
Oligo201 CCGGAAGCAAACTTTGCATCAAAAACCAAAATAGCGTAACGCCAC
Oligo202 GATATTCAACCGTTGCAATGCAAGGTGGCATCAATTGACCATTGA
Oligo203 AACTGTTGGGAAGCGCACTCCAGGAACGCCATCAAAAATTGTAAT
Oligo204 CTGGCCAACAGAGGATTAGTGATAGGGTTGAGTGTACGCGCGGCT
Oligo205 TGATTGTTTGGATAATAGATCAAATCAACAGTTGAAGTCTTTATT
Oligo206 TTTTTCAAATATAGTCGCTAAATTTCATTTGAATTATAAAGAACC
Oligo207 CCGGTATTCTAAGTCCTGAAAAAGTAATTCTGTCCGGCGTTAAAC
Oligo208 AAAGGTGGCAACAAGCCCAAAGAATTAACTGAACATTGCTATTAT
Oligo209 ACAAATAAATCCTATTAGCGATCAGTAGCGACAGATGGTTTACAT
Oligo210 TTGCTAAACAACTGAACCGCTTGATATAAGTATAGTTTGATGAAA
Oligo211 GCGCAGACGGTCACCATTAAGCAGCGAAAGACAGCTCACGTTGTT
Oligo212 CGGAATCGTCATAAGTTGAGCAGTCAGGACGTTGGATAGGCTGAG
Oligo213 AGCCTCAGAGCATTAACAGTTTAATTGCTGAATATAAATCAGGTG
Oligo214 TCTCCGTGGGAACGAAAAGCGAGTCTGGAGCAAACTTCAACGCAA
Oligo215 CACATTAATTGCGCTTTGATTAACGCCAGGGTTTTCTGCCAGAT
Oligo216 ATGGATTATTTACAGAAGAACCTGTTTGATGGTGGGCGCCAGGCA
Oligo217 AGCGGAATTATCAGTATTAGTAAAGCATCACCTTGAACATCGCAA
Oligo218 ATAACTATATGTATCCTTGAACCTGAGCAAAAGAAACGTCAGAGG
Oligo219 TCATCGTAGGAATCTAATTTAATTTAGGCAGAGGCTAATTACTAT
Oligo220 GGCATGATTAAGAAAATAGCATGAAAATAGCAGCCCCTGAATCTT
Oligo221 GCCGCCAGCATTGAAATCACACCATTACCATTAGCACATTCAACT
Oligo222 CGATCTAAAGTTTCATTTTCGAAGGATTAGGATTAGTTTTAACCC
Oligo223 CGCCTGATAAATTACTACGATATTCGGTCGCTGAGCAAAAGGAAA
Oligo224 GAAGTTTTGCCAGCTAATGCAATTTCAACTTTAATCTTGACAAAT
Oligo225 CATTAACATCCAAAGTAGATTAGAGAGTACCTTTACAGAAGCAAA
Oligo226 CCTTCCTGTAGCCTAAGCAAAATGCCGGAGAGGGTCTCATATAAG
Oligo227 ACATACGAGCCGGACCGTATCCTCTTCGCTATTACCGGCCTCAGG
Oligo228 ATTGCAACAGGAAGTAATATCCTGGCCCTGAGAGAAGACGGGCCG
Oligo229 TAATTTTAAAAGTCTCGTATGTCAGTATTAACACCACCAGCAGCC
Oligo230 TATCAAAATCATATAAGACGCCTGATTGCTTTGAATTTACATCAT
Oligo231 AGAACGGGTATTAAATAATCAGCCAACGCTCAACATATGCGTTTT
Oligo232 CAAAGTTACCAGACTTTTTAAAACAGCCATATTATTTCCAGAGCA
Oligo233 AACCGCCACCCTCAACCGCCATTATCACCGTCACCATATTGACAA
Oligo234 ACCAGTACAAACTAACCCATCTATTTCGGAACCTAGTGCCCGTAG
Oligo235 TTTGACCCCCAGCGAGGCAAAGCTTGATACCGATACAGCTTGCTC
Oligo236 ATAACCCTCGTTTATTACGAATAAGGCTTGCCCTGATCAACGTTC
Oligo237 ATATTTTCATTTGTTTCGCAGCGTTTTAATTCGAGTAAGAGGATC
Oligo238 GTTAAATCAGCTCATATTTTAAGGCCGGAGACAGTATGTGTAGCT
Oligo239 TAATCATGGTCATAAGGATCAGGCAAAGCGCCATTTTTCCGGCTT

Short inner scaffolds
Oligo240 ACTCCCTGATAGGCGTCTTTCAGGCGGGCGGACTCAGG
Oligo241 GGGACGCCAGACTGGGCTCACGAGTGATAGGCTTTCCGC
Oligo242 TTCGGCTTAGGTCCTTCTCGTGTGGTGCCCGCTGCCCTT
Oligo243 GCGAGCCACGCGGCGTGTAACCAACAGCATTTTCTCGCT
