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(54) **CUSTOMIZAREA SECVENȚELOR DE ACID
DEZOXIRIBONUCLEIC PENTRU CONSTRUIREA UNEI
STRUCTURI ADN ORIGAMI COMPLEXE DE TIP PIN**

(57) Rezumat:

Invenția se referă la o metodă de obținere a unei structuri de acid dezoxiribonucleic (ADN) origami sub formă de pin utilizată ca model de studiu al capacității de autoasamblare a secvențelor de ADN aplicabil la nivel educațional. Metoda, conform invenției, constă în combinarea de secvențe sintetice scurte de ADN monocatenar (secvențe capsă) care determină pliarea unei secvențe lungi de ADN monocatenar provenind de la

bacteriofagul M13mp18 (secvență scaffold) din care rezultă o structură ADN origami în formă predefinită de pin, având rigiditate mai mare față de abordarea clasică.

Revendicări: 1
Figuri: 3



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DESCRIEREA INVENȚIEI

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a). Customizarea secvențelor de acid dezoxiribonucleic pentru construirea unei structuri ADN origami complexe de tip pin

b). Invenția are utilitate în domeniul biotehnologiilor și se referă la crearea unei combinații specifice de secvențe sintetice scurte de ADN monocatenar (denumite și secvențe capsă) ce determină pliarea unei secvențe lungi de ADN monocatenar denumită și secvență scaffold în formă predefinită, cu o rigiditate mai mare față de abordarea clasică.

Combinația este caracterizată prin aceea că secvențele capsă sunt generate într-o succesiune exactă de baze azotate care determină pliarea secvenței scaffold în forma hexagonală predefinită prin legarea de aceasta (pe bază de complementaritate dintre bazele azotate) în anumite puncte fixe stabilite anterior, dar și modificarea manuală a unor secvențe astfel încât să asigure suprapunerea a două structuri pentru consolidarea rigidității acesteia.

c). Caracteristicile moleculei ADN care o fac potrivită pentru crearea unor astfel de structuri sunt conformația predictibilă a acestuia ce poate fi simulată cu diferite programe aceasta derivând din proprietățile moleculei de autoasamblare bazată pe complementaritatea dintre bazele azotate (A-T, C-G) (Zhang F., 2014).

Tehnica ADN Origami a fost introdusă în anul 2006 de către Rothermund pornind de la ideea propusă de către Seeman în anul 1982 (Seeman, 1982, Rothermund, 2006). Acest domeniu al nanotehnologiei ADN a avut o evoluție rapidă, pornindu-se de la formele bidimensionale propuse de Rothermund, la forme tridimensionale (Ke et. al., 2009, Andersen et.al., 2009), recent fiind introdus conceptul de structuri Meta-ADN (Yao și colab., 2020) și asocierea de structuri multiple cu ajutorul unor nanoparticule de aur (Fang și colab., 2019). Pumm și colaboratorii au dezvoltat un motor rotativ la scară nanometrică construit din ADN origami a cărui capacități mecanice se apropie de cele ale motoarelor biologice (Pumm și colab., 2022). De asemenea, a fost descrisă utilizarea nanostructurilor ADN care codifică o genă umană intactă și o genă care codifică o proteină fluorescentă pentru integrarea genelor prin repararea direcționată prin omologie mediată de CRISPR. Transferul și integrarea genomică au fost realizate prin transfecție și electroporare făcând posibilă editarea genetică (Lin-Shiao și colab., 2022).

d) Problema pe care o rezolvă invenția este reprezentată de găsirea unei soluții pentru sporirea gradului de complexitate a unei figuri simple, prin modificari minimale și costuri scăzute.

Astfel, va fi posibilă construirea unei structuri în formă de pin care are ca și bază o formă plană compusă din două dreptunghiuri. Structura poate fi pliată cu secvențe scaffold pentru a crea o buclă lungă de ADN monocatenar.

Printre avantajele se pot enumera simplificarea și accelerarea procesului de proiectare a nanostructurilor ADN. Procesul obișnuit de proiectare în caDNAno este împărțit în patru etape. Mai întâi, forma dorită este aproximată prin inserarea helixelor în lattice predefinită (tip fagure/honeycomb sau geometria patrata/ square lattice geometry) și apoi este construită calea scaffoldului care trece între elicele vecine. Scaffoldul trebuie să includă încrucișări antiparalele pentru a conecta elicele vecine. Scopul este de a construi un scaffold într-o manieră rasterizată, ceea ce înseamnă că aceasta cale este continuă de la început până la sfârșit. Odată ce scaffoldul este finalizat, ar trebui introduse staple strands. În mod implicit, caDNAno introduce toate încrucișările (crossover) permise, cu excepția celor care sunt la cinci perechi de baze distanță de un crossover al scaffoldului între aceleași două helici. În continuare, staple strands sunt divizate în segmente mai scurte (cu lungimi de 18 - 49 pb) și în final, secvența de ADN sau ARN dorită este inserată în scaffold generându-se automat secvențele complementare de staple strands.

e) Fig1. Conexiuni ale secvențelor capsă. – În această figura sunt exemplificate conexiunile secvențelor capsă în programul caDNAno.

Fig 2. Vizualizare 2D a structurii ADN origami în formă de pin

Fig 3. Vizualizare 3D a structurii ADN origami în formă de pin

În figurile 2 și 3 s-a realizat vizualizarea grafică a modelului cu ajutorul programelor utilizate, vizualizare 2D și 3D, observându-se forma finală a structurii în formă de pin.

f) În acest sens, a fost creată forma de pin cu ajutorul programelor caDNAno și Maya.

Structurile rectangulare regulate ale pinilor urmează un model similar (secvențe capsă, pauze și suprimări) ca și baza originală a dreptunghiului. Un exemplu de conectare a trunchiului structurii de pin la dreptunghiurile bazei pot fi văzute în imaginea 1 (Fig 1).

În porțiunile în care se regăsesc mai multe spații de-a lungul secvențelor capsă ce conectează nivelele, au fost dublate conexiunile pentru a oferi structurii un caracter mai rigid. Pattern-ul a fost divizat în patru secvențe separate de ADN. Dreptunghiurile de bază utilizează secvența M13, de la baza pinului până la primul dreptunghi al celei de-a doua grupări (al treilea dreptunghi al pinului din partea de jos) conține secvența de ADN p7560, iar vârful pinului (al patrulea dreptunghi al pinului – partea de sus) folosește secvența de ADN M13mp18.

Construcția fiecărei secțiuni:

Trunchiul de bază

Pentru realizarea trunchiului de bază a fost mutat fiecare dreptunghi al bazei în sus sau în jos. Acest lucru a fost realizat pentru ca structura și pattern-ul intersecțiilor secvențelor de tip capsă să fie același. De asemenea, au fost realizate intersecții pentru unele dintre secvențele capsă din partea stângă a bazei la fel ca și pe secvențele de pliere.

Primul nivel de ramuri

Ramurile de pe primul nivel au fost realizate din două dreptunghiuri (cele mai mari ca și dimensiune din cadrul formei). Acestea au fost cele mai mari dreptunghiuri create pentru pin, iar pentru fiecare nivel au fost rasucite separat de la o trecere la alta pentru a realiza o formă triunghiulară pentru pin. A fost urmată structura bazei dreptunghiulare, realizând: pauze, intersecții și ștergeri în cadrul aceluiași pattern. S-au adăugat conexiunile dintre cele două dreptunghiuri ca o singură intersecție de mijloc pe pliere și multiple încrucișări ale secvențelor capsă pe partea stângă și pe partea dreaptă.

Trunchiul de legătură (între nivelele de ramuri)

A fost creat un dreptunghi (una dintre cele mai mici piese din cadrul structurii). Acest mic dreptunghi, a fost creat de aceeași lungime ca și al celor două dreptunghiuri de bază. Singura diferență sunt intersecțiile care conectează ramura de sus cu cea de jos, care sunt axate în partea dreapta fiind singura locație potrivită.

Nivelul al doilea de ramuri – gruparea secundară a dreptunghiurilor ramificate (din trei)

Din nou, a fost urmărit modelul dreptunghiurilor ce formează baza. Cea mai mare diferență este conexiunea intersecțiilor dintre cele trei dreptunghiuri. Există intersecții între fiecare nivel iar în mijlocul acestora există o a doua intersecție care păstrează aceeași locație pentru toate cele trei dreptunghiuri. Acest lucru a fost realizat pentru a stabiliza și restricționa flexibilitatea acestui nivel al dreptunghiurilor.

Ultima piesă de conexiune a trunchiului

Pentru această piesă s-a folosit modelul de conexiune dreptunghiular din mijlocul trunchiului.

Vârful pinului

Pentru vârful s-a încercat urmărirea modelului folosit în toate celălalte dreptunghiuri. Pentru conexiunile dintre intersecții a fost urmărită menținerea modelului intersecției plierii în mijlocul dreptunghiurilor iar secvențele capsă distribuite pe ambele părți.

Din cauza restricțiilor privind plasarea intersecțiilor, nu a fost posibil să realizăm un șablon, pe fiecare parte, deoarece fiecare rând de ADN necesită o intersecție diferită în cadrul fiecărui dreptunghi. Pentru fiecare segment s-a încercat să extindem secvențele de tip capsă în cadrul secvenței de pliere pe fiecare parte în concordanță cu potențialul de pliere a ADN-ului la capetele terminale.

Grila este împărțită de segmente de perechi de baze. Urmând pasul helicoidal într-o structură 2D (Fig2), se poate observa că, după două segmente complete, helixul se rotește, permițând o următoare poziție crossover la o spirală vecină. Prin virajul helicoidal, structura proiectată va adopta în mod natural o ușoară întoarcere spre dreapta.

După 3 segmente complete, spirala se îndreaptă din nou spre direcția inițială. Totuși, se poate regla curbarea, răsucirea sau îndoirea structurii prin ștergerea sau inserarea perechilor de baze. Ștergerea perechilor de bază din segmente duce la un cuplu de stânga (mai puțin de 240 de rotații) și introducerea perechilor de bază determină un cuplu de dreapta (mai mult de 240 de rotații). Această funcție poate fi controlată complet, deoarece răsucirea sau îndoirea poate fi simulată.

Imagini ale structurii ADN Origami în formă (discretizată) de pin în toate etapele (

f). Structura obținută este formată din 2 secvențe scaffold (schelă) M13mp18 și una p7560 și o combinație de 863 de secvențe capsă:

Secvențe de ADN folosite pentru crearea structurii de ADN origami în formă de pin

| Start | End | Sequence | Length | Color |
|----------|----------|--|--------|---------|
| 1[23] | 32[23] | ?????GGCCCACTACGGCGGGAGCAGGAACGAGTAATAAAA????? | 48 | #333333 |
| 85[80] | 96[64] | GTATTAGATAATAGATTAGAGCCGCAACAGTGTATGCAAC???????? | 48 | #f7931e |
| 208] | 74[208] | CTTTCATCGGCGGATTATATAAAGCCTGTTTA | 32 | #aaaa00 |
| 66[148] | 57[148] | AGGGAGCCCGAGAAATCCCTTGCCGG | 26 | #f74308 |
| 76[95] | 78[96] | AACCGAGGTACGCAGTATGTTAGTAATGAGT | 31 | #03b6a2 |
| 18[207] | 16[208] | CTTATGCGACGTTGGGAAGAAAAAATAGCGA | 32 | #333333 |
| 90[223] | 92[224] | TAATATTTAAAAACAGGAAGATTGTCTACAA | 31 | #f7931e |
| 14[79] | 12[80] | ATTCTGTCTTAAATAAGAATAAACCAAGAAC | 32 | #333333 |
| 95[64] | 80[80] | ????????TTCAAATATCGCGTTTAGGAAGCCACATTCTGATTACAT | 48 | #333333 |
| 53[23] | 24[23] | ?????AACAAA????? | 18 | #333333 |
| 134[207] | 132[208] | GATTTGTACAATCATAAGGGAACCACTTTGAA | 32 | #57bb00 |
| 96[127] | 97[143] | TAGAGCTTAATTCTGCGAACGAGTAGATTTAG | 32 | #888888 |
| 10[312] | 37[312] | ?????AAAATTAAGCAGCTGATAAAAGCAATAGATAAATTAA????? | 49 | #333333 |

| | | | | |
|----------|----------|---|----|---------|
| 0[312] | 1[287] | ?????CAGGGTGGTTTTCTTTCCACCAGTGGGAGAGGC | 40 | #333333 |
| 110[159] | 111[175] | AGAACCACGGAGTGTACTGGTAATAAGTTTT | 31 | #333333 |
| 98[167] | 106[160] | AACCGATTAGTTGCTGGATTGTA | 23 | #b8056c |
| 36[312] | 7[312] | ?????TGCCA????? | 17 | #333333 |
| 38[143] | 36[144] | TTTCAATTACCTTTTACATCGGGATATCATT | 32 | #333333 |
| 42[312] | 13[312] | ?????CAAGC????? | 17 | #333333 |
| 92[95] | 94[96] | AGGGGGTATACTGCGGAATCGTCCATCAAAA | 31 | #7300de |
| 23[96] | 25[95] | GAGCCGCCTTTGATGATACAGGAAGGCTGAG | 31 | #333333 |
| 100[159] | 102[160] | ACCAAGCGACCAGGCGCAGGTAGACGAGTAG | 31 | #f7931e |
| 18[143] | 16[144] | AGGGAAGCTTTATCCCAATCCAAAATTACCGC | 32 | #333333 |
| 109[64] | 108[64] | ???????CCGGAACCAGAGCCACTTCATAATCAAAAATCA??????? | 48 | #b8056c |
| 4[288] | 33[287] | AGGATCCCTGGTGCCGAAACCAGAAGATCG | 31 | #333333 |
| 79[54] | 80[54] | ???????CCGCTTCCAGTCACCAGTCAC??????? | 36 | #f74308 |
| 78[207] | 89[207] | TTTTCAAGTTAAATATTCGCATTGTAGCCAG | 32 | #f74308 |
| 48[239] | 46[240] | TTAGCCGGGACCTTCATCAAGAGGATGGTTT | 31 | #333333 |
| 136[111] | 134[112] | TAAATGAAAGAAAAATCTACGTAAAGAACT | 31 | #03b6a2 |
| 30[312] | 1[312] | ?????GCTGC????? | 17 | #333333 |
| 119[76] | 118[76] | ???????TTAACATTTT??????? | 24 | #f74308 |
| 80[127] | 82[128] | AATACCTAAGCGTAAGAATACGTGCCTAAAAC | 32 | #aaaa00 |
| 80[79] | 92[64] | TGGCAGATTCGGGAAAATGTTTAG??????? | 32 | #f7931e |
| 67[129] | 66[149] | ???????AGGAACGGTACGCCAGTAA | 26 | #f74308 |
| 247[247] | 93[247] | ?????TAAAAATTTTAGGGTAGCTA????? | 31 | #7300de |
| 83[54] | 84[54] | ???????AACACCGCCTGTCAATAGATAA??????? | 36 | #f74308 |
| 66[164] | 71[185] | GCCTGTCACCTAAAAGAGTCTGT | 23 | #57bb00 |
| 152[178] | 153[178] | ?????TAAGTGGTAA????? | 22 | #f74308 |
| 36[271] | 34[272] | AAAGGCTATTGTAAAAATTCGCATATAATTTCG | 32 | #333333 |
| 134[111] | 132[112] | GGCTCATTATAAGGCTTGCCTGAACCCAAA | 31 | #888888 |
| 79[176] | 77[175] | AATTTATCTTCATCTTCTGACCTGTTTGA | 31 | #f74308 |
| 77[54] | 78[54] | ???????AGAAGTGGCATGCGCTCACTGC??????? | 36 | #f74308 |
| 74[159] | 76[160] | TTTTTGTGAAATAGCAAAACATACGCCTAG | 31 | #1700de |
| 121[176] | 127[175] | CTTCTGGTGAAAGGGGGATGTGCTTAAGTTGCGAACCAGAACTCCAA | 47 | #1700de |
| 86[95] | 88[96] | GCCAGGGTAGTGCCAAGCTTTCTTTCTAATC | 31 | #007200 |

