Claims:

1. A method of identifying a modified cytosine residue in a sample nucleotide sequence, the method comprising;

(i) providing a population of polynucleotides which comprise the sample nucleotide sequence,

(ii) reducing and deaminating a 5-methylcytosine (5mC) residue within the population,

(iii) sequencing the polynucleotides in the population or derivatives thereof following step (ii) to produce a treated nucleotide sequence, and;

(iv) identifying the residue in the treated nucleotide sequence which corresponds to a modified cytosine residue in the sample nucleotide sequence.

2. The method of claim 1, wherein the reduction is the reduction of the C5-C6 bond in a modified cytosine residue, and the deamination is the loss of the amino group at the C4 position in a modified cytosine residue, which is replaced with hydroxyl.

3. The method of claim 1 or claim 2, wherein the presence of a thymine residue in the treated nucleotide sequence is indicative that the modified cytosine residue in the sample nucleotide sequence is 5-methylcytosine (5mC).

4. A method of identifying 5-methylcytosine (5mC) or 5-carboxylcytosine (5caC) in a sample nucleotide sequence, the method comprising:

(i) providing a population of polynucleotides which comprise the sample nucleotide sequence,

(ii) treating the population with a radical initiator ~~optionally together with a nucleophile~~,

(iii) sequencing the polynucleotides in the population or derivatives thereof following step (ii) to produce a treated nucleotide sequence, and;

(iv) identifying the residue in the treated nucleotide sequence which corresponds to a modified cytosine residue in the sample nucleotide sequence,

wherein the presence of a thymine residue in the treated nucleotide sequence is indicative that the modified cytosine residue in the sample nucleotide sequence is 5-methylcytosine (5mC) or 5-carboxylcytosine (5caC).

5. A method of identifying a modified cytosine residue in a sample nucleotide sequence, the method comprising:

(i) providing a population of polynucleotides which comprise the sample nucleotide sequence,

(ii) oxidising a first portion of said population,

(iii) treating the oxidised first portion of said population with a radical initiator ~~optionally together with a nucleophile~~,

(iv) sequencing the polynucleotides in the first portions of the population or derivatives thereof following steps ii) and iii) to produce a first nucleotide sequence, and;

(v) identifying the residue in the first nucleotide sequences which corresponds to a modified cytosine residue in the sample nucleotide sequence.

6. The method of claim 5, wherein in step (ii), the oxidation is the oxidation of a C5 methyl group in a modified cytosine residue~~.~~, and optionally

~~7. The method of claim 5 or claim 6,~~ wherein the oxidation is an oxidation by a ten-eleven-translocation (TET) oxygenase, such as an oxygenase selected from TET1, TET2 and TET3.

7~~8~~. A method for modifying a polynucleotide, the method comprising converting a 5-methylcytosine (5mC) residue in a polynucleotide to a dihydrothymine (DHT) residue.

8~~9~~. Use of a radical initiator ~~optionally together with a nucleophile compound,~~ to convert a 5-methylcytosine (5mC) residue in a polynucleotide to a dihydrothymine (DHT) residue, or to convert a 5-carboxylcytosine (5caC) residue in a polynucleotide to a dihydrouracil (DHU) residue.

9~~10~~. The method or use according to any one of claims 4~~1~~ to 8~~9~~, wherein the radical initiator is a transition metal photocatalyst.

10~~11~~. The method or use according to claim 9~~10~~, wherein the transition metal photocatalyst is an iridium photocatalyst.~~,~~

~~12. The method or use according to claim 11,~~ wherein the ~~transition metal~~iridium photocatalyst comprises $[Ir(dF(CF_3)ppy)_2(dtbpy)]^+$, such as the radical initiator ~~is~~ $[Ir(dF(CF_3)ppy)_2(dtbpy)]Cl$.

11~~13~~. The method or use according to any one of claims 4~~1~~ to 10~~12~~, wherein the ~~nucleophile is~~ radical initiator is provided together with a thiol compound, and/or the disulfide form thereof.

12~~14~~. The method or use according to claim 11~~13~~, wherein the thiol compound has one, two or three thiol groups, such as one, and the thiol compound optionally has one, two or three hydroxyl groups, such as one.

13~~15~~. The method or use according to claim 12~~14~~, wherein the thiol is an alkyl thiol.

14~~16~~. The method or use according to claim 11~~13~~, wherein the thiol is mercaptoethanol.

1517. The method according to claim 5, wherein, in step (ii), the first portion of the polynucleotide is treated with a ten-eleven translocation (TET) dioxygenase.

1618. The method or use according to any one of claims 1 to 1517, wherein:

(i) the polynucleotides are genomic DNA, such as mammalian genomic DNA.; or

(ii) 19. The method or use according to any one of claims 1 to 17, wherein the polynucleotides are RNA., such as

20. The method or use according to claim 19, wherein the RNA is genomic RNA, mRNA, tRNA, rRNA or non-coding RNA, such as mammalian, plant or viral genomic RNA.

