

WHAT IS CLAIMED IS:

1. A method for synthesizing a nucleic acid,
comprising:
 providing an initiator having an unprotected
5 nucleoside base and a 3' hydroxyl group at a 3'
terminus thereof;
 providing a nucleic acid polymerase having at
least a conservative catalytic polymerase domain of
a family-B DNA polymerase;
10 providing a nucleotide monomer; and
 exposing the initiator to the nucleotide monomer
in the presence of the nucleic acid polymerase and
at least one type of metal cofactors which are
divalent cations, and in the absence of a template,
15 such that the nucleotide monomer is incorporated to
the initiator.
2. The method of Claim 1, wherein the initiator has a
sequence selected from a non-self complementary
sequence and a non-self complementarity forming
20 sequence.
3. The method of Claim 1, wherein the initiator is
linked to a solid support and has a 5' end linked
to the solid support.
4. The method of Claim 3, wherein the solid support is
25 selected from a microarray, a bead, a column, an
optical fiber, a wipe, nitrocellulose, nylon, glass,
quartz, a diazotized membrane, a silicone,

- polyformaldehyde, cellulose, cellulose acetate, paper, a ceramic, a metal, a metalloid, a semiconductor material, a magnetic particle, a plastic, a gel-forming material, a gel, a nanostructured surface, a nanotube, and a nanoparticle.
- 5
5. The method of Claim 1, wherein the initiator is exposed to the nucleotide monomer at a temperature ranging from 10°C to 90°C.
- 10
6. The method of Claim 1, wherein the initiator is exposed to the nucleotide monomer at a pH of not less than 8.0.
7. The method of Claim 1, wherein the metal cofactor is selected from the group consisting of Mg^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Mn^{2+} , Co^{2+} , Fe^{2+} , Ni^{2+} , Cu^{2+} , Zn^{2+} and combinations thereof.
- 15
8. The method of Claim 1, wherein the nucleic acid polymerase further has a 3' to 5' exonuclease domain and is a family-B DNA polymerase selected from the group consisting of a bacterial family-B DNA polymerase, a eukaryotic family-B DNA polymerase, an archaeal family-B DNA polymerase, and a viral family-B DNA polymerase.
- 20
9. The method of Claim 8, wherein the family-B polymerase is selected from the group consisting of a family-B DNA polymerase of *Thermococcus kodakaraensis* (KOD1), a family-B DNA polymerase of
- 25

Pyrococcus furious (Pfu), a family-B DNA polymerase of *Thermococcus sp.* (9°N), a family-B DNA polymerase of *Thermococcus gorgonarius* (Tgo), and a family-B DNA polymerase of *Thermococcus litoralis* (Vent).

- 5 10. The method of Claim 8, wherein the 3' to 5' exonuclease domain of the family-B DNA polymerase is modified in a manner selected from the group consisting of inactivation, attenuation, and deletion.
- 10 11. The method of Claim 1, wherein the initiator is in a single-stranded form.
12. The method of Claim 1, wherein the initiator has at least five nucleotide monomers.
13. The method of Claim 1, wherein the nucleotide
15 monomer has a phosphate group selected from a monophosphate, a diphosphate, a triphosphate, a tetraphosphate, a pentaphosphate, and a hexaphosphate.
14. The method of Claim 1, wherein the nucleotide
20 monomer has a removable blocking moiety selected from the group consisting of a 3'-O-blocking moiety, a base blocking moiety, and a combination thereof.
15. A kit for synthesizing a nucleic acid, comprising:
an initiator having an unprotected nucleoside
25 base and a 3' hydroxyl group at a 3' terminus thereof;

a nucleic acid polymerase having at least a conservative catalytic polymerase domain of a family-B DNA polymerase;

a nucleotide monomer; and

5 at least one type of metal cofactors,

wherein the kit is used according to a method as described in Claim 1.

16. The kit of Claim 15, wherein the initiator has a sequence selected from a non-self complementary sequence and a non-self complementarity forming sequence.

17. The kit of Claim 15, wherein the nucleic acid polymerase further has a 3' to 5' exonuclease domain and is a family-B DNA polymerase selected from the group consisting of a bacterial family-B DNA polymerase, a eukaryotic family-B DNA polymerase, an archaeal family-B DNA polymerase, and a viral family-B DNA polymerase.

18. The kit of Claim 17, wherein the family-B polymerase is selected from the group consisting of a family-B DNA polymerase of *Thermococcus kodakaraensis* KOD1, a family-B DNA polymerase of *Pyrococcus furiosus* (Pfu), a family-B DNA polymerase of *Thermococcus* sp. (9°N), a family-B DNA polymerase of *Thermococcus gorgonarius* (Tgo), and a family-B DNA polymerase of *Thermococcus litoralis* (Vent).

19. The kit of Claim 17, wherein the 3' to 5' exonuclease domain of the family-B DNA polymerase is modified in a manner selected from the group consisting of inactivation, attenuation, and deletion.
- 5 20. The kit of Claim 15, wherein the nucleotide monomer has a removable blocking moiety selected from the group consisting of a 3'-O-blocking moiety, a base blocking moiety, and a combination thereof.