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|----------|----------|--|----|---------|
| 97[144] | 95[143] | TTTGACCAAAGAGGTCATTTTTGCTCAGGATT | 32 | #f7931e |
| 11[288] | 13[287] | GCAAGGCATAAATATGCAACTAATTAATTGC | 31 | #333333 |
| 9[288] | 11[287] | CCGTTCTAATAAAGCCTCAGAGCTCATACAG | 31 | #333333 |
| 117[76] | 116[76] | ???????AACGGCGATG??????? | 24 | #cc0000 |
| 89[112] | 87[111] | ACTCGTCGCCAAAATAACCCCGCCAGGAGAA | 31 | #f7931e |
| 84[255] | 83[255] | ???ATCCTGATTGTTTGGATTATAACAATAACGGATTTCGCCTGA??? | 47 | #f74308 |
| 35[256] | 37[255] | TTAATATTTTCAGGTCATTGCCTGACCGGAGAC | 32 | #333333 |
| 132[159] | 134[160] | CTTCATCATTGAGATGGTGCTCCGACCTTTA | 31 | #7300de |
| 53[160] | 53[191] | GGAATAGGTGTATCACCGTACTCCAGTACAA | 31 | #333333 |
| 48[175] | 47[191] | ACATAAAGGTTAGCAAACGTAGATGAAAGAG | 31 | #333333 |
| 3[96] | 5[95] | TAATCAGTGAAAAACGCTCATGCTGACCTG | 31 | #333333 |
| 10[64] | 31[63] | CTAAATCGATCAGAGCGGGAGCTAGAGAAGTG | 32 | #333333 |
| 37[192] | 38[176] | TTTAAATGAAAATTTTTAGAACCCAATACCAA | 32 | #333333 |
| 139[87] | 138[112] | ???????GTTTATCAGCTTGCTTTTCGAGGTGAATCCAAAA | 39 | #f74308 |
| 89[64] | 74[80] | ???????TCTATGATACCGACAGCTCGCCCTATTGAGCGTTAGACGG | 48 | #888888 |
| 38[47] | 36[48] | GGAAACAGAACCTACCATATCAATTGTTTGG | 31 | #333333 |
| 12[239] | 10[240] | TCCAATTAGGTGGCATCAATTCTGACCCTG | 31 | #333333 |
| 142[131] | 148[119] | TTTCATTTTCAGAGAGGCTGAGA?????? | 29 | #7300de |
| 23[256] | 25[255] | TGACAACAAACAACCTAAAGGAATTCTAAAGTT | 32 | #333333 |
| 17[23] | 48[23] | ???????GTTGCTATTTTCCAATATATCTTACGAAGGTAAAT?????? | 48 | #333333 |
| 79[144] | 68[129] | GCGCCAGGCACACAACCTCGGCCTTGCTGAGTAGAAGAAC??????? | 47 | #aaaa00 |
| 3[159] | 110[160] | TTAGCGTCCAGAGCCGCCAGTACTGCTCACC | 31 | #b8056c |
| 122[127] | 124[128] | AAAGCTAATTTATTTCAACGCAAGGTAGGTAA | 32 | #aaaa00 |
| 39[23] | 10[23] | ???????AATCCT?????? | 18 | #333333 |
| 6[312] | 5[312] | ???????TTTTTTAACCACAGCCAGCTT??????? | 33 | #333333 |
| 150[155] | 149[175] | TACAATTTCTGACAGTCCTGGGGGTTTTGCTCAGTACCAGGCG | 43 | #cc0000 |
| 91[208] | 76[208] | AAAGCCCCTGTAAAAAGAATAAAGCCAACGC | 32 | #007200 |
| 42[175] | 41[191] | GTAATTTAGCCATATTTAACAACCAGACCGG | 31 | #333333 |
| 2[312] | 29[312] | ???????CGAGCTCGAATTATTGGGCCGAATTCGTGGGCGCCAG?????? | 49 | #333333 |
| 28[312] | 29[287] | ???????GGTGGTTTTTCTTTTACCAGTGAGAGAGGCGGT | 40 | #333333 |
| 88[191] | 90[192] | GTCACGTTTCGCGTCTGGCCTTCTAAATTTTT | 32 | #f7931e |
| 3[128] | 5[127] | GTCCATCACCAGAACAATATTACCGACAATAT | 32 | #333333 |

| | | | | |
|----------|----------|--|----|---------|
| 41[64] | 43[63] | CGGAATCACAGCTAATGCAGAACGCCTAATTT | 32 | #333333 |
| 107[176] | 99[192] | CCCATGTATGAATTTGTTTACCAGCGCC???? | 32 | #f7931e |
| 38[79] | 36[80] | TTAACAATAACAGAAATAAAGAAACAGATGAT | 32 | #333333 |
| 35[128] | 37[127] | AGAAGTATAAAGAAACCACCAGAAAATATACA | 32 | #333333 |
| 47[256] | 49[255] | ACAAGAACAATCCGCGACCTGCTCAGAATACA | 32 | #333333 |
| 6[175] | 5[191] | ACCGAACGCCTAAAACATCGCCACGGATTGA | 31 | #333333 |
| 45[128] | 47[127] | AGAAACGAACCCTGAACAAAGTCAGAATACCC | 32 | #333333 |
| 46[111] | 44[112] | TTGAGCGCTATTATTTATCCCAAACGCGAGG | 31 | #333333 |
| 32[271] | 30[272] | GCCATTCGTGCATGCCTGCAGGTCCTGTTCC | 32 | #333333 |
| 114[143] | 122[128] | CCAAAAGAAAGTTACCTAAAGCCTCAGAGCAT | 32 | #f7931e |
| 32[143] | 30[144] | CAGCCATTTCTTTGATTAGTAATACGCCGCGC | 32 | #333333 |
| 4[312] | 51[312] | ??????TAAACAACCTTCGCTGAGGACTTCAATGAGGCTTGC?????? | 49 | #333333 |
| 46[143] | 44[144] | AACTGAACTTTTTTGTTTAACGTCCAGATATA | 32 | #333333 |
| 23[192] | 24[176] | TTATCAGAAAAGGAGCCTTTAATAACAAATA | 32 | #333333 |
| 52[239] | 50[240] | TTTTTCAACCGATAGTTGCGCCGAACGAGG | 31 | #333333 |
| 62[164] | 65[185] | TTAAACAGCAAGCGGTCCACGCT??????? | 30 | #888888 |
| 102[191] | 104[192] | CAGCAGCGGATAGTTGCGCCGACTAATTGTA | 32 | #aaaa00 |
| 4[207] | 2[208] | TATTACGCATTAAGTTGGGTAACGATAAAGTG | 32 | #333333 |
| 0[143] | 1[127] | CAAAAGAATAGCCCGAGATAGGGTATTTAGAG | 32 | #333333 |
| 87[144] | 86[128] | ATTCATGCTATTACGCCAGCTGGCGAAAGGGG | 32 | #007200 |
| 41[160] | 57[185] | TGAGAATCGGCAGAGGTCCACTATTAAGAACG??????? | 40 | #f74308 |
| 13[85] | 124[85] | ????????CCTGTAATACCGGAGACAGTC???????? | 37 | #888888 |
| 51[192] | 52[176] | ATCAGCTTAGGAGCCTTTAATTGTAATGGAAA | 32 | #333333 |
| 140[159] | 142[160] | AACCACCAATCCTCATTACCGGACACCAAAG | 31 | #f74308 |
| 37[256] | 39[255] | AGTCAAATACCAAAAACATTATGATAATAGTA | 32 | #333333 |
| 8[79] | 6[80] | CATCATATAGGAAGGTATCTAACAGCAAAT | 32 | #333333 |
| 126[127] | 128[128] | AGGAATTA AAAA ACCAAAATAGCGACTGGATA | 32 | #7300de |
| 147[176] | 146[160] | CACCGTACTAGTACCGCCACCCTCAGAACCG | 31 | #333333 |
| 63[129] | 69[139] | ???????AAAGAATATTTTAGACTAAACAGGCACCAGTGCAA | 43 | #f74308 |
| 90[127] | 92[128] | TGGTGTAAGCTGTTTCTGTGTGACAAAATAG | 32 | #7300de |
| 64[164] | 69[185] | GGCGATATCCGTTGTAGCAATAC??? | 26 | #1700de |
| 120[95] | 111[111] | GTTGGTGTATCGTAACTTGATATTTGGAAAGCGCAGTCTCTGAATTT | 47 | #f74308 |

| | | | | |
|----------|----------|--|----|---------|
| 114[127] | 116[128] | GATTAAGAAAAGACACCACGGAATAAAGGCTA | 32 | #888888 |
| 53[128] | 52[144] | TGCCGTCGAGAGGGTTGATATAAGCCAGTAAG | 32 | #333333 |
| 5[160] | 7[159] | CTGATAGCAACCACCAGCAGAAGTTAGAAGT | 31 | #333333 |
| 43[288] | 45[287] | ACGAGAATGCCAAAAGGAATTACTTAGGAAT | 31 | #333333 |
| 18[175] | 17[191] | GCAGCCTTGTTTAAACGTCAAAAACATTATAC | 31 | #333333 |
| 40[271] | 38[272] | TGGAAGTTAACATCCAATAAATCAAAGCTAAA | 32 | #333333 |
| 41[192] | 42[176] | AAGCAAACGAGCTTCAAAGCGAACGCCAACAT | 32 | #333333 |
| 47[224] | 49[223] | GGCTGGCTAACGAGGCGCAGACGGAAGGCAC | 31 | #333333 |
| 82[95] | 84[96] | GCAGAAGAAGAGCCAGCAGCAAATAGGAGCA | 31 | #888888 |
| 22[111] | 20[112] | TTTTCATCGAGCCATTTGGGAATGCAAAGAC | 31 | #333333 |
| 35[192] | 36[176] | TTGATAATGCATGTCAATCATATGACGTTATT | 32 | #333333 |
| 5[192] | 143[205] | ACCCCAGGCCACTACTTGCCATC?????? | 30 | #7300de |
| 121[144] | 127[143] | AGATCGCACCGTCGGATTCTCCGTCAGCTTTCATGTTTAGAGAGGCTT | 48 | #333333 |
| 37[96] | 39[95] | ATTTTCAGCAAGAAAACAAAATTTTAGAATC | 31 | #333333 |
| 127[85] | 128[85] | ????????ATAACCCTCGATAAATATTCA???????? | 37 | #1700de |
| 2[271] | 0[272] | TCCTGTGTATCGGCCAACGCGCGGAGACGGGC | 32 | #333333 |
| 82[223] | 84[224] | CGCAGAGGTTTTACATCGGGAGAACTTCTGA | 31 | #f74308 |
| 48[111] | 46[112] | AATCAATAAACGCAATAATAACGGAGGGTAA | 31 | #333333 |
| 67[157] | 67[185] | TGAGAAGTGTTTTTATAATCA???????? | 28 | #f74308 |
| 11[192] | 12[176] | ACCTGTTTGATACATTTGCGAAATAAAATCAT | 32 | #333333 |
| 148[143] | 150[130] | AAGTATTAGGATAGCACCCCTGCC?????? | 30 | #888888 |
| 36[239] | 34[240] | AGCAAACAAGCAAATATTTAAATTTTCATCAA | 31 | #333333 |
| 45[224] | 47[223] | AAAACGAACTTTAATCATTGTGAGGCGCATA | 31 | #333333 |
| 86[159] | 88[160] | CTCTTCGCGCACGACTTAAACCGATCGTAGT | 31 | #1700de |
| 138[227] | 139[227] | ???????AAGGCAGTTA???????? | 24 | #57bb00 |
| 37[64] | 39[63] | GCACGTAATTCATTTGAATTACCTTCTGTAAA | 32 | #333333 |
| 120[127] | 121[143] | ACGGCGGAACGACGACAGTATCGGCCTCAGGA | 32 | #333333 |
| 35[160] | 37[159] | CTCGTATTAAGTTTGAGTAACATGAAACAAT | 31 | #333333 |
| 114[95] | 105[95] | CAAACGTAACATAAAGAAACGAACTCATCAGT | 32 | #1700de |
| 13[128] | 15[127] | ATATGCGTAGGCATTTTCGAGCCAGCTGTCTT | 32 | #333333 |
| 10[175] | 9[191] | ATTCGCCTTACATCGGGAGAAACCCCTCATA | 31 | #333333 |
| 81[176] | 79[175] | TAATTACACTTAGATTAAGACGCCAATAGTG | 31 | #f74308 |

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|----------|----------|--|----|---------|
| 32[79] | 30[80] | ATGGATTAATCAGTGAGGCCACCGTGCTTTCC | 32 | #333333 |
| 2[143] | 0[144] | GCGCGTAAGGAAAGCCGGCGAACGTTATAAA | 32 | #333333 |
| 19[96] | 21[95] | TAGCCGAAATAAGTTTATTTGTTCACCGTC | 31 | #333333 |
| 15[224] | 17[223] | CCAATACTGACGATAAAAACCAATCTACGTT | 31 | #333333 |
| 83[160] | 85[175] | TCAAATTTAAAGTGGTCAGTTGGTTGAGTAACATTATCATTTTGCG | 46 | #aaaa00 |
| 48[271] | 46[272] | TGTGTCGACGGATATTCATTACCCAAACACCA | 32 | #333333 |
| 51[23] | 22[23] | ??????GCCCA?????? | 18 | #333333 |
| 146[159] | 148[163] | CCACCCTCAGGATGGAAAGGAATAGCCC | 28 | #aaaa00 |
| 82[255] | 81[255] | ???TTGCTTTGAATACCAAGTTACATCAATATATGTGAGTGAAT??? | 47 | #f74308 |
| 84[95] | 85[111] | CTAACAACTTTACAAACAATTCGACAACCT | 31 | #b8056c |
| 20[111] | 18[112] | ACCACGGACAAAGTTACCAGAAGTTAACTGA | 31 | #333333 |
| 1[207] | 14[208] | GAGGCTTTTAAAATGTTTAGACTGAAATATCG | 32 | #333333 |
| 104[159] | 98[132] | GCGATTTTTACAGGGAGAGGGGAGGCATAGTAAGAGCAAC???? | 44 | #007200 |
| 50[143] | 48[144] | AGCGCGTTGGCCGAAACGTCACCAGAAACGC | 32 | #333333 |
| 29[23] | 0[23] | ??????ATCGAT?????? | 18 | #333333 |
| 138[207] | 136[208] | CGGGATCGTTTTCATGAGGAAGTTGGGTAAAA | 32 | #cc0000 |
| 24[207] | 22[208] | AAGGCTCCCTTGCTTTGAGGTGATTTGAGGA | 32 | #333333 |
| 12[79] | 10[80] | GCGAGAAATAACCTTGCTTCTGTAGAAACAAA | 32 | #333333 |
| 120[191] | 121[207] | CAGCTGGCGCCGAAACCAGGCAAAGCGCCAT | 32 | #aaaa00 |
| 2[79] | 0[80] | TGACGAGCTCGAGGTGCCGTAAAGACTATTA | 32 | #333333 |
| 88[127] | 90[128] | ATGTCCCGGTGGGCACGAATATAGCTCCTGGT | 32 | #007200 |
| 105[85] | 126[85] | ????????AAATCACCATGCAACACTATC???????? | 37 | #f74308 |
| 30[111] | 28[112] | TGCTTTGAGACGGGGAAAGCCGGGTGTTGT | 31 | #333333 |
| 149[119] | 148[144] | ??????CTCCTCAAGAGAAGGATTAGGATTAGCAAACATGA | 41 | #007200 |
| 7[128] | 9[127] | TCAATAGATGAGTAACATTATCATTAGATTTT | 32 | #333333 |
| 5[288] | 7[287] | TCGCACTCATAGGAACGCCATCACATTAAT | 31 | #333333 |
| 136[143] | 141[143] | TCTAAAGTGAACAACACGTAACACATTCACAA | 32 | #888888 |
| 123[176] | 112[160] | GTTTAGCTATCATACAGTTGCAGCGAGATAGGGTTGAGTGTGTTTC | 46 | #f74308 |
| 22[312] | 49[312] | ??????TGCAGGGAGTTAGCGGAAGAGTTAAAGCGAAACAAA?????? | 49 | #333333 |
| 137[87] | 138[87] | ??????GGATTTTGCTTAATTGTATCG?????? | 33 | #03b6a2 |
| 86[191] | 88[192] | GCAACTGTAGGGGACGACGACAGTTGGGATAG | 32 | #cc0000 |
| 29[224] | 31[223] | CAGTCGGGCGAGCCGGAAGCATAGGGTTTTTC | 31 | #333333 |