Oligo244 TGCGGCAGCATCAAGGACCTACCATCTTGACCGGTCGCC
Oligo245 ACTCCAGTTGCTAGAACGGTCTCGCGCACACACGGTGGG
Oligo246 CGTGCTTTGATCCGACTGACACTGCGTGGCCGATGGGCT
Oligo247 GTGCCCGTTGTGAGTCGGAGAACCTTGCGCGGCCTATTG
Oligo248 CGCAGGGACGCCGTCGAAACACAGCACTCCACATCGTAC
Oligo249 CACGACTCTCACACGGAGCCAGCCTATCTCCCGTTGCGG
Oligo250 AACAGCCTTGGACCGGTCGCTCACAGTCCTTTCGTGCCC
Oligo251 CTCGTCGTTTCCGTTCTTGCAGTGCTGCCAGAGGCGGTG
Oligo252 AGAAGGAAAGTCTCACCGGGCGCCCTAGGCCTTCCGAGG
Oligo253 GCCTCAATGCTCTTCACCTGGGTCCATGCCCGGACGGAG
Oligo254 AGCAGCTGACAACCTAGACGTGTGCCTCGGGTAGTGCGC
Oligo255 GAACAGAGCGCCCGTTTCGCCGAACGCGGTGGATAAACA
Oligo256 ACTTCCGGCCCGCCGCACTCATGCCTGTACGGGTTTAGT
Oligo257 CATTTACGTCGCCAGCCGCCGGTATCCATCTGCGAGCAC
Oligo258 AGCAGCGGCATCTCCAGTTTTGGGCCAGGGTTGGGATCC
Oligo259 GCATATGCGAATCGACTCCAACGCGCGAAAGGACGGGCT
Oligo260 GGCACTAGCCTCGGCCACAAACTGTAGGCGCGCTATCGA
Oligo261 CTGCTCGCGCGTTGAACCTAGCCTCGAGTGGCATTGACG
Oligo262 TCAATTCCGCGCGGAGAGAGAACAACAACCACGCACCGG
Oligo263 TGACCACCGTCGAACCATCCGGCAGTCGGGCCATAAGCT
Oligo264 GGCGCTATACTCGGCTCTCGGCTGGGTCCGTTCCTTCAC
Oligo265 TCACGCAGTTCGCCCGATCCTACACCTGTCCGTCACCAC
Oligo266 AGTTGATGCCGTGGCACAAGCAGAGGTCTGGACGCCCAG
Oligo267 TCGCTGGCGCGCGGTGAGTGTTGAGCAGAGAACTTCTGT
Oligo268 AGGGCGGACTGTTTGCTCTTTCGACCGGGCTCATCACGG
Oligo269 ACGGGCTGCTATGCACTCGACTCTGGCCTGGCTTCCCAA
Oligo270 ATGCCCGGATCGTAACTAAGACGCCGGCCGGTCCGTATG
Oligo271 CGCGGCCCGGAGCAACCACTGCCCAGTCAATATGCTACA
Oligo272 CGCGCGACGACGACAATCATCGAACGAACACCATGTGGC
Oligo273 CCGACAGGGTTTCTCGACGCCCACGTAAGCTCCGAGGTG
Oligo274 ACACAACAAGGCACACGTCCTCTTCGGGCCACCATCCGG
Oligo275 GCGGTGCACAAGCCTGGCGCTGTTGTCTTTATGCCCGAT
Oligo276 TGGTGTTCCCTTTCGCCGCCTTGCAAGTCCCATCATGCC
Oligo277 GCAAGAAGCCTACGCGAAGCTGTCGGGACCACGGCAATG
Oligo278 CTCCGTGCTTGTTACCTTCGAGTCGCGGCACACCACACG
Oligo279 TCTGCTCCCGTGAATCCCGCTCGTTCGTTCTCCCGGCTA
Oligo280 ATGGGAATGTAGAAGCGCTGCAAATCGTCGCCCGTGCCG
Oligo281 GTCTGCTCGTAGTTAGTCGCCTCGACGCACGACGGGACC
Oligo282 GGCCCAACTAGAGAAGCAGAAGGCATCCCGGTCGGCCAC
Oligo283 AGTTCGCACCGCCATTCTCGGCAGACTCCCACCGACATG
Oligo284 GAAAAGCACGGCGTGCAGTGGCCCAGGTAGGTCGTTCCA
Oligo285 GGTAATGCGTTCGGGCTACTGCGGTGTGAGATCGTGCGG
Oligo286 TCTACGTAGGCATCAGCGTCGCGGCACTACACGTGGGTC
Oligo287 CGAAGGGACGCGGGAGGCTAGGGAATGCTGCATCAGTGG
Oligo288 CCTACAGGGTTAGCTCCACAGCCGGGTCCGTGCAGATGC
Oligo289 AGAGGCCTCCTCAGCGGTCCTACGCGGTCTTGGACGATG
Oligo290 CGTACTCATCCCGTGCCAGTGCCGGCCTACTCACCTGTG
Oligo291 GCCTGCGACAATGTGGGCTGGAACGGTTTGCTAGGGCAC
