(b) processor unit for converting the at least one digital sequence to a plurality of bioencrypted oligonucleotide sequences; (c) a synthesizer unit for receiving machine instructions from the processor unit for synthesizing the plurality of bioencrypted oligonucleotide sequences; and (d) a storage unit for receiving the plurality of oligonucleotides deposited from the synthesizer unit.

[0018] Provided herein are systems for retrieving information, the method comprising: (a) a storage unit comprising a plurality of oligonucleotides on a surface; (b) a deposition unit for applying at least one form of biodecryption to the plurality of oligonucleotides; (c) a sequencing unit for sequencing the plurality of oligonucleotides to obtain nucleic acid sequence; and (d) a processor unit for converting the nucleic acid sequences to at least one digital sequence, wherein the at least one digital sequence encodes for at least one item of information.

[0019] Provided herein are systems for retrieving information, the method comprising: (a) a storage unit comprising a plurality of oligonucleotides on a surface; (b) a deposition unit for applying at least an enzymatic, electromagnetic, chemical, or affinity based bioencryption to the plurality of oligonucleotides; (c) a sequencing unit for sequencing the plurality of oligonucleotides to obtain nucleic acid sequence; and (d) a processor unit for converting the nucleic acid sequences to at least one digital sequence, wherein the at least one digital sequence encodes for at least one item of information.

[0020] Provided herein are systems for retrieving information, the method comprising: (a) a storage unit comprising a plurality of oligonucleotides on a surface; (b) a deposition unit for applying CRISPR/Cas complex to the plurality of oligonucleotides; (c) a sequencing unit for sequencing the plurality of oligonucleotides to obtain nucleic acid sequence; and (d) a processor unit for converting the nucleic acid sequences to at least one digital sequence, wherein the at least one digital sequence encodes for at least one item of information.

[0020a] Provided herein are methods for storing information, the method comprising: a) receiving at least one item of information in a form of at least one digital sequence; b) receiving instructions for selection of at least one bioencryption format, wherein the bioencryption format is enzymatic based bioencryption, wherein the enzymatic based bioencryption format is configured for decryption by exposure of an encrypted sequence to a nuclease complex; c) converting the at least one digital sequence to a plurality of oligonucleotide sequences based on the selected bioencryption format; d) synthesizing a plurality of oligonucleotides encoding for the oligonucleotide sequences; and e) storing the plurality of oligonucleotides.

[0020b] Provided herein are methods for retrieving information, the method comprising: a) releasing a plurality of oligonucleotides from a surface; b) applying an enzymatic based decryption to the plurality of oligonucleotides, wherein the enzymatic based decryption is configured for

decryption by exposure of an encrypted sequence to a nuclease complex; c) enriching the plurality of oligonucleotides; d) sequencing enriched oligonucleotides from the plurality of oligonucleotides to generate nucleic acid sequences; and e) converting the nucleic acid sequences to at least one digital sequence, wherein the at least one digital sequence encodes for digital information.

[0020c] Provided herein are systems for storing information, the system comprising: a) a receiving unit for receiving machine instructions for at least one item of information in a form of at least one digital sequence, and machine instructions for selection of at least one bioencryption format, wherein the bioencryption format is enzymatic based bioencryption, wherein the enzymatic based bioencryption format is configured for decryption by exposure of an encrypted sequence to a nuclease complex; b) a processor unit for automatically converting the at least one digital sequence to a plurality of oligonucleotide sequences based on the selected bioencryption format; c) a synthesizer unit for receiving machine instructions from the processor unit for synthesizing a plurality of oligonucleotides encoding for the oligonucleotide sequences; and d) a storage unit for receiving the plurality of oligonucleotides deposited from the synthesizer unit.

[0020d] Provided herein are systems for for retrieving information, the system comprising: a) a storage unit comprising a plurality of oligonucleotides on a surface; b) a deposition unit for applying enzymatic based bioencryption to the plurality of oligonucleotides, wherein the enzymatic based bioencryption is configured for decryption by exposure of an encrypted sequence to a nuclease complex; c) a sequencing unit for sequencing the plurality of oligonucleotides to obtain nucleic acid sequences; and d) a processor unit for automatically converting the nucleic acid sequences to at least one digital sequence, wherein the at least one digital sequence encodes for digital information.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The novel features of the invention are set forth with particularity in the appended claims. A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the invention are utilized, and the accompanying drawings of which:

[0022] **Figure 1** illustrates an exemplary workflow for nucleic acid-based data storage.

[0023] **Figure 2** illustrates an exemplary workflow for storage for bioencryption.

[0024] **Figure 3** illustrates an exemplary workflow for retrieval following bioencryption.

[0025] **Figures 4A-4B** depict a bioencryption method using a Cas enzyme.

[0026] **Figures 5A-5C** depict various oligonucleotide sequence design schemes.

[0027] **Figures 6A-6C** depict various oligonucleotide sequence design schemes.