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|----------|----------|--|----|---------|
| 9[224] | 11[223] | GTAAAGATTTGCGGGAGAAGCCTGGGGCGCG | 31 | #333333 |
| 45[23] | 16[23] | ??????TTTTTA?????? | 18 | #333333 |
| 36[207] | 34[208] | TAAACTACAGAAAAGCCCCAAAACCCGTCGG | 32 | #333333 |
| 45[64] | 47[63] | TTCCAGAGTTAAGCCCAATAATAGAAAAGTA | 32 | #333333 |
| 10[47] | 8[48] | ATTCATTATACTTCTGAATAATATGGCAAT | 31 | #333333 |
| 70[185] | 79[162] | ??????CCATCACGCAAATTAACCATA | 28 | #f74308 |
| 15[288] | 17[287] | AAAACGAGAACGCCAAAAGGAATGATTTAGG | 31 | #333333 |
| 36[111] | 34[112] | ATTATCATATAGATAATACATTTGCCAGCAG | 31 | #333333 |
| 33[64] | 35[63] | GACCTGAAATATCAAACCCTCAATTCTAAAAT | 32 | #333333 |
| 1[224] | 3[223] | TTCCAGTCATACGAGCCGGAAGCCCAGGGTT | 31 | #333333 |
| 8[239] | 6[240] | TGGAGCAAATAAGCAAATATTTAGCTTTCAT | 31 | #333333 |
| 4[159] | 116[160] | AATAATAAAATCAATAGACCAGTGCTTTAAA | 31 | #cc0000 |
| 0[175] | 1[159] | GGTCCGAAATCGGCAAATCCCTGGCGAGA | 31 | #333333 |
| 35[64] | 37[63] | ATCTTAGATCAATATAATCCTGAAATTATTT | 32 | #333333 |
| 13[256] | 15[255] | TCATTTTTCAAAGCGGATTGCATCATATTCAT | 32 | #333333 |
| 78[127] | 80[128] | TAAAGTGTGGGGAGAGGCGGTTTGCTCATGGA | 32 | #333333 |
| 43[256] | 45[255] | ATCCCCCTAACACTATCATAACCCTATTACAG | 32 | #333333 |
| 122[159] | 124[160] | TAGCAAAAACCCTCATATTGGTCGCAAAAT | 31 | #1700de |
| 17[160] | 19[159] | GATTTTTTTACAGAGAGAATAACCCAAAAGA | 31 | #333333 |
| 101[176] | 100[160] | ACAGAGGCCATCTTTGACCCCCAGCGATTAT | 31 | #7300de |
| 7[23] | 38[23] | ??????CAATATCTGGTATAATCCAGGGTTAGTACATAAATC?????? | 48 | #333333 |
| 8[228] | 129[228] | ????????GCCCGAGGAA???????? | 26 | #cc0000 |
| 40[207] | 38[208] | CATTAGATTATATTTTCATTTGGGTTTCAACG | 32 | #333333 |
| 30[239] | 28[240] | ACAACATAAAACCTGTCGTGCCACCCTGAGA | 31 | #888888 |
| 50[111] | 48[112] | CCCCTTATAAATCACCAGTAGCATTGTGCAC | 31 | #333333 |
| 104[207] | 122[192] | GGAGCCTTAATGACAACTTTTCACGTTTCCCAGTAGTAGCATTAAACA | 48 | #f7931e |
| 102[111] | 112[96] | ATTACCCAGGAACCGAAAAGGGCGAAAACCG | 32 | #888888 |
| 42[143] | 56[129] | AATAAGAGCAACGCTCTCACTTGA???????? | 31 | #f74308 |
| 43[64] | 45[63] | ACGAGCATCCTTAAATCAAGATTACGAGCGTC | 32 | #333333 |
| 112[95] | 103[95] | TCTATCAATATCTTACTAACAAAGGAGAAAACA | 32 | #cc0000 |
| 4[239] | 2[240] | TGGGAAGGCACGACGTTGTAACACAATTC | 31 | #333333 |
| 52[47] | 50[48] | GCCCCCTGAACCGCCACCCTCAGCCACCGGA | 31 | #333333 |

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|----------|----------|---|----|---------|
| 121[112] | 108[112] | TTGAGGGGTTGACCGCCGCCACCTCATAGC | 30 | #f74308 |
| 113[108] | 122[85] | TTAAGTACCAAAAACATTATGAC???????? | 31 | #f74308 |
| 40[47] | 38[48] | GGTTTGAAGTGAATAACCTTGCTTTTTTAAT | 31 | #333333 |
| 16[143] | 14[144] | GCCCAATAATTCCAAGAACGGGTACATGTAAT | 32 | #333333 |
| 110[191] | 111[207] | AAGGATTACAGTGCCTTGAGTAACAGTGCCCC | 32 | #007200 |
| 1[288] | 3[287] | GGTTTGCCTCGTAATCATGGTCAGTCGACTC | 31 | #333333 |
| 11[160] | 13[159] | GAAGAGTCGAGACTACCTTTTTAAGTATAAA | 31 | #333333 |
| 107[96] | 120[96] | CGGAAACTAGCGTTTACGCCATTAGGTCAC | 30 | #888888 |
| 53[288] | 53[312] | TGTATGGGATTTTGCTAA?????? | 24 | #333333 |
| 46[207] | 44[208] | ATGCGATTTTGGGAAGAAAAATCTAGCGAGAG | 32 | #333333 |
| 4[143] | 2[144] | GGTAATATCGCAAATTAACCGTTGGTCACGCT | 32 | #333333 |
| 3[207] | 36[208] | CAAGGATACAATGCCTGAGTAATGGGTAATCG | 32 | #333333 |
| 40[312] | 11[312] | ??????ACAGC?????? | 17 | #333333 |
| 58[164] | 63[185] | TGTTCAAGTGTGCGCGTAACCAC?????? | 30 | #1700de |
| 32[239] | 30[240] | GAAGGGCGGACGTTGTAAAACGAAATCCAC | 31 | #333333 |
| 134[175] | 140[160] | AAATCCGCATGTTACTTCAGAGCCGCCACCAG | 32 | #b8056c |
| 44[312] | 15[312] | ??????AGATA?????? | 17 | #333333 |
| 136[159] | 138[160] | ATTATTAGAAAGGAATTGGTAGCCGAGGCGA | 31 | #b8056c |
| 28[111] | 29[95] | CCAGTTTGAACAAGAGTCCACTCCCCGATT | 31 | #333333 |
| 144[159] | 145[175] | GACTTGAGAAACCATCGATAGCAGCACCGTA | 31 | #1700de |
| 48[143] | 46[144] | AAAGACACTGGCATGATTAAGACTGGAGAATT | 32 | #333333 |
| 223] | 97[247] | CAATAAATGAAAAGGTGGCATCAATTCTACTAAT????? | 39 | #f74308 |
| 108[127] | 110[128] | ATTTTCGGCTCAGAACCGCCACCCAGCATTGA | 32 | #03b6a2 |
| 49[23] | 20[23] | ??????ATTTTC?????? | 18 | #333333 |
| 36[175] | 35[191] | AATTTTAAAAATCCTTTGCCCGATACCCCGG | 31 | #333333 |
| 25[288] | 25[312] | TTCTGTATGGGATTTTGC?????? | 24 | #333333 |
| 99[152] | 94[160] | TTAATCAGTCACACCCGAGAATGACAGGCCGAGAACAT | 39 | #f74308 |
| 89[144] | 87[143] | AATCGGCTTGCTGAATTGTCAACCGTTGTGA | 32 | #888888 |
| 94[223] | 96[224] | TCATATATGAGAAGCCTTTATTTCTAACATC | 31 | #333333 |
| 100[95] | 114[96] | CGCGACCTACGGTCAATCATAAGAATCAACGGAAGCCTATGTTAG | 46 | #1700de |
| 121[208] | 108[208] | TCGCCATTGTGCGGGCGCCCGAAACCCTCAG | 32 | #1700de |
| 6[111] | 4[112] | AACAGTGCAGAATACGTGGCACAGCCAGCCA | 31 | #333333 |

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|----------|----------|--|----|---------|
| 85[144] | 83[143] | TTAAAAGTCAAATCAACAGTTGAACAAATATC | 32 | #7300de |
| 115[76] | 114[76] | ???????TACATGAAAA??????? | 24 | #7300de |
| 75[112] | 73[111] | AAGAATTGAGAGAGAATAACATACTAATTTG | 31 | #888888 |
| 148[194] | 149[194] | ?????GAGAGCCGTC????? | 22 | #03b6a2 |
| 51[256] | 53[255] | CAACAACCAACTAAAGGAATTGCGAAGTTTTG | 32 | #333333 |
| 108[207] | 125[207] | AACCGCCACGTCACCAAGAGGATCTCCACACAGATGGCTTGTTTCATT | 48 | #aaaa00 |
| 28[175] | 29[159] | TCCGAAATCGGCAAAATCCCTTAAAAGGAGC | 31 | #333333 |
| 47[128] | 49[127] | AAAAGAACCACGGAATAAGTTTATCCATTACC | 32 | #333333 |
| 15[96] | 17[95] | ATGTAGAATATTCTAAGAACGCGTCTTTCCA | 31 | #333333 |
| 133[87] | 134[87] | ?????CATTCACTGAATACCAGTCAG????? | 33 | #57bb00 |
| 125[208] | 102[208] | CCATATAACCAATTCTACGCGCGGTGGTTTTTCAACCATCCCGCTTTT | 48 | #333333 |
| 1[128] | 23[127] | GCAAAATCCCTTTAGCGTCAGACTAGAGCCGC | 32 | #333333 |
| 5[128] | 7[127] | TTTTGAATGCGGTCAGTATTAACATAGAGCCG | 32 | #333333 |
| 78[95] | 80[96] | GAGCTAACGCCAGCTGCATTAATTCGTCTGA | 31 | #1700de |
| 24[271] | 22[272] | TAGAAAGGACCATCGCCACGCATGGGATCGT | 32 | #333333 |
| 40[175] | 39[191] | TCCGGCTTTCTGAGAGACTACCTCAATAACC | 31 | #333333 |
| 131[168] | 141[175] | GGCGACATAAACGAAAAATACACTACCAGAGCACCGCCTC | 40 | #333333 |
| 73[54] | 74[54] | ???????TATCCTGAATCACTGAACACCC??????? | 36 | #f74308 |
| 153[135] | 150[156] | ?????CAGTGCCCGTATAAACAGGATGA | 29 | #333333 |
| 43[23] | 14[23] | ?????CCTACG????? | 18 | #333333 |
| 7[224] | 9[223] | AAGATTGTACAAGAGAATCGATGATGTGTAG | 31 | #333333 |
| 14[175] | 13[191] | ATCGCCATTCAACAGTAGGGCTTAACCGAGC | 31 | #333333 |
| 103[96] | 116[96] | CCAGAACCGTTAATAGTGGCAAGAGCAAAC | 30 | #cc0000 |
| 53[224] | 52[240] | CTCATAGTTAGCGTAACGATCTAAATAATAA | 31 | #333333 |
| 99[132] | 99[151] | ????ACTATCATAACCCTCG | 20 | #888888 |
| 52[312] | 23[312] | ?????ACACT????? | 17 | #333333 |
| 32[111] | 30[112] | ATACCTACCATCACGCAAATTAACCTATGGT | 31 | #333333 |
| 21[64] | 23[63] | AAATTATTTTGCATCTTTTCATGCCACCT | 32 | #333333 |
| 20[239] | 18[240] | TACTTAGCGCTGACCTTCATCAATGAGATGG | 31 | #333333 |
| 13[224] | 15[223] | AGTACCTTAGCCCGAAAGACTTCGATAGCGT | 31 | #333333 |
| 12[47] | 10[48] | ATTCATCAACAGTACATAAATCATTTAACA | 31 | #333333 |
| 118[175] | 130[168] | TAATCATGTTTCTGTGCTGTAGCTTAAATATAATATTGA | 40 | #aaaa00 |

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|----------|----------|--|----|---------|
| 82[127] | 84[128] | ATCGCCATTACCTTGCTGAACCTAGGAATTG | 32 | #aaaa00 |
| 95[176] | 93[175] | GTTGTACCAAGATTCAAAGGGTGGAGACAG | 31 | #b8056c |
| 122[191] | 124[192] | TCCAATAAATATTTTCATTTGGGGGTAGATTT | 32 | #f7931e |
| 20[143] | 18[144] | AAGGTGGCAATAATAACGGAATACATAAAAAC | 32 | #333333 |
| 36[143] | 34[144] | TGCGGAACTAGACTTTACAAACAATTAACACC | 32 | #333333 |
| 108[250] | 107[250] | ????????TTAGTACCGCCTCCACAGAC???????? | 37 | #03b6a2 |
| 58[185] | 58[165] | ????????TGTAGCGGTCACGC | 21 | #f74308 |
| 140[127] | 135[127] | GGAGGTTGGACGATTGGCGATTTTATAAAAACG | 32 | #7300de |
| 151[130] | 152[135] | ?????TATTTGCGTAA????? | 23 | #f74308 |
| 34[239] | 32[240] | CATTAAATACCGTGCATCTGCCAACTGTTGG | 31 | #333333 |
| 84[191] | 85[207] | ATTATTTGAAACCACCAGAAGGAGCGGAATTA | 32 | #f74308 |
| 111[111] | 1[95] | GTTCCAGTTTGAACAAGAGTCCCACTAAAT | 31 | #333333 |
| 7[160] | 9[159] | ATTAGACTCTTGCCCGAACGTTTCAGTAACA | 31 | #333333 |
| 92[223] | 94[224] | AGGCTATCTAAATTAATGCCGGAGAGAACCC | 31 | #333333 |
| 93[208] | 78[208] | CTAGCTGAAGGTCATTCTTTTAAGAGAAAAC | 32 | #cc0000 |
| 103[64] | 102[64] | ????????TAAGGCTTGCCCTGACCTGCTCATTCAGTGAA???????? | 48 | #888888 |
| 141[176] | 132[160] | CCTCAGAGACCACCCTAGCCGGAACCAGGCGCATAGGCTGGCTGAC | 46 | #aaaa00 |
| 18[79] | 16[80] | CGCTAATACCAACGCTAACGAGCGAGGCGTTT | 32 | #333333 |
| 3[256] | 5[255] | AGTGCCAATCGCCATTCAGGCTGCCAGTTTG | 32 | #333333 |
| 47[160] | 49[159] | CGCAGTATGTGGCAACATATAAAAATGAAAC | 31 | #333333 |
| 104[191] | 106[192] | TCGGTTTATTTAGCGGAGTGAGATCCAGACG | 32 | #57bb00 |
| 119[47] | 18[48] | GACAAAAGCAATGAAATAGCAATCAAGAATT | 31 | #333333 |
| 120[312] | 47[312] | ?????AAAGTACAACGAAAGCTGCCAACGGAGGCTGCTCATT????? | 49 | #333333 |
| 34[143] | 32[144] | GCCTGCAAGATAGCCCTAAAACATATTACCGC | 32 | #333333 |
| 146[143] | 146[119] | CACCCTCAGAGCCACCACC????? | 25 | #888888 |
| 143[172] | 147[175] | CATAATAAGTATAGGTGTAT | 20 | #03b6a2 |
| 118[239] | 109[223] | ????????TTGCATGCCTGCAGGACGGCCAGGAACCGCCTAGGTGTA | 47 | #f74308 |
| 107[64] | 106[64] | ????????TAGCACCATTACCATTCCAGCAAAATCACCAG???????? | 48 | #b8056c |
| 99[168] | 105[175] | TTCATATGTCTGTATGAAACAAC | 24 | #333333 |
| 34[312] | 33[312] | ?????TTTAACCAATACCAGCTTTCC????? | 33 | #333333 |
| 46[271] | 44[272] | GAACGAGTATTCATCAGTTGAGATGAGGCATA | 32 | #333333 |
| 78[79] | 90[64] | ATTGCGTTGATTAAGACGATAAAG???????? | 32 | #f74308 |