1721. The method or use according to any one of claims 1 to 1620, wherein the population of polynucleotides or a portion of the population are immobilised.

1822. The method or use according to any one of claims 1 to 1721, wherein a portion of the population is amplified before sequencing.

1923. The method or use according to claim 1822, wherein a portion of the population is amplified following treatment with the radical initiator, optionally together with the nucleophile.

2024. A kit for use in a method of identifying a modified cytosine residue according to any one of claims 1 to 1923 comprising:

(a) a radical initiator, such as a transition metal photocatalyst, such as $[Ir(dF(CF_3)ppy)_2(dtbpy)]Cl$; and

(b) a nucleophile, such as a thiol compound, such as mercaptoethanol.

25. A method of identifying a nucleotide in a sample nucleotide sequence, the method comprising:

(i) providing a population of polynucleotides which comprise the sample nucleotide sequence,

(ii) treating the population with a radical initiator optionally together with a nucleophile to produce treated polynucleotides,

(iii) sequencing the treated polynucleotides following (ii) or derivatives thereof, to obtain a nucleotide sequence comprising a transformed nucleotide corresponding to the nucleotide in the sample nucleotide sequence, and;

(iv) identifying the transformed nucleotide in the nucleotide sequence, thereby identifying the nucleotide in the sample nucleotide sequence.

26. The method of claim 25, wherein the transformed nucleotide comprises a thymine residue.

27. The method of claim 25 or claim 26, wherein the nucleotide identified in the sample nucleotide sequence corresponds to an adenine residue.

28. The method of claim 25 or claim 26, wherein the nucleotide identified in the sample nucleotide sequence corresponds to a guanine residue.

29. The method of claim 25 or claim 26, wherein the nucleotide identified in the sample nucleotide sequence corresponds to a cytosine residue.

30. The method of claim 25 or claim 26, wherein the nucleotide identified in the sample nucleotide sequence corresponds to a modified cytosine residue.

31. The method of claim 25 or claim 26, wherein the nucleotide identified in the sample nucleotide sequence corresponds to a 5-carboxylcytosine (5caC) residue.

32. The method of claim 25 or claims 26, wherein the nucleotide identified in the sample nucleotide sequence corresponds to a 5-methylcytosine (5mC) residue.

33. The method of any one of claims 25 to 32, wherein the population of polynucleotides, or a portion of the population are immobilised.

34. The method according to any one of claims 25 to 33, wherein a portion of the population is copied before sequencing.

35. The method according to claim 34, wherein the portion of the population is copied following treatment with the radical initiator, optionally together with the nucleophile.

36. The method according to claim 34, wherein the portion of the population is copied prior to treatment with the radical initiator, optionally together with the nucleophile.

37. The method according to any one of claims 25 to 36, wherein the radical initiator is a transition metal photocatalyst.

38. The method according to claim 37, wherein the transition metal photocatalyst comprises $[Ir(dF(CF_3)ppy)_2(dtbpy)]^+$.

39. The method according to claim 38, wherein the transition metal photocatalyst is $[Ir(dF(CF_3)ppy)_2(dtbpy)]Cl$.

~~40. The method according to any one of claims 25 to 39, wherein the nucleophile is a thiol compound, and/or a disulfide form thereof.~~

~~41. The method according to claim 40, wherein the thiol compound has one, two or three thiol groups, such as one, and the thiol compound optionally has one, two or three hydroxyl groups, such as one.~~

~~42. The method according to claim 41, wherein the thiol is an alkyl thiol.~~

~~43. The method according to claim 42, wherein the thiol is mercaptoethanol.~~

~~44. The method according to any one of claims 25 to 43, wherein the polynucleotides are genomic DNA, such as mammalian genomic DNA.~~

~~45. The method according to any one of claims 25 to 44, wherein the polynucleotides are RNA.~~

~~46. The method or use according to claim 45, wherein the RNA is genomic RNA, mRNA, tRNA, rRNA or non-coding RNA, such as mammalian, plant or viral genomic RNA.~~

~~47. The method according to any one of claims 25 to 33, wherein a portion of the population is amplified before sequencing.~~

~~48. The method according to claim 47, wherein the portion of the population is amplified following treatment with the radical initiator, optionally together with the nucleophile.~~

~~49. The method according to claim 47, wherein the portion of the population is amplified prior to treatment with the radical initiator, optionally together with the nucleophile.~~

~~50. A kit for use in a method of identifying a nucleotide residue according to the method of any one of claims 25 to 49 comprising:~~

~~(a) a radical initiator, such as a transition metal photocatalyst, such as $[Ir(dF(CF_3)ppy)_2(dtbpy)]Cl$; and~~

~~(b) a nucleophile, such as a thiol compound, such as mercaptoethanol.~~