CLAIMS

WHAT IS CLAIMED IS:

1. A method for storing information, the method comprising:

    a) receiving at least one item of information in a form of at least one digital sequence;

    b) receiving instructions for selection of at least one bioencryption format, wherein the bioencryption format is enzymatic based bioencryption, wherein the enzymatic based bioencryption format is configured for decryption by exposure of an encrypted sequence to a nuclease complex;

    c) converting the at least one digital sequence to a plurality of oligonucleotide sequences based on the selected bioencryption format;

    d) synthesizing a plurality of oligonucleotides encoding for the oligonucleotide sequences; and

    e) storing the plurality of oligonucleotides.

2. The method of claim 1, wherein the enzymatic based bioencryption comprises CRISPR/Cas based bioencryption.

3. The method of claim 1, wherein the enzymatic based bioencryption comprises instructions for synthesis of the oligonucleotides which are sensitive to an enzyme as set out in Table 1.

4. The method of claim 1, wherein 2, 3, 4, or 5 bioencryption formats are used.

5. The method of claim 1, wherein the plurality of oligonucleotides comprises at least 100,000 oligonucleotides.

6. The method of claim 1, wherein the plurality of oligonucleotides comprises at least 10 billion oligonucleotides.

7. A method for retrieving information, the method comprising:

a) releasing a plurality of oligonucleotides from a surface;

b) applying an enzymatic based decryption to the plurality of oligonucleotides, wherein the enzymatic based decryption is configured for decryption by exposure of an encrypted sequence to a nuclease complex;

c) enriching the plurality of oligonucleotides;

d) sequencing enriched oligonucleotides from the plurality of oligonucleotides to generate nucleic acid sequences; and

e) converting the nucleic acid sequences to at least one digital sequence, wherein the at least one digital sequence encodes for digital information.

8. The method of claim 7, wherein decryption of the plurality of oligonucleotides comprises applying a CRISPR/Cas complex to the plurality of oligonucleotides.

9. The method of claim 7, wherein the enzymatic based decryption comprises applying an enzyme as set out in Table 1.

10. The method of claim 7, wherein 2, 3, 4, or 5 forms of decryption are used.

11. A system for storing information, the system comprising:

a) a receiving unit for receiving machine instructions for at least one item of information in a form of at least one digital sequence, and machine instructions for selection of at least one bioencryption format, wherein the bioencryption format is enzymatic based bioencryption, wherein the enzymatic based bioencryption format is configured for decryption by exposure of an encrypted sequence to a nuclease complex;

b) a processor unit for automatically converting the at least one digital sequence to a plurality of oligonucleotide sequences based on the selected bioencryption format;

c) a synthesizer unit for receiving machine instructions from the processor unit for synthesizing a plurality of oligonucleotides encoding for the oligonucleotide sequences; and

d) a storage unit for receiving the plurality of oligonucleotides deposited from the synthesizer unit.

12. The system of claim 11, wherein the enzymatic based bioencryption comprises CRISPR/Cas based bioencryption.

13. The system of claim 11, wherein the enzymatic based bioencryption comprises machine instructions for synthesis of the oligonucleotides which are sensitive to an enzyme as set out in Table 1.

14. The system of claim 11, wherein the plurality of oligonucleotides comprises at least 100,000 oligonucleotides.

15. The system of claim 11, wherein the plurality of oligonucleotides comprises at least 10 billion oligonucleotides.

16. A system for retrieving information, the system comprising:

a) a storage unit comprising a plurality of oligonucleotides on a surface;

b) a deposition unit for applying enzymatic based bioencryption to the plurality of oligonucleotides, wherein the enzymatic based bioencryption is configured for decryption by exposure of an encrypted sequence to a nuclease complex;

c) a sequencing unit for sequencing the plurality of oligonucleotides to obtain nucleic acid sequences; and

d) a processor unit for automatically converting the nucleic acid sequences to at least one digital sequence, wherein the at least one digital sequence encodes for digital information.

17. The system of claim 16, wherein the deposition unit applies CRISPR/Cas complex to the plurality of oligonucleotides.

18. The system of claim 16, wherein the enzymatic based bioencryption comprises applying an enzyme as set out in Table 1.

19. The method of claim 1, wherein the enzymatic based decryption comprises contacting the plurality of oligonucleotides with Cas nuclease (CRISPR associated), a Zinc Finger Nuclease (ZFNs), a Transcription Activator-Like Effector Nucleases, an Argonaute nuclease, SI Nuclease, mung bean nuclease, or a DNAse.

20. The method of claim 7, wherein the enzymatic based decryption comprises contacting the plurality of oligonucleotides with Cas nuclease (CRISPR associated), a Zinc Finger Nuclease (ZFNs), a Transcription Activator-Like Effector Nucleases, an Argonaute nuclease, SI Nuclease, mung bean nuclease, or a DNAse.

21. The method of claim 11, wherein the enzymatic based decryption comprises contacting the plurality of oligonucleotides with Cas nuclease (CRISPR associated), a Zinc Finger Nuclease (ZFNs), a Transcription Activator-Like Effector Nucleases, an Argonaute nuclease, SI Nuclease, mung bean nuclease, or a DNAse.

22. The method of claim 16, wherein the enzymatic based decryption comprises contacting the plurality of oligonucleotides with Cas nuclease (CRISPR associated), a Zinc Finger Nuclease (ZFNs), a Transcription Activator-Like Effector Nucleases, an Argonaute nuclease, SI Nuclease, mung bean nuclease, or a DNAse.