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|----------|----------|--|----|---------|
| 88[223] | 90[224] | GAACAAACAACATTAAATGTGAGCTAAACGT | 31 | #aaaa00 |
| 14[143] | 12[144] | TTAGGCAGTATACAAATCTTACCACCTCCGG | 32 | #333333 |
| 147[119] | 137[127] | ??????CTCGTCACCAGAACGCCTGCTTCCAGTTTCAGCG | 41 | #333333 |
| 141[109] | 140[109] | ??????GGTCAAGGCA?????? | 22 | #f74308 |
| 52[175] | 51[191] | GCGCAGTCCCTCATTAAAGCCAGATCGGTTT | 31 | #333333 |
| 83[176] | 81[175] | TTTCAGGTAAGATGATGAAACAAAACAAAAT | 31 | #f74308 |
| 81[54] | 82[54] | ??????ACGACCAGTAACGGTCAGTATT?????? | 36 | #f74308 |
| 123[208] | 113[211] | GAAAAGGTCTACTAATCAGC | 20 | #03b6a2 |
| 4[271] | 2[272] | AGGCCATGCTTGCATGCCTGCAGTAGCTGTT | 32 | #333333 |
| 31[192] | 32[176] | AGGCGATTCTGGCGAAAGGGGATTATCGGGCC | 32 | #333333 |
| 70[156] | 67[156] | ACGTTATTGCCCTGCCCTGAAATCC | 25 | #f74308 |
| 19[312] | 19[312] | ??????GTATC?????? | 17 | #333333 |
| 40[239] | 38[240] | CAATTCTGTGGCATCAATTCTACCCCTGTAA | 31 | #333333 |
| 21[192] | 22[176] | AACGGGTATTTTTTCATGAGGAAGTAACCATCG | 32 | #333333 |
| 77[144] | 75[143] | AAGAAACGCCGAAGCCCTTTTTAAAAGAGCAA | 32 | #57bb00 |
| 31[160] | 33[159] | TGCCTGAGAATATCCAGAACAATCGCCATTA | 31 | #333333 |
| 87[176] | 86[160] | CCAGTTTGTGGGAAGGGCGATCGGTGCGGGC | 31 | #f7931e |
| 104[127] | 106[128] | AGGACGTAACTAATGCAGATACAAAGGTGAA | 32 | #f7931e |
| 90[191] | 92[192] | GTTAAATCTATGTACCCCGTTGAGTCTGGAG | 32 | #888888 |
| 94[191] | 96[192] | TGTAGGTAAAAACATTATGACCCAGAATTAG | 32 | #007200 |
| 3[288] | 5[287] | TAGAGGATTTCTGGTGCCGAAACAGGAAGA | 31 | #333333 |
| 108[191] | 110[192] | GCCACCACGTCGAGAGGGTTGATACTCAAGAG | 32 | #333333 |
| 52[271] | 50[272] | AAAGGAACATCGCCACGCATAACATCGTCAC | 32 | #333333 |
| 16[79] | 14[80] | TAGCGAACAATATCCCATCCTAATGTAAAGTA | 32 | #333333 |
| 56[185] | 56[165] | ??????TGGACTCCAACGTC | 21 | #f74308 |
| 49[224] | 51[223] | CAACCTAAGGCTACAGAGGCTTTTCTTAAAC | 31 | #333333 |
| 0[207] | 0[176] | TGCCCCAGCAGGCGAAAATCCTGTTTGATGGT | 32 | #333333 |
| 18[111] | 16[112] | ACACCCTGTTTGCCAGTTACAAATAGAAGGC | 31 | #333333 |
| 13[160] | 15[159] | GCCAACGCATTTAACAACGCCAATTAACCA | 31 | #333333 |
| 33[256] | 35[255] | GGACGACGCTTCTGTAGCCAGCTTGTAACG | 32 | #333333 |
| 131[152] | 128[160] | ATTCAAAGAGCGCCAAGAAGTTTTGCAAGCAACCGGCAG | 39 | #333333 |
| 5[64] | 7[63] | CTGGCCAATAAAGCATCACCTTGCCAGTTGAA | 32 | #333333 |

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|----------|----------|---|----|---------|
| 47[96] | 49[95] | ACCGAGGAGAAAATTCATATGGTGAATTAG | 31 | #333333 |
| 0[47] | 30[23] | ACCGTCTATCAGGGCAAGTTTTTAAGGGATTTT????? | 39 | #333333 |
| 88[159] | 90[160] | GTCCTTAGGACGCATTTTCGGAACCAATAACA | 31 | #1700de |
| 41[224] | 43[223] | ACCTTTAACCGAAAGACTTCAAAGCGTCCA | 31 | #333333 |
| 16[239] | 14[240] | TACCAGACGCGGAATCGTCATAAAAAAAGAT | 31 | #333333 |
| 4[175] | 3[191] | GAGTAGAAATTAGTAATAACATCGATGTGCT | 31 | #333333 |
| 111[208] | 119[203] | TATAAACATAAGAGGCTGAGACTCTAAGTATACTCTTCGCACGA | 44 | #03b6a2 |
| 32[175] | 31[191] | TTGCTGGTTAGAAGAACTCAAACGTGCTGCA | 31 | #333333 |
| 36[79] | 34[80] | GGCAATTCGAGCACTAACAACTAACCTTGCTG | 32 | #333333 |
| 78[255] | 77[255] | ???ATGCTGATGCAAATCCAATCGACTAGAAAAAGCCTGTTTAG??? | 47 | #f74308 |
| 144[127] | 139[143] | AATCACCATAACCATTAATAAGGCTTTCTTAAACAGCTTGATACCGAT | 48 | #b8056c |
| 4[143] | 22[144] | GTCTCTGATTGACAGGAGGTTGAGGACAGAAT | 32 | #333333 |
| 87[64] | 72[80] | ????????TTGTAAAACGACGGCCTTTCCAGGCTAACGATTGCTATT | 48 | #03b6a2 |
| 59[129] | 42[144] | ???????AGGGAAGAAAGCGAAAACGTGGCGTCATCGAGGAGCCAGT | 47 | #f74308 |
| 72[255] | 72[224] | ???CGAGAACAAGCAAGCCGTTTTATTTTC | 31 | #f74308 |
| 22[271] | 20[272] | CACCCTCAACACTCATCTTTGACCGCCTGATA | 32 | #333333 |
| 19[160] | 21[159] | ACTGGCATCAAACGTAGAAAATACCATTAGC | 31 | #333333 |
| 28[79] | 29[63] | ACGTGGACTCCAACGTCAAAGGGCGTAAAGCA | 32 | #333333 |
| 50[239] | 48[240] | GTAGCAACAACGAAAGAGGCAAACATGTTAC | 31 | #333333 |
| 35[23] | 6[23] | ??????CAGAAT?????? | 18 | #333333 |
| 127[112] | 104[112] | ACGACGATCGAGGCATCATATGTTTGCCTGCCACATTCGGGAAGA | 45 | #03b6a2 |
| 125[144] | 114[144] | GGAGAGGGAATGCCTGTTTGTACCCGGAATAC | 32 | #cc0000 |
| 80[191] | 82[192] | AGCGATAGTTTAACAATTTCAATTTATTACCTG | 32 | #f74308 |
| 124[191] | 126[192] | AGTTTGACAGTACGGTGTCTGGAAAGAGCTTA | 32 | #f74308 |
| 29[160] | 31[159] | GGGCGCTACGTAACCACCACACCACATCACT | 31 | #333333 |
| 47[288] | 49[287] | GTAACAAAATTTGTATCATCGCCAGCGATTA | 31 | #333333 |
| 127[208] | 104[208] | CCTTTTGATTTTTGCGACATACGACCTAATGAGAACAACCTCTCCAAAA | 48 | #007200 |
| 44[143] | 57[139] | GAAGGCTTTACCGCACAGAAAGGACGGG | 28 | #f74308 |
| 92[247] | 91[247] | ?????TTTTTGAGAGATATAAGCAAA????? | 31 | #cc0000 |
| 134[159] | 130[128] | ATTTCAACGGTTTAAATTCAGAAAGATTTCATCAGTTGA????????? | 48 | #03b6a2 |
| 6[271] | 4[272] | TCGCGTCTACGACAGTATCGGCCTCCAGGCAA | 32 | #333333 |
| 6[143] | 4[144] | GAGGTGAGGGCTATTAGTCTTTAAGCCTTGCT | 32 | #333333 |

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|----------|----------|--|----|---------|
| 97[208] | 82[208] | CGCGAGCTCATAACAGGACAGTACCCGAATTAT | 32 | #f7931e |
| 16[175] | 15[191] | TTTTTATTACTCATCGAGAACAACCAGAGGG | 31 | #333333 |
| 16[111] | 14[112] | TTATCCGGACCAATCAATAATCGGTAATAAG | 31 | #333333 |
| 73[176] | 72[160] | TGTAGAAAGATATAGAAGGCTTATCCGGTAT | 31 | #03b6a2 |
| 128[191] | 129[207] | ATTCGAGCGAAGCAAAGCGGATTGCATCAAAA | 32 | #b8056c |
| 109[176] | 107[175] | TAAGTGCCCTCATTTTCAGGGAAATAGGAA | 31 | #007200 |
| 44[175] | 43[191] | ACCGCGCCTTATTTTCATCGTAGGAGGGGGT | 31 | #333333 |
| 126[228] | 127[228] | ????????GGTCATAAGA???????? | 26 | #f7931e |
| 79[163] | 81[159] | AGAGTTGAGACCGCCAGCCATTGAATGGC | 29 | #b8056c |
| 97[64] | 82[80] | ????????TAAAGTACGGTGTCTGGTTTTAAACCACGCTGTAAAACAG | 48 | #f74308 |
| 74[95] | 76[96] | GAAGCGCACTAATATCAGAGAGACAGAAGGA | 31 | #57bb00 |
| 129[129] | 79[143] | ????????AGACGGGCGAAAAACGCGTATTGG | 31 | #f74308 |
| 113[76] | 112[76] | ????????ATAGCTAGCA???????? | 24 | #888888 |
| 50[47] | 48[48] | ACCGCCTCTTATTCATTAAAGGTAACCGATT | 31 | #333333 |
| 8[111] | 6[112] | ACAAAGAATAACAACTAATAGATCCGCCTGC | 31 | #333333 |
| 20[271] | 18[272] | AATTGTGTAACCGGATATTCATTAGAGAAACA | 32 | #333333 |
| 17[128] | 19[127] | CCATATTAGCATTAGACGGGAGAAGAAACCGA | 32 | #333333 |
| 10[207] | 8[208] | ACGCAAGGATGCAATGCCTGAGTAAACGGTAA | 32 | #333333 |
| 134[143] | 140[128] | TTGTGAATGAGTAGTAGCCGCCAGCATTGACA | 32 | #57bb00 |
| 25[128] | 24[144] | GTTTTGCTCAGTACCAGGCGGATAAAAGCGCA | 32 | #333333 |
| 35[96] | 37[95] | AGCCGTCACATATTCCTGATTATTTGCGTAG | 31 | #333333 |
| 271[271] | 42[272] | GTAAGAGCCAAATGCTTTAAACAGTTATAGTC | 32 | #333333 |
| 96[247] | 95[247] | ????AGTAGTAGCATAACGCAAGGA???? | 31 | #1700de |
| 118[191] | 120[192] | CCGAGCTCCAGGGTTTTCCAGTCTATTACGC | 32 | #b8056c |
| 43[96] | 45[95] | GTCTTTCCCGAACCTCCCGACTTACAAAATA | 31 | #333333 |
| 114[239] | 105[223] | ????????TATTGGGCGCCAGGGGGAGAGGCACAAAAGGAAAGGAAT | 47 | #aaaa00 |
| 83[112] | 81[111] | CTAAAGCATAAAAATACCGAACGACCCTTCT | 31 | #cc0000 |
| 92[127] | 94[128] | CGAGAGGCTCCCCCTCAAATGCTTTGACTATT | 32 | #cc0000 |
| 9[192] | 10[176] | TATTTTAAATAAAAATTTTAGAAAATAACGG | 32 | #333333 |
| 31[128] | 33[127] | GCAATACTGCAACAGGAAAAACGCCTTTAATG | 32 | #333333 |
| 112[191] | 114[192] | GAATAGCCCAAGCGGTCCACGCTGCAGTGAGA | 32 | #aaaa00 |
| 24[79] | 22[80] | GTAATAAGCCACCCTCAGAGCCACAGCCCCCT | 32 | #333333 |

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|----------|----------|----------------------------------|----|---------|
| 145[176] | 137[179] | ATCAGTAGTGTAGCGCAGA | 19 | #007200 |
| 49[96] | 51[95] | AGCCAGCATAGCGTTTGCCATCTCCACCAGA | 31 | #333333 |
| 13[96] | 15[95] | CATAATTAAGTACCGACAAAAGTTACGAGC | 31 | #333333 |
| 31[256] | 33[255] | GCCAAGCTCCATTCAGGCTGCGCAGTTTGAGG | 32 | #333333 |
| 44[239] | 42[240] | CAGACGACGAATCGTCATAAATAAGATTAA | 31 | #333333 |
| 74[223] | 76[224] | AGAACGCGTACCGACAAAAGGTAATCTTACC | 31 | #f74308 |
| 137[192] | 145[205] | TAAAGACTTCACCCTCTCAAGTT?????? | 30 | #aaaa00 |
| 96[159] | 97[175] | CTTTTGATTTAGATACATTTGCAAATGGTC | 31 | #888888 |
| 87[112] | 86[96] | GCCAGGGTGCAAGGCGATTAAGTTGGGTAAC | 31 | #007200 |
| 138[111] | 136[112] | GGAGCCTTAAACAACCTTCAACAGACGTTAG | 31 | #b8056c |
| 2[239] | 0[240] | CACACAACGGGAAACCTGTCGTGTGGCCCTG | 31 | #333333 |
| 64[64] | 52[80] | GCTGAGACTCCTCAAGAGAAGGATGTCAGTGC | 32 | #333333 |
| 76[207] | 87[207] | TCAACAGTATAAGAGAGACCGTAAATCGGCCT | 32 | #f7931e |
| 11[256] | 13[255] | GTAGTAGCGTTTCATTCCATATAAATAAGAGG | 32 | #333333 |
| 12[111] | 10[112] | CTGATGCATAATTTCCCTTAGACATTTCAA | 31 | #333333 |
| 52[207] | 50[208] | GCTCCAAAGCTTTCGAGGTGAATTGAGGACTA | 32 | #333333 |
| 135[128] | 144[128] | AACTAACGTTTGTCGTTAGCATTGCCAGCAA | 32 | #333333 |
| 111[176] | 109[175] | AACGGGGTGGATTAGCGGGGTTTCAGGCGGA | 31 | #57bb00 |
| 82[207] | 93[207] | TCATTTCAGAATTACCCAATGCCTCAACCGTT | 32 | #333333 |
| 68[156] | 65[156] | CACTTGCTGGTAAAAATCCTGAGAG | 25 | #f74308 |
| 107[224] | 119[239] | CTGTAGCAACCCTCATGCCAAGC???????? | 31 | #888888 |
| 256[256] | 41[255] | GTAGCATTTATTCCATATAACAGAGAGGTCA | 32 | #333333 |
| 28[47] | 28[23] | GTCTATCACATCACCCAA?????? | 24 | #333333 |
| 41[23] | 12[23] | ?????TGCTA?????? | 18 | #333333 |
| 9[64] | 11[63] | TAGAACCTAAACAAAATTAATTACAATATATG | 32 | #333333 |
| 103[224] | 115[239] | ATAACCGATCTCCAAGTTTGCG???????? | 31 | #333333 |
| 43[224] | 45[223] | ATACTGCGGATAAAAACCAAATACGTTAAT | 31 | #333333 |
| 96[95] | 97[111] | CTCAACATGAAGTTTCATTCCATATAACAGT | 31 | #03b6a2 |
| 28[239] | 29[223] | GAGTTGCAGCAAGCGGTCCACGCCGCTTTC | 31 | #333333 |
| 51[288] | 53[287] | TCGGTCGCCAGTTTCAGCGGAGTGAATTTTC | 31 | #333333 |
| 102[207] | 112[192] | GCGGGATCTTTTCATCCCTTATAAATCAAAA | 32 | #cc0000 |
| 46[175] | 45[191] | AAAACAGGGCCTTACAGAGAGATATACCAG | 31 | #333333 |