Oligo292 CACCCGATGTGTTATGACGTGCGTCGCCCTCGAGCACCT
Oligo293 AGCATACAGAGGGCAGCTTGGCAGGGCCGCGAAGTTAGG
Oligo294 GACGCCCGATTGTCCTTGTTCGCCATGCCGCAAGGTGAG
Oligo295 GGTGGCGAGATGACGACAGTGCAGAAGGTGGCGGTAGGG
Oligo296 TCTGTGAAGCGGGTGGAGTACGGAGGTGTTCTTCGCGCC
Oligo297 TTTTGCGCAATCATGGCAGCGGACTCAACACCCTCCGGC
Oligo298 GACCTCGGAGCTAGACGGGAGTGTTGCGTGTGCAGGGTG
Oligo299 CGGTTCGAGTGCGCAGTGCTTAACGTGAAGCGAGGGAGG

Handles to hybridize with nanodisc-DNA conjugates
Oligo300 TCGGGCCCGTCATCGTCTCATATCCTCAGCAACTGCGGGTTTTTTCTTCACACCACACTCCATCTA
Oligo301 GGGCGACTGGCTACCGCTGCTACCCAGATATCACCGCACTTTTTTCTTCACACCACACTCCATCTA
Oligo302 TCGTGGGCAAGATATATGTGGTCCGGGATGGGCGGTGCGTTTTTTCTTCACACCACACTCCATCTA
Oligo303 CGGCCCACAGGGTCAATAGCCGTCGCCTCACCCGACTTATTTTTTCTTCACACCACACTCCATCTA

Oligo304	GAACCGCTAGCCTCGGCCGCGCATTTACACCTTGGTCCATTTTTTCTTCACACCACACTCCATCTA
Oligo305	CGGTCCAGCACCATGGTCCCGTACCCTCACTCGCCATTGTTTTTTCTTCACACCACACTCCATCTA
Oligo306	GCACAACTCCTGAACAAGGCGCCCAGTGCAGTCGACGTCTTTTTTCTTCACACCACACTCCATCTA
Oligo307	CGACTAGAGCTGCTGTGCGTCCCGTTGCGTGAGTTAGGCTTTTTTCTTCACACCACACTCCATCTA
Oligo308	CCTACCCTCGGTGCCGAGTCCCTAGACGCTGGGCCAGTATTTTTTCTTCACACCACACTCCATCTA
Oligo309	CGGCCACCGCTCGGATTATCCACAGATTATGGCGCGAGGTTTTTTCTTCACACCACACTCCATCTA
Oligo310	CCTTGAGCCGCATGCGCTACGTCTTGGCCTCCTACCCTCTTTTTTCTTCACACCACACTCCATCTA
Oligo311	GCGCAGTCCCGTTCTCGAGTGTGCCCACTTGCCCTCAATTTTTTTCTTCACACCACACTCCATCTA
Oligo312	CCTCAACCTCGCTCGAACGTACGCAGCCGCAACACTGGATTTTTTCTTCACACCACACTCCATCTA
Oligo313	GAAGCGGCATAGCTCCGTCCTCGGGTAGTAAAGCGCGCATTTTTTCTTCACACCACACTCCATCTA
Oligo314	GGGAACAGCGCATAATTCGCCGTGTGTGTGGCCATCGCATTTTTTCTTCACACCACACTCCATCTA
Oligo315	CGACGCCACAACGAACGGCCTCCTCGAAACCTTGTGAGGTTTTTTCTTCACACCACACTCCATCTA
Oligo316	GGGATGTAACACCACGTGGCGCACGCACTGTGTAGGAGCTTTTTTCTTCACACCACACTCCATCTA
Oligo317	CTGGGAGGTACAGCTAGGGTGACCGGCCTCCTGCCCTCATTTTTTCTTCACACCACACTCCATCTA
Oligo318	GCCCTTGCCACAGACCCGCACAGCGAGTTCTGGCTTCATTTTTTTCTTCACACCACACTCCATCTA
Oligo319	GCGCAACGTGACGGTACGCCAACGGTCACCAGAAGTCAGTTTTTTCTTCACACCACACTCCATCTA
Oligo320	CGGCCAACCTCAAAGGCGTCCACGGCGAATCTGCGTCTATTTTTTCTTCACACCACACTCCATCTA
Oligo321	CGCGCATAGGGAGTGTGCTGGCGGGCTGCGAGTAAGAATTTTTTTCTTCACACCACACTCCATCTA
Oligo322	CTCAGGAAGCGAGCAGTAAATCCTTGGCCGACCGCAGCGTTTTTTCTTCACACCACACTCCATCTA
Oligo323	GAGCAGAGCAGCTTATCCCTGGGTCTCCGGCATCTGCGCTTTTTTCTTCACACCACACTCCATCTA

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