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|----------|----------|---|----|---------|
| 16[271] | 14[272] | ATAGTAAGCCTCAAATGCTTTAACTATTATA | 32 | #333333 |
| 20[79] | 18[80] | ATAGAAAACCCCTTTTAAAGAAAAGTAATTGAG | 32 | #333333 |
| 143[109] | 142[109] | ?????ACTACTACAA?????? | 22 | #03b6a2 |
| 123[112] | 100[96] | GAGAAGCCATCGGTTGAAAAGTACAACGCTACTGACCAGCCTGATAAATTGTGTCGAAATC | 61 | #cc0000 |
| 49[160] | 51[159] | CATCGATAGTTTGCCTTTAGCGTTCACAAAC | 31 | #333333 |
| 118[95] | 109[95] | ATCAGCTCCAATAGGAGCCATCTTCACCGGAA | 32 | #57bb00 |
| 129[85] | 129[111] | ???????TTGAATCCCCCTCAAATG | 26 | #b8056c |
| 51[224] | 53[223] | AGCTTGATCGTTGAAAATCTCCAAGACAGCC | 31 | #333333 |
| 57[140] | 64[129] | GAAAATAAATCATTCTCTGTCGGGAGC??????? | 35 | #f74308 |
| 56[164] | 61[185] | AAAGGCCGAATGCGCCGCTACAG??????? | 30 | #aaaa00 |
| 32[312] | 3[312] | ?????GGCAC?????? | 17 | #333333 |
| 5[256] | 17[255] | TGAATCCCAGCAACTATCATAACATTATTA | 32 | #333333 |
| 48[79] | 46[80] | GCCAAAGAGCCGAACAAAGTTACCAACCCACA | 32 | #333333 |
| 105[144] | 103[143] | AAAGGAATAAGAACTGGCTCATTATCAACTTT | 32 | #007200 |
| 10[239] | 8[240] | TAATACTTTCAAAGGGTGAGAATGAGAGTC | 31 | #333333 |
| 136[207] | 134[208] | TACGTAATCGATTATACCAAGCGCACAAACGGGA | 32 | #f74308 |
| 76[79] | 88[64] | TAATAACGAGAGGGTAGGAGTGAC???????? | 32 | #f7931e |
| 80[207] | 91[207] | GAATCCTTGAGACTACGCCTGAGATAATCAGA | 32 | #1700de |
| 100[127] | 102[128] | GTATCATCACTTTGAAAGAGGACAATCTTGAC | 32 | #b8056c |
| 19[192] | 20[176] | GAGGACAGGAACCGAACTGACCAATTACGCAG | 32 | #333333 |
| 113[212] | 100[192] | AGGCGGCAAAATGAGGAAGTACGAAAGAGGCCAAAAGAATACACT | 44 | #b8056c |
| 191[191] | 94[192] | CAAACAAGCCATCAATATGATATTGAGTAATG | 32 | #f74308 |
| 38[312] | 9[312] | ?????ATTAT?????? | 17 | #333333 |
| 85[176] | 83[175] | GAACAAAGCACGTAAAACAGAAAGCGTAGAT | 31 | #f74308 |
| 107[144] | 105[143] | GCGACAGACGGAAATTATTCATTATAACGCCA | 32 | #03b6a2 |
| 30[207] | 28[208] | AGCCTGGGGCGTTGCGCTCACTGCTGTTTGC | 32 | #333333 |
| 45[256] | 47[255] | GTAGAAAGAGTAAATTGGGCTTGATAATCTTG | 32 | #333333 |
| 148[162] | 151[183] | GCGATTTACCGTTCAGTAAG????? | 26 | #1700de |
| 74[127] | 76[128] | GCCTTTACAGTTAAGCCCAATAATGAAAAGTA | 32 | #57bb00 |
| 53[192] | 52[208] | ACTACAACGCCTGTAGCATTCCACAAAAAAG | 32 | #333333 |
| 9[96] | 11[95] | AAAACAGAGCAAAAGAAGATGATAATCGTGC | 31 | #333333 |
| 15[128] | 17[127] | TCCTTATCGCAAGCAAATCAGATAATAAACAG | 32 | #333333 |

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|----------|----------|--|----|---------|
| 11[23] | 42[23] | ?????TTTTAATGGATTCTGACGATAAATAATAGATAAGT????? | 48 | #333333 |
| 14[312] | 41[312] | ?????AATCAAAAATCATGCTGTAAAATCAGGCTGTAGCTCA????? | 49 | #333333 |
| 130[167] | 136[160] | CGGAAATTGGAAAAGGAGGCTGA | 23 | #cc0000 |
| 1[64] | 3[63] | TTTTGGGGACGTATAACGTGCTTTAGACAGGA | 32 | #333333 |
| 44[79] | 42[80] | TTTTGAAGGTAGAAAACCAATCAATCAATAAAC | 32 | #333333 |
| 3[23] | 34[23] | ?????AACAGGAGGCCCTTGGCAGACATTCTGGGCAAATCAA????? | 48 | #333333 |
| 49[128] | 51[127] | ATTAGCAATTCATCGGCATTTTCGGTTGAGGC | 32 | #333333 |
| 90[95] | 92[96] | GTGGTGCTTACCGAGCTCGAATTTTTGCCAG | 31 | #888888 |
| 4[111] | 2[112] | TTGCAACAGAGGCCACCGAGTAAGCTTAATG | 31 | #333333 |
| 12[312] | 39[312] | ?????TCAACATGTTAAGAATTATGTTTTAAAATTAGCAAA????? | 49 | #333333 |
| 128[159] | 129[175] | AGGGGGTAAATCAGGCTTTACCCTGACTAT | 31 | #03b6a2 |
| 224[224] | 24[240] | GCCCTCATAGTTAGCGTAACGATGCGAATAA | 31 | #333333 |
| 84[127] | 85[143] | AGGAAGGTTCTTTGCCGAACGTTATTAATT | 32 | #f74308 |
| 58[156] | 45[159] | GTTTGGGAGCGGGAAGCAAATAAAAATGA | 29 | #f74308 |
| 33[23] | 4[23] | ?????GGGATT????? | 18 | #333333 |
| 112[159] | 114[160] | CAGTTTGGACCGAGGAAACTGGCACCGCCGC | 31 | #f74308 |
| 53[96] | 52[112] | GCGGGGTTTTGCTCAGTACCAGGCAGGAGTG | 31 | #333333 |
| 43[128] | 45[127] | AAACCAAGATCCGGTATTCTAAGATCCAAATA | 32 | #333333 |
| 24[47] | 22[48] | TAACAGTGGCCTCCCTCAGAGCCAATCAAAA | 31 | #333333 |
| 6[79] | 4[80] | GAAAAATCCAGAGATAGAACCCTTGAAATACC | 32 | #333333 |
| 0[79] | 1[63] | AGAACGTGGACTCCAACGTCAAAGATCAAGTT | 32 | #333333 |
| 19[204] | 127[207] | CGTTCAAATATCTAATTGCT | 20 | #7300de |
| 85[208] | 95[207] | TCATCATAAGGGTTAGAACCTACCATACAGTACAAGGCAATGTAATAC | 48 | #f74308 |
| 137[180] | 125[179] | GGCTCAACCTATCAACCGAGAAGGTAGCAA | 30 | #b8056c |
| 76[223] | 78[224] | AGTATAAACACCGGAATCATAATTCAAGACA | 31 | #f74308 |
| 75[54] | 76[54] | ?????TGAACAAAGTCGAATACCCAAA????? | 36 | #f74308 |
| 31[96] | 33[95] | AGTCTGTCATTTTGACGCTCAATGCACAGAC | 31 | #333333 |
| 72[79] | 72[54] | TTGCACCCAGCTACAATTT????? | 26 | #888888 |
| 17[192] | 18[176] | CAGTCAGGATTTAAGAACTGGCTTGAAAATA | 32 | #333333 |
| 143[144] | 134[144] | GCCCTCATCCATGTACTTATTACATTTAATCA | 32 | #f7931e |
| 109[96] | 121[111] | CCGCCTCGATTGGCCCGTGCATCTGCCAGT | 30 | #b8056c |
| 33[128] | 35[127] | CGCGAACTCAGTGCCACGCTGAGAGAGGATTT | 32 | #333333 |

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|----------|----------|--|----|---------|
| 64[148] | 60[129] | TCAGATAGAATGAGCACGTATAACGTGCT??????? | 36 | #f74308 |
| 7[256] | 9[255] | ACGTTAATCTATCAGGTCATTGCCAGGCCGGA | 32 | #333333 |
| 111[144] | 109[143] | ATGATACACACCAGAGCCGCCCTCAGAGCC | 32 | #333333 |
| 126[191] | 128[192] | ATTGCTGAGATTAGAGAGTACCTTGCGTTTTA | 32 | #f74308 |
| 105[224] | 117[239] | TGCGAATATTAGCGTCATAAAGT??????? | 31 | #333333 |
| 39[224] | 41[223] | TGAAAAGGCGAACGAGTAGATTTTAGAGAGT | 31 | #333333 |
| 152[151] | 146[144] | GCCTTGAGAACCTATTGTTAATGCAGCCCAATAGAACCGC | 40 | #888888 |
| 105[176] | 103[175] | TTCAACAGTCAGCTTGCTTTCGATTAACAG | 31 | #b8056c |
| 84[223] | 85[255] | ATAATGGATTCTGATTATCAGATGATGGCAATTCATCAATATA??? | 47 | #f74308 |
| 91[144] | 89[143] | TCCGCTCATTCTCCGAACTCTGACGGGCCTTG | 32 | #007200 |
| 8[207] | 6[208] | TCGTAAAAAATCAGAAAAGCCCCACAACCCGT | 32 | #333333 |
| 4[185] | 62[165] | ???????CACACCCGCCGCGC | 21 | #f74308 |
| 116[95] | 107[95] | AAGAGAATTAATCGTAAATTAGAGAGCAAGGC | 32 | #03b6a2 |
| 25[64] | 24[80] | ATTCTGAAACATGAAAGTATTAAGGTGTA | 32 | #333333 |
| 5[96] | 7[95] | AAAGCGTACACGCTGAGAGCCAGATATCTTT | 31 | #333333 |
| 45[96] | 47[95] | AACAGCCATAATATCAGAGAGATAGAAGGAA | 31 | #333333 |
| 2[175] | 1[191] | CTAGGGCGGAAGAAAGCGAAAGGGAGCTAAC | 31 | #333333 |
| 106[159] | 108[160] | AATATTGAATCAAGTTTGAGCCCTAGCACCT | 31 | #aaaa00 |
| 120[159] | 121[175] | GTAACAACCTCCAGCCAGCTTCCGGCACCG | 31 | #f7931e |
| 119[108] | 127[111] | AATAGAATCGTCTTTACCAG | 20 | #f74308 |
| 110[127] | 111[143] | CAGGAGGTAGTAAGCGTCATACATGGCTTTTG | 32 | #f7931e |
| 112[112] | 91[111] | TCATTGAATTTTGCAAAAGAAGTCGTAATCA | 31 | #f7931e |
| 13[192] | 14[176] | CGGAAGCATTGAGCTTCAAAGCGAATTGAGA | 32 | #333333 |
| 18[271] | 16[272] | CCAGAACGAAGATTCATCAGTTGATACGAGGC | 32 | #333333 |
| 8[312] | 35[312] | ??????TAATGCCGGAGAATCAGCTCGGAGAGGCAGCTCATT?????? | 49 | #333333 |
| 93[176] | 98[168] | TCAAATCAAGAATCGATGAACGGACTAGCATCGACATTC | 39 | #1700de |
| 133[192] | 141[205] | CAGACGGTTCATCGCCCTCAGAAC?????? | 30 | #1700de |
| 34[79] | 32[80] | AACCTCAAAGCGTAAGAATACGTGCGTCTGAA | 32 | #333333 |
| 23[288] | 25[287] | TATTCGGTCAACAGTTTCAGCGGAATGAATT | 31 | #333333 |
| 12[271] | 10[272] | GTCTGGAAATTAACATCCAATAAAATAAAGCT | 32 | #333333 |
| 44[111] | 42[112] | CGTTTTAGTTATCATTCCAAGAAAAAAGGTA | 31 | #333333 |
| 40[111] | 38[112] | AGAACGCGCATAGCGATAGCTTAATGATGAA | 31 | #333333 |

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|----------|----------|---|----|---------|
| 111[112] | 119[107] | ACCGTTCCTGAGGCAGGTCAGACCCTCAGAGTAATGGGACAAA | 43 | #f74308 |
| 45[160] | 47[159] | AAATAGCAGAAGCGCATTAGACGCCTTATTA | 31 | #333333 |
| 39[128] | 41[127] | CGCTGAGAGATGCAAATCCAATCGCTTACCAG | 32 | #333333 |
| 22[79] | 20[80] | TATTAGCGCATTAAAGGTGAATTACACAATCA | 32 | #333333 |
| 101[144] | 100[128] | GTGTACAGCGAAACAAAGTACAACGGAGATTT | 32 | #cc0000 |
| 125[112] | 102[112] | TATTCAACAAGGGTGAGAAACGCCTCCTTAAATTGGGCGATATTC | 45 | #333333 |
| 34[175] | 33[191] | AAACAGAGGAACGAACCACCAGCATTGACCG | 31 | #333333 |
| 7[192] | 8[176] | CGGTTGATCTAGCATGTCAATCATCAACTCGT | 32 | #333333 |
| 47[23] | 18[23] | ??????AGCATA?????? | 18 | #333333 |
| 112[239] | 103[223] | ???????GGTGGTCCGAAATCGAAAATCCGTTAAAGGGCCACGC | 47 | #b8056c |
| 90[247] | 89[247] | ?????TATTTAAATTGGAGTAACAAC????? | 31 | #333333 |
| 288 | 23[287] | TTATACCAAAGGCCGCTTTTGAACCGATA | 31 | #333333 |
| 48[47] | 46[48] | GAGGGAGGCGAAGCCCTTTTAAAGAGCAAG | 31 | #333333 |
| 76[159] | 68[157] | CTATCTTACAAAGACAAT | 18 | #1700de |
| 20[207] | 18[208] | TCATAAGGATGAACGGTGTACAGATGAATTAC | 32 | #333333 |
| 94[159] | 96[160] | AAATCAAACCTTTAATTGTAAAGGAGCACTC | 31 | #b8056c |
| 9[160] | 11[159] | GTACCTTTGATTGCTTTGAATACGACGCTGA | 31 | #333333 |
| 16[312] | 43[312] | ??????TGCAGATACATAATGACCATACATAACGACCATAAAT?????? | 49 | #333333 |
| 72[127] | 74[128] | CGACTTGCAAATAAACAGCCATAAAATAGCA | 32 | #aaaa00 |
| 21[160] | 23[159] | AAGGCCGGACCGTAATCAGTAGCGCAGGTCA | 31 | #333333 |
| 12[143] | 10[144] | CTTAGGTTGATAGCTTAGATTAACAAGTTAC | 32 | #333333 |
| 191 | 78[192] | ATTGAGAAGTGTGATAAATAAGGCATATATTT | 32 | #f74308 |
| 127[144] | 116[144] | TTGCAAAACTAATGCACCCAAAAATTTTTGAG | 32 | #1700de |
| 18[239] | 16[240] | TTTAATTTGAACTAACGGAACAACCCTCGTT | 31 | #333333 |
| 118[143] | 125[143] | TTGTAAACAGAAAAGCGATACATATTAATGCC | 32 | #7300de |
| 47[192] | 48[176] | GACAGATGCCGAACTGACCAACTTAAATACAT | 32 | #333333 |
| 13[23] | 44[23] | ??????AATTTAATGGTATGCAGAGAACAAGACAGCTACAAT?????? | 48 | #333333 |
| 81[144] | 64[149] | AATATTTTTGCAACAGAACAGCTGTTCTTTTAGGCCGATGTT | 43 | #007200 |
| 128[127] | 129[143] | GCGTCCAAAGTTCAGAAAACGAGAATGACCAT | 32 | #333333 |
| 88[95] | 90[96] | TATTTACGTGCGGCCCTGCCATCTAAGCTAC | 31 | #57bb00 |
| 40[79] | 38[80] | TAGTTAATATTAATTAATTTTCCCAATTACAT | 32 | #333333 |
| 51[64] | 53[63] | CCCTCAGAACAGTGCCCGTATAAAATTAAGAG | 32 | #333333 |

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|----------|----------|--|----|---------|
| 14[271] | 12[272] | GTCAGAAGGCGGATGGCTTAGAGCAGTACGGT | 32 | #333333 |
| 10[143] | 8[144] | AAAATCGCACGTCAGATGAATATAATTAATTT | 32 | #333333 |
| 103[144] | 101[143] | AATCATTGACCTTCATCAAGAGTAGATGAACG | 32 | #888888 |
| 1[192] | 2[176] | TCACATTAGGGGTGCCTAATGAGTAGCGGGCG | 32 | #333333 |
| 50[271] | 48[272] | CCTCAGCACTCATCTTTGACCCCTGATAAAT | 32 | #333333 |
| 8[47] | 6[48] | TCATCAATCAGTTGGCAAATCAATGAACCTC | 31 | #333333 |
| 74[207] | 86[192] | TCAACAATTGTCTTTCTCGCCATTCAGGCTGC | 32 | #b8056c |
| 72[159] | 74[160] | TCTAAGAAAAATAAGAAATAATTCATCCCGA | 31 | #aaaa00 |
| 39[288] | 41[287] | AGGCAAAGATATGCAACTAAAGTATTGCTGA | 31 | #333333 |
| 120[239] | 111[223] | ????????TGGGAAGGGCGATCGCAGGCTGCGAAAGTATGTTAATGC | 47 | #888888 |
| 73[144] | 72[128] | CCCAATCCCGCGAGGCGTTTTAGCGAACCTCC | 32 | #b8056c |
| 1[224] | 33[223] | CCAGTCACATCGGTGCGGGCCTCAGATGGGC | 31 | #333333 |
| 78[191] | 80[192] | TAGTTAATAAAATCATAGGTCTGAGAAAACAT | 32 | #f74308 |
| 104[111] | 113[107] | AAAATCTAGAGTAGTATTACGCAGCTTT | 28 | #f7931e |
| 82[191] | 84[192] | AGCAAAAGTTAACGTCAGATGAATATATCAAA | 32 | #f74308 |
| 95[208] | 80[208] | TTTTGCGGTTTAAATGTTTTTAAATCCCTTA | 32 | #f74308 |
| 15[160] | 17[159] | AGTACCGCTTCATCGTAGGAATCTAAGAAAC | 31 | #333333 |
| 130[197] | 131[197] | ????????GGAGGTTGAG???????? | 28 | #333333 |
| 15[64] | 17[63] | AGAAAAATCTCCCGACTTGCGGGATTTATCCT | 32 | #333333 |
| 19[128] | 21[127] | GGAAACGCAACATATAAAAGAACTAGAGCCA | 32 | #333333 |
| 41[288] | 43[287] | ATATAATGTCTTTACCCTGACTATTCAGAAA | 31 | #333333 |
| 160 | 59[185] | AGCCGTTTCAATAGCCGCTAGGGCGCTGGCAAG??????? | 40 | #f74308 |
| 122[228] | 123[228] | ????????CAATTGGCAT???????? | 26 | #f7931e |
| 83[144] | 81[143] | AAACCCTCTGCGCGAACTGATAGCGCACAGAC | 32 | #b8056c |
| 38[111] | 36[112] | ACAAACATGTTTAAACGTCAGATGGGAGCGGA | 31 | #333333 |
| 39[96] | 41[95] | CTTGAAAAAGAAAACTTTTCAACCTGTTTA | 31 | #333333 |
| 51[128] | 53[127] | AGGTCAGAATGGCTTTTGATGATACGGATAAG | 32 | #333333 |
| 5[192] | 6[176] | CCGTAATGCCGTGGGAACAAACGGTTAAAAAT | 32 | #333333 |
| 111[64] | 110[64] | ????????CTCATTAAAGCCAGAACACAAACAAATAAATC???????? | 48 | #57bb00 |
| 80[95] | 82[96] | AATGGATTGCCAACAGAGATAGAAACCACCA | 31 | #f7931e |
| 42[239] | 40[240] | GAGGAAGCTTGCTCCTTTTGATATTGATTCC | 31 | #333333 |
| 87[208] | 72[192] | CAGGAAGAAGCGCCATCTTATCATAATCATTACCGCGCCCAATAGCAA | 48 | #03b6a2 |

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|----------|----------|---|----|---------|
| 108[111] | 125[111] | CCCCTTATGTCACCAAATTAATTCATGTCAATAGTAAGACAATATGA | 48 | #f74308 |
| 94[95] | 96[96] | AGATTAAGTAATTCGAGCTTCAATGCTGTAG | 31 | #b8056c |
| 102[127] | 104[128] | AAGAACCGTTGAGATGGTTAATTTACCAGTC | 32 | #57bb00 |
| 53[40] | 52[48] | CTGAAACATGAAAGTCAGTTAAT | 23 | #333333 |
| 129[208] | 106[208] | AGATTAAGAAAGACTTGTAACGTCGACTCTGTACAAACAAAGTTTT | 48 | #f74308 |
| 30[79] | 28[80] | TCGTTAGAGAACCCTAAAGGGAGCATTAAAGA | 32 | #333333 |
| 76[255] | 75[255] | ??TATCATATGCGTTATACAAATAGTAATCTGTCCAGACGAC?? | 47 | #f74308 |
| 24[175] | 23[191] | AATCCTCAGCCTTGATATTCACATGTATCGG | 31 | #333333 |
| 4[47] | 2[48] | TATTTACAGATTAAGGGATTTTCCTCGTTA | 31 | #333333 |
| 116[191] | 118[192] | TAATTGCGGTTATCCGCTCACAATCCCGGGTA | 32 | #03b6a2 |
| 28[207] | 28[176] | CCCAGCAGGCGAAAATCCTGTTTGATGGTGGT | 32 | #333333 |
| 143 | 6[144] | TAAAAGTTAATACATTTGAGGATATAAAAACA | 32 | #333333 |
| 80[255] | 79[255] | ??AACCTTGCTTCTGTAAATCGTGGTTATATAACTATATGTAA?? | 47 | #f74308 |
| 46[47] | 44[48] | AAACAATGTCTTACCAACGCTAAGTTGCTAT | 31 | #333333 |
| 37[288] | 39[287] | TTCTAGCTAAGCCTCAGAGCATATACAGGCA | 31 | #333333 |
| 116[239] | 107[223] | ???????GTAAGCCTGGGGTGGCCGGAAGAACGATCTTACAACGC | 47 | #7300de |
| 33[224] | 35[223] | GCATCGTAGTGAGCGAGTAACAAACAGGAAG | 31 | #333333 |
| 53[256] | 52[272] | TCGTCTTCCAGACGTTAGTAAATGAGAATAG | 32 | #333333 |
| 112[127] | 114[128] | GTGGACTCAGCAGATAGCCGAACAACACTGGCAT | 32 | #03b6a2 |
| 33[192] | 34[176] | TAATGGGATGGGAACAAACGGCGGAGAAGATA | 32 | #333333 |
| 44[47] | 42[48] | TTTGACACAAAATAATATCCCATCGCCTGTT | 31 | #333333 |
| 30[175] | 29[191] | ACGCTGCGGGGCGCTGGCAAGTGCTAACTCA | 31 | #333333 |
| 10[271] | 1[255] | AACAGCTGATTGCCCTTCACCGCCCCAGCTGC | 32 | #333333 |
| 86[223] | 88[224] | CCAGGCAATCGCACTCCAGCCAGCTCCGTGG | 31 | #f74308 |
| 100[250] | 100[224] | ???????TGCCACTACGAAGGCACC | 26 | #888888 |
| 10[111] | 8[112] | TTACCTGAAATAAAGAAATTGCGTTTGCGGA | 31 | #333333 |
| 94[127] | 96[128] | ATAGTCAGAGCAAACCTCCAACAGGGGATGGCT | 32 | #888888 |
| 31[23] | 2[23] | ?????AGACTA????? | 18 | #333333 |
| 9[256] | 11[255] | GACAGTCATGTACCAAAAACATTATACTAATA | 32 | #333333 |
| 65[157] | 58[157] | TTGTCGGCAATAGGGTTGCA | 20 | #f74308 |
| 142[205] | 137[191] | ?????TTTTCATAATCAAATATTAGCGTGAAGGCACTTGAGGAC | 46 | #57bb00 |
| 144[205] | 139[191] | ?????GCCTTTAGCGTCAGACCGACAGAAAGCAGCGAACCGATAT | 46 | #f74308 |

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|----------|----------|---|----|---------|
| 21[256] | 23[255] | ACACTAAAGCAGCGAAAGACAGCAGCCGACAA | 32 | #333333 |
| 49[288] | 51[287] | TACCAAGCGGCCGCTTTTGCGGGCGATATAT | 31 | #333333 |
| 34[47] | 32[48] | GGTCAGTTGCCAACAGAGATAGACACCCAGTC | 31 | #333333 |
| 45[288] | 47[287] | ACCACATTGCTTGCCCTGACGAGAAATCAAC | 31 | #333333 |
| 19[256] | 21[255] | TTGACAAGCGAAATCCGCGACCTGAAAAGAAT | 32 | #333333 |
| 69[140] | 77[143] | ACTAATACGAGCACATATAA | 20 | #f74308 |
| 23[64] | 25[63] | CAGAACCGTTTTAACGGGGTCAGTAACCTATT | 32 | #333333 |
| 88[247] | 87[247] | ?????CCGTCGGATTCTTCCGGCAC????? | 31 | #7300de |
| 138[159] | 139[175] | ATAATAATCGACAATGACAACAACCATCGCC | 31 | #1700de |
| 18[312] | 45[312] | ??????ATTTCAGTGAATATTCAACTGAATAAGCAACTAATGC?????? | 49 | #333333 |
| 52[111] | 50[112] | TACTGGTACAGCATTGACAGGAGGTCATAGC | 31 | #333333 |
| 1[64] | 100[64] | ????????CCGGAACGAGGCGCAGGCTCCATGTTACTTAG???????? | 48 | #1700de |
| 21[96] | 23[95] | ACCGACTTGGCATTTCGGTCATCACCCCTCA | 31 | #333333 |
| 100[223] | 113[239] | AACCTAAATTCATTAAACGGGTAGCAGGGATGTTTGAT???????? | 47 | #f74308 |
| 40[143] | 38[144] | TAAATGCTAGAGTCAATAGTGAATATTATTCA | 32 | #333333 |
| 135[87] | 136[87] | ??????GACGTTGGGATTTCTGTATG?????? | 33 | #b8056c |
| 23[128] | 25[127] | CGCCAGCAATTTACCGTTCAGTATTAGCGGG | 32 | #333333 |
| 64[185] | 64[165] | ????????GGTTTGCCCCAGCA | 21 | #f74308 |
| 7[96] | 9[95] | AGGAGCACACCACAGAAGGAGCTTGCACGT | 31 | #333333 |
| 139[192] | 138[208] | ATTCGGTCGCTGAGGCTTGAGGGCGCTTTTG | 32 | #b8056c |
| 13[288] | 15[287] | TGAATATAAGGTCTTTACCCTGACAGTTCAG | 31 | #333333 |
| 104[228] | 125[228] | ????????GATTCAGT???????? | 26 | #007200 |
| 39[64] | 41[63] | TCGTCGCTTTCATCTTCTGACCTAATAAACAC | 32 | #333333 |
| 16[47] | 14[48] | AGCCTTAACAACAATAGATAAGTACAACATG | 31 | #333333 |
| 89[176] | 87[175] | AAATAATTGGTGTAGATGGGCGCTGCATCTG | 31 | #007200 |
| 85[54] | 85[79] | ????????TACATTTGAGGATTTAGAA | 26 | #f74308 |
| 22[239] | 20[240] | AGGGTAGCTAAAACGAAAGAGGCCTCCATGT | 31 | #333333 |
| 80[223] | 82[224] | AATTAATTTGGAAACAGTACATAAAAAATCG | 31 | #f74308 |
| 35[288] | 37[287] | TGTTAAATGTAGCTATTTTTGAGTTCAACCG | 31 | #333333 |
| 17[256] | 19[255] | CAGGTAGAAGTAGTAAATTGGGCTGAGTAATC | 32 | #333333 |
| 43[192] | 44[176] | AATAGTAAAAAAGAAGTTTTGCCAGAATCATT | 32 | #333333 |
| 23[23] | 53[39] | ??????CCACCGGAACCCCGTATCTATTATT | 32 | #333333 |

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|----------|----------|--|----|---------|
| 90[159] | 99[167] | TAAATCATCAAAGTTTATGTAAATAATCTTTATAGAAAA | 39 | #888888 |
| 11[96] | 13[95] | CTATTAATAATCCAATCGCAAGAACCGGAAT | 31 | #333333 |
| 50[207] | 48[208] | AAGACTTTTACGTAATGCCACTACGTCAATCA | 32 | #333333 |
| 1[256] | 3[255] | ATTAATGAGAAAATTGTTATCCGCTCGACGGCC | 32 | #333333 |
| 109[224] | 121[239] | TCACCGTAGAAACATGCAACTGT???????? | 31 | #f74308 |
| 5[23] | 36[23] | ??????CACCAGTCACAAACCCTCTTGAAAGGTCTGAATAAT?????? | 48 | #333333 |
| 25[160] | 25[191] | CGAGAGGGTTGATATAAGTATAGCACCAGTA | 31 | #333333 |
| 19[288] | 21[287] | AACGTAACGAGATTTGTATCATCCCCAGCGA | 31 | #333333 |
| 56[156] | 43[159] | GAAAAGAACAAGAGCATTTTCAACAAGCA | 29 | #f74308 |
| 33[160] | 35[159] | AAAATACCGTGAGGCGGTCAGTATTCGACAA | 31 | #333333 |
| 129[176] | 118[176] | TATAGTCATTCAAAGGGTAACGCGAATTCG | 30 | #aaaa00 |
| 192 | 4[176] | GCAAGGCGCAGCTGGCGAAAGGGGACTTGCCCT | 32 | #333333 |
| 8[271] | 6[272] | TACAAAGGATTTTGTAAAATTCGAAAATAAT | 32 | #333333 |
| 91[64] | 76[80] | ????????ACGGAGGATCCCCGGGTGTACCTCTCCTTATAAACGCAA | 48 | #7300de |
| 102[159] | 104[160] | GCTGGCTGTGAATTACCTATTTCCGGTGATAT | 31 | #7300de |
| 42[111] | 40[112] | AAGTAATTTGCGTTATACAAATTCAGACAA | 31 | #333333 |
| 35[224] | 37[223] | ATTGTATAAGAGAATCGATGAACTGTAGGTA | 31 | #333333 |
| 116[175] | 123[175] | CACTGCCCCGGGAAACTACATTTCAATAACCT | 32 | #aaaa00 |
| 14[47] | 12[48] | TTCAGCTATTGAAATACCGACCGTTTAGTTA | 31 | #333333 |
| 82[79] | 94[64] | AGGTGAGGTAAAAGGGCGAAAGAC???????? | 32 | #f74308 |
| 149[176] | 134[176] | GATAAGTGGGTTGATGCCCCCTTCACCGGAAAAACACTTGTGTGCG | 45 | #b8056c |
| 14[159] | 131[167] | TTAAATGCTAGATGGTTTATGTTTCAACACCACAAAAG | 38 | #7300de |
| 104[250] | 103[250] | ????????CACGTTGAAAATATATTCGGT???????? | 37 | #7300de |
| 25[192] | 24[208] | CAAACTACAACGCCTGTAGCATTCCCAAAAAA | 32 | #333333 |
| 102[250] | 101[250] | ????????CGCTGAGGCTTAAATACGTAA???????? | 37 | #007200 |
| 29[256] | 31[255] | AATGAATCATTGTTATCCGCTCACCGGCCAGT | 32 | #333333 |
| 24[239] | 22[240] | TAATTTTTGATACCGATAGTTGCTCGGAACG | 31 | #333333 |
| 77[112] | 75[111] | GAAAATACGCCGAACAAAGTTACTAACCAC | 31 | #333333 |
| 22[143] | 20[144] | CAAGTTTGACCAGTAGCACCATTACATACATA | 32 | #333333 |
| 129[144] | 118[144] | AAATCAAAATAGTAAATCAACATTATTTAAA | 32 | #f7931e |
| 2[47] | 0[48] | GAATCAGATGAACCATCACCCAAGGCGAAAA | 31 | #333333 |
| 106[127] | 108[128] | TTATCACCTCGATAGCAGCACCGTTCATCGGC | 32 | #888888 |

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|----------|----------|---|----|---------|
| 37[160] | 39[159] | AACGGATTATCGCGCAGAGGCGATTATCAAA | 31 | #333333 |
| 95[112] | 93[111] | AGACCGGAAAGCAAAGCGGATTGATAAATAT | 31 | #1700de |
| 30[47] | 28[48] | GCCGATTATGGGGTCGAGGTGCCGAAAACC | 31 | #333333 |
| 52[79] | 50[80] | CTTGAGTAGCCGCCACCAGAACCATTTTCATAA | 32 | #333333 |
| 11[64] | 13[63] | TGAGTGAACTTTTTCAAATATATTGTGATAA | 32 | #333333 |
| 91[112] | 89[111] | TGGTCATATGAGTAAACAGGGCTTGTAAGCA | 31 | #f74308 |
| 7[288] | 9[287] | TTTTGTAAAGGGTAGCTATTTTTATATTCAA | 31 | #333333 |
| 33[288] | 35[287] | CACTCCAGGGAACGCCATCAAAATAAATTTT | 31 | #333333 |
| 121[76] | 120[76] | ???????GGCGCAGATG??????? | 24 | #57bb00 |
| 34[111] | 32[112] | CAAATGAATGAATGGCTATTAGTTCATGGAA | 31 | #333333 |
| 20[175] | 19[191] | TATGTTAGGATTAAGACTCCTTACTTTGAAA | 31 | #333333 |
| 17[175] | 11[191] | AGGTCTGAAATAGTGAATTTATCGGTCAATA | 31 | #333333 |
| 98[192] | 89[175] | ????AAAGACAAAAGGGTCAATCAAGCTCATTTTTAACGCCATCAA | 48 | #57bb00 |
| 38[239] | 36[240] | TACTTTTGAAAGGGTGAGAAAGGGAGTCTGG | 31 | #333333 |
| 7[64] | 9[63] | AGGAATTGCCTGATTATCAGATGGGAAGGGT | 32 | #333333 |
| 37[23] | 8[23] | ?????GGATGA?????? | 18 | #333333 |
| 12[207] | 10[208] | GACCATTAAGCTATATTTTCATTTTTATTCA | 32 | #333333 |
| 74[255] | 73[255] | ???GACAATAAACCAACATGTTTCAGAAACCAAGTACCGCACTCAT??? | 47 | #f74308 |
| 75[144] | 73[143] | GAAACAATTTAACGTCAAAAATGATTATTTAT | 32 | #57bb00 |
| 37[128] | 39[127] | GTAACAGTACCTGAGCAAAAGAAGGATTAAGA | 32 | #333333 |
| 81[112] | 79[111] | GACCTGAACATTTTGACGCTCAAGAATCGGC | 31 | #03b6a2 |
| 115[143] | 123[143] | AGATCTACAAGTTTATAGTAATGTGATAAAAA | 32 | #cc0000 |
| 46[312] | 17[312] | ?????CAGAA?????? | 17 | #333333 |
| 29[288] | 31[287] | TTGCGTATTAATCATGGTCATAGGACTCTAG | 31 | #333333 |
| 22[175] | 21[191] | ATAGCAGCAAACGTCACCAATGATTCCATTA | 31 | #333333 |
| 4[79] | 2[80] | TACATTTTCCAGAATCCTGAGAAGGGTTGCTT | 32 | #333333 |
| 129[112] | 106[112] | CTTTAACTACTGCGATTGCGTAATTCGCTGAAACCAGTCACCG | 45 | #03b6a2 |
| 2[111] | 0[112] | CGCCGCTATAAAGGGAGCCCCGTGAGTGTT | 31 | #333333 |
| 136[227] | 137[227] | ???????TAACTCCAT??????? | 24 | #b8056c |
| 29[96] | 31[95] | TAGAGCTTCGAGCACGTATAACGAGTAAAAG | 31 | #333333 |
| 77[163] | 70[157] | TAATGAAATTACGGAATATTCGTGAATATGA | 31 | #f74308 |
| 139[176] | 143[171] | CACGCATAAAGACAGCATCGGAAAACGGCTACGTTTTACGGT | 43 | #03b6a2 |

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|----------|----------|--|----|---------|
| 137[128] | 145[143] | GAGTGAGATCTCAAAGCAAGGCCGAAACGT | 32 | #03b6a2 |
| 76[127] | 78[128] | AGCAGATAATACATAAAGGTGGCACGGAAGCA | 32 | #888888 |
| 116[159] | 118[160] | TTCATCTACAGGAAGATTAGCTGGTCATGTA | 31 | #f7931e |
| 106[207] | 123[207] | GTCGTCTTATAGAAAGGTGAGCTAATCGGCCAGCGAACGACGCGAGCT | 48 | #b8056c |
| 11[224] | 13[223] | AGCTGAAACTGCGAACGAGTAGAGATTAGAG | 31 | #333333 |
| 9[23] | 40[23] | ?????TTGTTGGATTTGAATTAATATGTGAATACCGACCG?????? | 48 | #333333 |
| 74[79] | 86[64] | GAGAATTATTACCAACTCACGACG???????? | 32 | #f74308 |
| 3[64] | 5[63] | ACGGTACGGACGCTCAATCGTCTGGGGACATT | 32 | #333333 |
| 32[207] | 30[208] | TACGCCAGAAGTTGGGTAACGCCAAAGTGTA | 32 | #333333 |
| 19[23] | 50[23] | ?????AGAGCAAGAAAGGCGACAGACGGAAACCTCAGAGCC?????? | 48 | #333333 |
| 17[224] | 19[223] | AATAAAACCAACTTTAATCATTGCCAGGCGC | 31 | #333333 |
| 2[111] | 132[87] | TCAACGTAACAAAGCTGCT?????? | 25 | #03b6a2 |
| 14[239] | 12[240] | TAAGAGGATAATTGCTCCTTTTGCAGTTGAT | 31 | #333333 |
| 30[271] | 28[272] | TGTGTGAAGGCCAACGCGCGGGGACGGGCAAC | 32 | #333333 |
| 10[79] | 8[80] | CATCAAGAACCATATCAAATTATGGAATTAT | 32 | #333333 |
| 109[144] | 107[143] | ACCACCCTAGACTGTAGCGCGTTTAATCAGTA | 32 | #f74308 |
| 85[112] | 83[111] | GTATTAATATCTAAAATATCTTTGAAAAAT | 31 | #888888 |
| 78[223] | 80[224] | AAGAACGCCCTCCGGCTTAGGTTGCGCTATT | 31 | #f74308 |
| 10[271] | 8[272] | AAATCGGTAATCACCATCAATATGGAGAGATC | 32 | #333333 |
| 44[207] | 42[208] | GCTTTTGAATGTTTAGACTGGATTATCGCGT | 32 | #333333 |
| 111[224] | 111[250] | CCCCTGCCTATTTTCGAA???????? | 26 | #7300de |
| 112 | 95[111] | TGATCCCAATTGCTGAATATAAAGCGAACC | 31 | #1700de |
| 15[192] | 16[176] | GGTAATAGTGCAAAAGAAGTTTTGGCAAGCCG | 32 | #333333 |
| 110[250] | 109[250] | ???????CCTATTATTCTCTCAGGAGGT???????? | 37 | #888888 |
| 96[191] | 97[207] | CAAAATTAGTTTAGCTATATTTTCATTTGGGG | 32 | #03b6a2 |
| 42[79] | 40[80] | AACATGTTTAATTACTAGAAAAAGATATATT | 32 | #333333 |
| 97[176] | 95[175] | AATAACCTAGCAATAAAGCCTCACTAAATCG | 31 | #333333 |
| 77[176] | 75[175] | TACCGACCTCGCCATATTTAACAGTAATTTA | 31 | #f74308 |
| 6[239] | 4[240] | CAACATTAGTAACCGTGCATCTGGCAACTGT | 31 | #333333 |
| 123[144] | 112[128] | TTTTTAGATTAAGCAAAGAAGGAAAACAAGAGTCCACTATTAAGAAC | 48 | #007200 |
| 57[149] | 40[144] | CGAACCGTCTAAACAGTAGACTATATG | 27 | #f74308 |
| 42[207] | 40[208] | TTTAATTCTCCAACAGGTCAGGATAGTTTGAC | 32 | #333333 |

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|----------|----------|--|----|---------|
| 49[192] | 50[176] | GGGTAAAATTCATGAGGAAGTTTCGTAGCGAC | 32 | #333333 |
| 118[159] | 120[160] | TAAGCAAATAAATGTGAGGGCGATGCAACGA | 31 | #007200 |
| 131[128] | 131[151] | ????????GATTTAGGAATACCAC | 24 | #57bb00 |
| 100[191] | 102[192] | AAAACACTTTTGAGGACTAAAGACGTCACCCT | 32 | #333333 |
| 38[271] | 36[272] | TCGGTTGTCACCATCAATATGATAAGATCTAC | 32 | #333333 |
| 17[64] | 19[63] | GAATCTTATCAGAGAGATAACCCAAGCTATCT | 32 | #333333 |
| 17[96] | 19[95] | GAGCCTAAAACAAAGTCAGAGGGTAAGCAGA | 31 | #333333 |
| 81[160] | 83[159] | TAAAGAAACATCTTAGTCTTTAAAATCAATA | 31 | #b8056c |
| 37[224] | 39[223] | AAGATTCACGGGAGAAGCCTTTAGCGCGAGC | 31 | #333333 |
| 75[176] | 73[175] | GGCAGAGGAGAAAAATAATATCCTACGAGCA | 31 | #f74308 |
| 86[127] | 88[128] | GATGTGCTGGATGTTCTTCTAAGTTTATGACA | 32 | #7300de |
| 11[144] | 132[128] | ACAAATAACCAGAGCCAATTGGGCAGAGTAATCTTGACAAGAACCGGA | 48 | #333333 |
| 29[128] | 31[127] | GCGAGAAACCGCTACAGGGCGCGTCCGTTGTA | 32 | #333333 |
| 132[227] | 133[227] | ???????GACCAGAACT??????? | 24 | #b8056c |
| 28[271] | 29[255] | AGCTGATTGCCCTTCACCGCTGGGCTGCATT | 32 | #333333 |
| 72[223] | 74[224] | ATCGTAGGTCCAAGAACGGGTATTCTAATGC | 31 | #f74308 |
| 34[207] | 32[208] | ATTCTCCGTAGGTCACGTTGGTGTTCGCTAT | 32 | #333333 |
| 4[312] | 31[312] | ?????TCCGGCACCGCCCCGGGTACCGCTTCCGGGTACCGA????? | 49 | #333333 |
| 49[256] | 51[255] | CTAAACAGCGAAAGACAGCATCGGACAATGA | 32 | #333333 |
| 51[96] | 53[95] | GCCGCCGCATAAGTTTTAACGGGTAGGATTA | 31 | #333333 |
| 114[191] | 116[192] | CGGGCAACCCAGCTGCATTAATGAACTCACAT | 32 | #cc0000 |
| 11[312] | 21[312] | ?????AGGAC????? | 17 | #333333 |
| 38[175] | 37[191] | GTTACAAACGCCTGATTGCTTTGTCATATAT | 31 | #333333 |
| 145[109] | 144[109] | ?????ACCATGTAGC????? | 22 | #57bb00 |
| 21[23] | 52[23] | ?????AACCGATTGAGACCAGAGACCCTCAGCCTATTTTCGG????? | 48 | #333333 |
| 46[239] | 44[240] | AATTTCAACTAACGGAACAACATTCGTTTAC | 31 | #333333 |
| 9[128] | 11[127] | CAGGTTTAGCAGAGGCGAATTATTATCCTTGA | 32 | #333333 |
| 106[250] | 105[250] | ????????AGCCCTCATAGATAATTTTTT????????? | 37 | #f7931e |
| 41[256] | 43[255] | TTTTTGCGAGCGGATTGCATCAAATTCATTGA | 32 | #333333 |
| 28[143] | 29[127] | AAGAATAGCCCGAGATAGGGTTGACGAACGTG | 32 | #333333 |
| 95[144] | 93[143] | AGAGAGTAAATCAGGTCTTTACCCTAAACAGT | 32 | #7300de |
| 49[64] | 51[63] | ACCGTCACACCGGAACCAGAGCCAAGCCACCA | 32 | #333333 |

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|----------|----------|---|----|---------|
| 93[64] | 78[80] | ????????ACTGGATAGCGTCCAAATAGTAAACCTGTCGTTACATTA | 48 | #57bb00 |
| 145[144] | 136[144] | CACCAATGCCATTTGGGAACAACCTCGTAACGA | 32 | #7300de |
| 41[128] | 43[127] | TATAAAGCAATATAAAGTACCGACCGGGTATT | 32 | #333333 |
| 50[79] | 48[80] | TCAAAATCCGACTTGAGCCATTTGTTACCAGC | 32 | #333333 |
| 45[192] | 46[176] | TCAGGACGTTAAGAAGCTGGCTCATATAACATA | 32 | #333333 |
| 66[185] | 66[165] | ????????GTGAGGCCACCGAG | 21 | #f74308 |
| 50[175] | 49[191] | AGAATCAAGCAGCACCGTAATCACATTA AAC | 31 | #333333 |
| 30[143] | 28[144] | TTAATGCGGGAAGGGAAGAAAGCGTAAATCAA | 32 | #333333 |
| 1[128] | 3[127] | CTTGACGGCCACCACACCCGCCGCAAGAGTCT | 32 | #333333 |
| 39[192] | 40[176] | TGTTTAGCACATTTGCAAATGGTTTTTAACC | 32 | #333333 |
| 36[47] | 34[48] | ATTATACTAATTGAGGAAGGTTACAATATCT | 31 | #333333 |
| 160 | 5[159] | CTTCTTTGGAAGCTCAAATATCGTGCGCGAA | 31 | #333333 |
| 42[271] | 40[272] | AGAAGCAAGATGGCTTAGAGCTTAACGGTGTC | 32 | #333333 |
| 60[185] | 56[157] | ????????GGCGGCTACTATGGTTGCTTTGACGATGGTGGTTGC | 43 | #f74308 |
| 1[160] | 3[159] | AAGGAAGGCTGGCAAGTG TAGCGTAGCAATA | 31 | #333333 |
| 11[128] | 13[127] | AAACATAGGGTTATATAACTATATTAGTATC | 32 | #333333 |
| 29[192] | 30[176] | CATTAATTGTGCCTAATGAGTGAGTAGCGGTC | 32 | #333333 |
| 146[194] | 147[194] | ??????AGGTTTCAGG?????? | 22 | #f7931e |
| 5[256] | 7[255] | AGGGGACGGCCTTCTGTAGCCAAATTGTAA | 32 | #333333 |
| 106[191] | 108[192] | TTAGTAAACCGTAACACTGAGTTCCCTCAGA | 32 | #7300de |
| 125[180] | 114[176] | CTAACATTAGACTGTCGTGAGCTGAT | 26 | #888888 |
| 17[176] | 116[176] | CAGGTCAGATATAATGTGAAATTTTGCCT | 30 | #f7931e |
| 19[64] | 21[63] | TACCGAAGTTCATATGGTTTACCAATTGACGG | 32 | #333333 |
| 105[96] | 118[96] | TGAGATTCATTTGGGAAACTAGTTTGTTAA | 30 | #03b6a2 |
| 2[207] | 0[208] | TAAAGCCTATTGCGTTGCGCTCACCGCTGGTT | 32 | #333333 |
| 150[183] | 152[152] | ????CGTCATACATGGCTTTTGAGTGTACTTTTAACGGGGTCAGT | 46 | #1700de |
| 41[96] | 43[95] | GTATCATACTGTCCAGACGACGAAATCGGCT | 31 | #333333 |
| 42[47] | 40[48] | TATCAACAAGGCGTTAAATAAGAAATTTAAT | 31 | #333333 |
| 93[144] | 91[143] | TCAGAAAAAGACGACGATAAAAAACAATTGTTA | 32 | #7300de |
| 14[207] | 12[208] | CGTTTTAAAACCTCAACAGGTCAGTTTAGTTT | 32 | #333333 |
| 24[111] | 22[112] | ACATGGCTACCAGAACCACCACCGTAGCGCG | 31 | #333333 |
| 51[160] | 53[159] | AAATAAATTCTGAATTTACCGTTTATAGCCC | 31 | #333333 |

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| | | | | |
|----------|----------|--|----|---------|
| 73[112] | 72[96] | CCAGTTACGGGAGGTTTTGAAGCCTTAAATC | 31 | #007200 |
| 79[112] | 77[111] | CAACGCGCAAAGCCTGGGGTGCCCAAACGTA | 31 | #1700de |
| 46[79] | 44[80] | AGAATTGAGCCTAATTTGCCAGTTGCGGGAGG | 32 | #333333 |
| 134[227] | 135[227] | ???????AAAGTGAAAC??????? | 24 | #b8056c |
| 86[247] | 86[224] | ?????CGCTTCTGGTGCCGGAAA | 23 | #f7931e |
| 6[47] | 4[48] | AAATATCACGACCAGTAATAAAAAAATGGAT | 31 | #333333 |
| 6[207] | 4[208] | CGGATTCTGGATAGGTCACGTTGGCTCTTCGC | 32 | #333333 |
| 39[160] | 41[159] | ATCATAGGAGGTTGGGTTATATAGGCTTAAT | 31 | #333333 |
| 142[159] | 144[160] | CCAGAAACAGTCACCGTCATTTTTCGGCACC | 31 | #f7931e |
| 0[239] | 1[223] | AGAGAGTTGCAGCAAGCGGTCCATGCCCGCT | 31 | #333333 |
| 13[64] | 15[63] | ATAAGGCGCAGACGACGACAATAACCTGAACA | 32 | #333333 |
| 2[256] | 24[272] | TTGTCGTCTTCCAGACGTTAGTAAGTGAGAA | 32 | #333333 |
| 52[143] | 50[144] | CGTCATACCGATTGGCCTTGATATCAGACTGT | 32 | #333333 |
| 21[224] | 23[223] | CACCAACCAACGGCTACAGAGGCATTTCTTA | 31 | #333333 |
| 22[47] | 20[48] | TCACCGGAGGAGGGAAGTAAATGCGCCAAA | 31 | #333333 |
| 68[185] | 77[162] | ???????TTCTTTGATTAGTAATAACCC | 28 | #f74308 |
| 15[23] | 46[23] | ???????CGCCTGTTTATATCAAGAATCCTGAAAAATAGCAAT??????? | 48 | #333333 |
| 18[47] | 16[48] | GAGTTAAGGCACCCAGCTACAATGGTTTTGA | 31 | #333333 |
| 3[224] | 5[223] | TTCCAGTGCGATCGGTGCGGGCTGTAGATG | 31 | #333333 |
| 105[64] | 104[64] | ???????TTACAGGTAGAAAAGATTAACGGAACAACATTA????????? | 48 | #333333 |
| 47[64] | 49[63] | AGCAGATACAAAAGGGCGACATTCGAATTATC | 32 | #333333 |
| 1[224] | 25[223] | AACAGCTTTCACGTTGAAAATCTCACAGACA | 31 | #333333 |
| 48[207] | 46[208] | TAAGGGAAAACGGTGTACAGACCAATTACCTT | 32 | #333333 |
| 124[127] | 126[128] | AGATTCAACGTTCTAGCTGATAAAACGCCAAA | 32 | #333333 |
| 19[224] | 21[223] | ATAGGCTGCGGAACGAGGCGCAGTACGAAGG | 31 | #333333 |
| 23[160] | 25[159] | GACGATTGTTAAAGCCAGAATGGAGTGCCGT | 31 | #333333 |
| 106[111] | 123[111] | ACTTGAGCTAGGAATAAGAGTCTGCATATAAAAGAAAGGCTTTTGGCG | 48 | #b8056c |
| 14[111] | 12[112] | AGAATATACTAGAAAAAGCCTGTTGTAATG | 31 | #333333 |
| 118[127] | 120[128] | TTTGTTAACTGGCCTTCTGTAGCGGGAACAA | 32 | #03b6a2 |
| 8[175] | 7[191] | ATTAAATCTTACAAACAATTGCAATGTACCC | 31 | #333333 |
| 72[191] | 74[192] | GCAAATCACCAATCAATAATCGGCAGATAAGT | 32 | #f74308 |
| 5[224] | 7[223] | GGCGCATCAATGTGAGCGAGTAAAAACAGG | 31 | #333333 |

| | | | | |
|----------|----------|---|----|---------|
| 140[205] | 135[191] | ??????CGCCACCCTCAGAGCCCCGCCACCTGATAAATCATCTTTG | 46 | #cc0000 |
| 132[127] | 142[132] | TATTCATTCGAGAAACACCAGAACTACCTTATGCCTTGATTGAG | 44 | #aaaa00 |
| 132[207] | 133[191] | AGAGGACAGATGAACGGTGTACAGACGAGGCG | 32 | #7300de |
| 25[96] | 24[112] | ACTCCTCAAGAGAAGGATTAGGAAGCGTCAT | 31 | #333333 |
| 25[23] | 24[48] | ??????CAGTTAATGCCCCCTGCCTATTTGGGCCTTGAG | 40 | #333333 |
| 139[144] | 143[143] | AGTTGCGCTTTTTACGTTGAAAAATAGAAAGGAATTAGACACAGACA | 48 | #f74308 |
| 31[64] | 33[63] | TTTTTATATTTACATTGGCAGATTACCCTTCT | 32 | #333333 |
| 103[176] | 101[175] | CTTGATACAAAGACAGCATCGGACAACGGCT | 31 | #03b6a2 |
| 17[288] | 19[287] | AATACCACAAGGCTTGCCCTGACCCCAAATC | 31 | #333333 |
| 32[47] | 30[48] | ACACGACCGTACGCCAGAATCCTAACAGGAG | 31 | #333333 |
| 72[95] | 74[96] | AAGATTAGGCGTCTTCCAGAGCAAAACAGG | 31 | #03b6a2 |
| 96] | 3[95] | CGGAACCCCAGGGCGGCTACTATTGTTTTTA | 31 | #333333 |
| 114[175] | 122[160] | TGCCCTTCCCTGAGAGAGGCAAGGCAAAGAAT | 32 | #57bb00 |
| 22[207] | 20[208] | CTAAAGACAAATACGTAATGCCACACGGTCAA | 32 | #333333 |
| 33[96] | 35[95] | AATATTTTAAATCTAAAGCATCATAGATTAG | 31 | #333333 |
| 34[271] | 32[272] | CGTCTGGCACAGTATCGGCCTCAGGGCAAAGC | 32 | #333333 |
| 116[127] | 118[128] | TCAGGTCAACCCCGTTGATAATCGTTAATAT | 32 | #f7931e |
| 74[191] | 76[192] | CCTGAACACATTTTCGAGCCAGTAAGGGCTTA | 32 | #f74308 |

Se dă în continuare un exemplu de realizare:

EXEMPLU

Pentru construirea formei de pin se utilizează un amestec de concentrație 3 - 5 nM secvență scaffold și un exces de 18-20 ori din fiecare dintre secvențele capsă (indicate mai sus) într-un volum final de 100 μ l.

Protocol:

1. TAE/Mg²⁺ - buffer (600 μ l apa, 400 μ l TAE 5X, 1000 μ l MgCl₂ sau Acetat de magneziu);
2. In tub Eppi de 2 ml: 729 μ l buffer, 1 μ l staple x 221, 50 μ l scaffold;
3. Vortex;
4. Transfer 100 μ l in tuburi PCR;
5. Program PCR (90°C la 4°C în aproximativ 12 ore după cum urmează: de la 90° la 86°C cu o rată de 4°C per 5 min, de la 85° la 70°C cu o rată de 1°C per 5 min, de la 70° la 40°C cu o rată de 1°C per 15 min, și 40°C la 25°C cu o rata de 1°C per 10 min, ținute la final la 4°C

Structurile obținute in urma acestui proces pot fi vizualizate cu ajutorul microscopiei de forță atomică.

g) Combinația de secvențe ADN monocatenare ce permite asamblarea și obținerea structurii la nivel nanometric poate fi utilizată în domeniul biotehnologiilor la nivel educațional, servind ca model de studiu al capacității de autoasamblare a ADN-ului în cadrul laboratoarelor de profil din centre educaționale (licee, universități sau laboratoare de cercetare) putând fi comercializată sub formă de kit de reactivi de laborator fiind disponibile multiple abordări.

Bibliografie

1. Zhang Y., Wang C., Dong Y., Wang D., Cao T., Wang S., Liu S., 2019, Fold 2D Waven DNA Origami to Origami Structures, *Adv. Funct. Mater.* 1-8.
2. Jung H., Zhang F., Shepherd T., Ratanalert S., Qi X., Yan H., Bathe M., 2019, Autonomously designed free-form 2D DNA origami, *Science Advances*, 5: aav0655.
3. Zhang F., Jiang S., Wu S., Li Y., Mao C., Liu Y., Yan H., 2015, Complex wireframe DNA origami nanostructures with multi-arm junction vertices, *Nature Nanotechnology*, 10, 779-784.
4. Rothemund P.W.K., 2006, Folding DNA to create nanoscale shapes and patterns, *Nature*, 440, 297-302.
5. Andersen E.S., Dong M., Nielsen M., Jahn K., Subramani R., Mamdough W. Et al., 2009, *Nature*, 459(7243), 73-76.
6. Pumm A.K., Engelen W., Kopperger E. *et al.* 2022, A DNA origami rotary ratchet motor. *Nature* **607**, 492–498. <https://doi.org/10.1038/s41586-022-04910-y>
7. Lin-Shiao E., Pfeifer W.G., Shy B.R., Doost M.S., Chen E., Vykunta V.S., Hamilton J.R., Stahl E.C., Lopez D.M., Sandoval Espinoza C.R., Deyanov A.E., Lew R.J., Poirer M.G., Marson A., Castro C.E., Doudna J.A., 2022, CRISPR–Cas9-mediated nuclear transport and genomic integration of nanostructured genes in human primary cells, *Nucleic Acids Research*, Volume 50, Issue 3, Pages 1256–1268, <https://doi.org/10.1093/nar/gkac049>
8. Yao G., Zhang F., Wang F. et al., 2020, Meta-DNA structures. *Nat. Chem.* 12, 1067–1075 <https://doi.org/10.1038/s41557-020-0539-8>
9. Fang W., Jia S., Chao J. et al., 2019, Quantizing single-molecule surface-enhanced Raman scattering with DNA origami metamolecules, *Science Advances*, DOI: 10.1126/sciadv.aau4506
10. <http://perdix-dna-origami.org/>
11. <https://www.cgl.ucsf.edu/chimera/>
12. <https://www.freecadweb.org/>

REVENDICĂRI

Revendicarea invenției 'Customizarea secvențelor de acid dezoxiribonucleic pentru construirea unei structuri ADN origami complexe de tip pin' care se referă la crearea unei combinații specifice de secvențe sintetice scurte de ADN monocatenar (denumite și secvențe capsă) ce determină plierea unei secvențe lungi de ADN monocatenar provenind de la bacteriofagul M13mp18 (denumită și secvență scaffold) în formă predefinită, de pin cu o rigiditate mai mare față de abordarea clasică.

DESENE

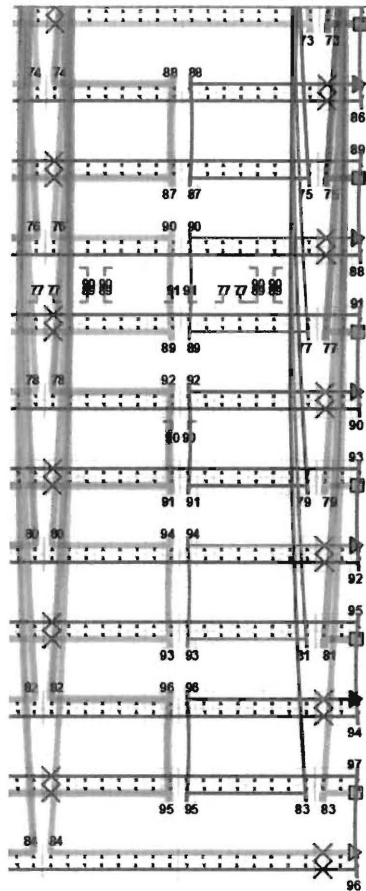


Fig1. Conexiuni ale secvențelor capsă.

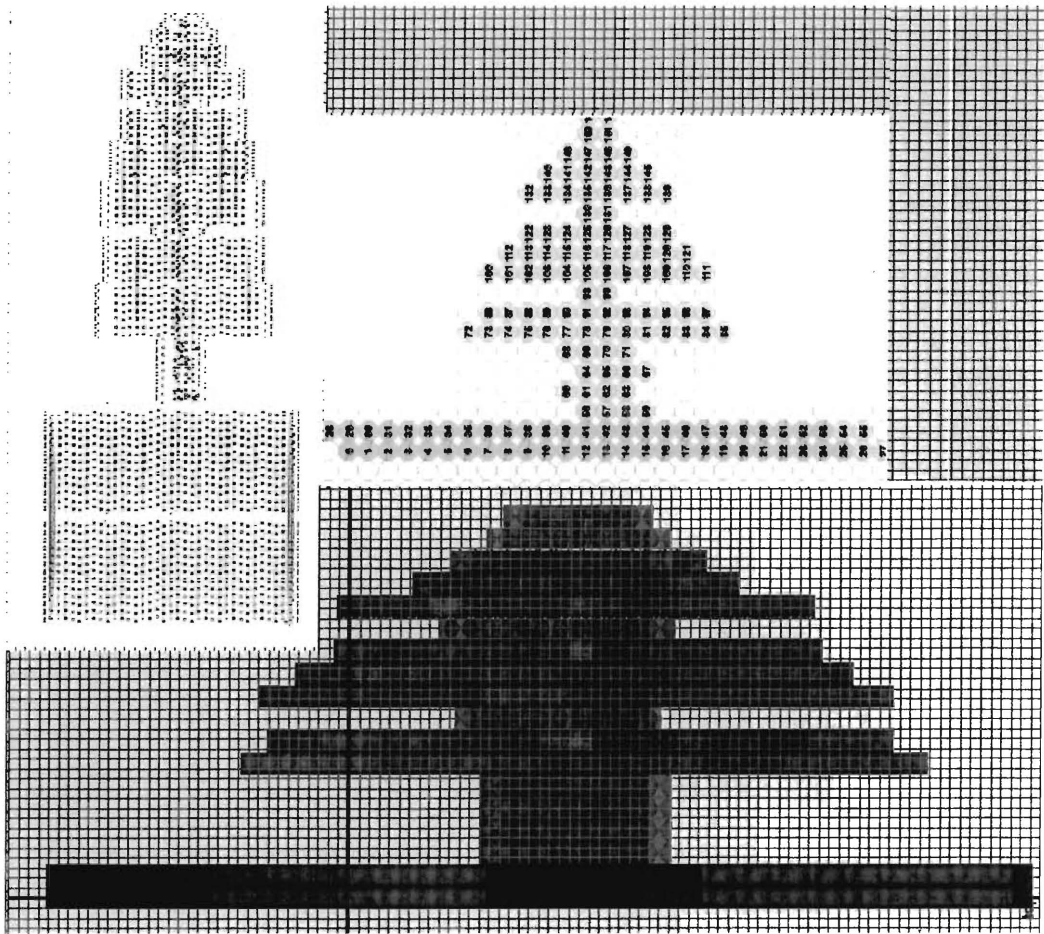


Fig 1 Vizualizare 2D a structurii ADN origami în formă de pin



Fig 3. Vizualizare 3D a structurii ADN origami în formă de pin