CLAIMS

What is claimed:

1. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, said bacterial cell comprising:

a lysogenized bacteriophage genome lacking a bacteriophage gene encoding a packaging initiation site sequence, wherein deletion of said bacteriophage gene prevents packaging of a bacteriophage nucleic acid molecule into said non-replicative transduction particle; and

a reporter nucleic acid molecule comprising a second bacteriophage gene, wherein said second bacteriophage gene encodes a packaging initiation site sequence and facilitates the packaging a replica of said reporter nucleic acid molecule into said non-replicative transduction particle, wherein said second bacteriophage gene is capable of expressing a protein that is encoded by said gene, wherein said replica of said reporter nucleic acid molecule forms a replicon amenable to packaging into said non-replicative transduction particle.

2. The bacterial cell packaging system of claim 1, wherein said reporter nucleic acid molecule is operatively linked to a promoter.

3. The bacterial cell packaging system of claim 2, wherein said promoter is selected for contributing to reactivity of a reporter molecule expressed from said reporter nucleic acid molecule in said bacterial cell.

4. The bacterial cell packaging system of claim 1, wherein said reporter nucleic acid molecule comprises an origin of replication.

5. The bacterial cell packaging system of claim 1, wherein said replicon comprises a concatamer amenable to packaging into said non-replicative transduction particle.

6. The bacterial cell packaging system of claim 1, wherein said first and said second bacteriophage genes each comprises a pacA gene of the Enterobacteriaceae bacteriophage P1 and comprises said packaging initiation site sequence.

7. The bacterial cell packaging system of claim 1, wherein said second bacteriophage gene comprises the sequence of SEQ ID NO:9.

8. The bacterial cell packaging system of claim 1, wherein said replicon is the Enterobacteriaceae bacteriophage P1 lytic replicon.

9. The bacterial cell packaging system of claim 1, wherein said replicon comprises a C1 repressor-controlled P53 promoter, a promoter P53 antisense, a repL gene, and an in-frame deletion of a kilA gene.

10. The bacterial cell packaging system of claim 1, wherein said replicon comprises of the sequence of SEQ ID NO:3.

11. The bacterial cell packaging system of claim 1, wherein said first and said second bacteriophage genes each comprises a small terminase (terS) gene comprising said packaging initiation site sequence.

12. The bacterial cell packaging system of claim 1, wherein said terS gene is a *S. aureus* bacteriophage φ11 or φ80α terS gene.

13. The bacterial cell packaging system of claim 1, wherein said replicon is derived from a *S. aureus* pT181 plasmid origin of replication.

14. The bacterial cell packaging system of claim 1, wherein said replicon comprises the sequence of SEQ ID NO:5.

15. The bacterial cell packaging system of claim 1, wherein said packaging initiation site sequence of said second bacteriophage gene comprises a pac-site.

16. The bacterial cell packaging system of claim 1, wherein said pac-site of said second bacteriophage gene comprises the sequence of SEQ ID NO:7.

17. The bacterial cell packaging system of claim 1, wherein said packaging initiation site sequence of said second bacteriophage gene comprises a cos-site.

18. The bacterial cell packaging system of claim 1, wherein said packaging initiation site sequence of said second bacteriophage gene comprises a concatamer junction.

19. The bacterial cell packaging system of claim 1, further comprising a plasmid comprising said reporter nucleic acid molecule.

20. The bacterial cell packaging system of claim 1, wherein said second bacteriophage gene is operatively linked to a promoter.

21. The bacterial cell packaging system of claim 1, wherein said promoter is an inducible promoter or a constitutive promoter.

22. The bacterial cell packaging system of claim 1, wherein said bacteriophage comprises the Enterobacteriaceae bacteriophage P1.

23. The bacterial cell packaging system of claim 22, wherein said bacteriophage comprises a *S. aureus* bacteriophage φ80α or a bacteriophage φ11.

24. The bacterial cell packaging system of claim 1, wherein said bacterial cell comprises an *E. coli* cell.

25. The bacterial cell packaging system of claim 1, wherein said bacterial cell comprises an *S. aureus* cell.

26. The bacterial cell packaging system of claim 1, wherein said bacterial cell comprises a Gram-negative cell.

27. The bacterial cell packaging system of claim 1, wherein said bacterial cell comprises a Gram-positive cell.

28. The bacterial cell packaging system of claim 1, wherein said reporter nucleic acid molecule comprises a reporter gene.

29. The bacterial cell packaging system of claim 28, wherein said reporter gene encodes a detectable and/or a selectable marker.

30. The bacterial cell packaging system of claim 28, wherein said reporter gene is selected from the group consisting of enzymes mediating luminescence reactions (luxA, luxB, luxAB, luc, ruc, nluc), enzymes mediating colorimetric reactions (lacZ, HRP), fluorescent proteins (GFP, eGFP, YFP, RFP, CFP, BFP, mCherry, near-infrared fluorescent proteins), affinity peptides (His-tag, 3X-FLAG), and selectable markers (ampC, tet(M), CAT, erm).

31. The bacterial cell packaging system of claim 1, wherein said reporter nucleic acid molecule comprises an aptamer.

32. The bacterial cell packaging system of claim 28, wherein said reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in said reporter nucleic acid molecule.

33. The bacterial cell packaging system of claim 32, wherein said nucleic acid transcript sequence is complementary to a cellular transcript.

34. The bacterial cell packaging system of claim 32, wherein said nucleic acid transcript sequence comprises a cis-repressing sequence.

35. The bacterial cell packaging system of any one of claims 1-34, wherein said replica of said reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in said replica of said reporter nucleic acid molecule.

36. The bacterial cell packaging system of claim 35, wherein said nucleic acid transcript sequence is complementary to a cellular transcript.

37. The bacterial cell packaging system of claim 35, wherein said nucleic acid transcript sequence comprises a cis-repressing sequence.

38. A method for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, comprising:

providing conditions to said bacterial cell of any of the claims 1-31 that induce a lytic phase of said bacteriophage to produce non-replicative transduction particles packaged with said reporter nucleic acid molecule; and

isolating said non-replicative transduction particle comprising said reporter nucleic acid molecule.

39. The method of claim 38, wherein said non-replicative transduction particle does not contain a replicated bacteriophage genome.

40. The method of claim 38, wherein said induction of said lytic phase triggers excision of said genomic island nucleic acid molecule from said genome of said bacterial cell.

41. A composition comprising said non-replicative transduction particle comprising a replica of said reporter nucleic acid molecule produced from said method of any one of claims 38-40.

42. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, said bacterial cell comprising:

a lysogenized bacteriophage genome comprising a first bacteriophage packaging initiation site sequence, wherein said first bacteriophage packaging initiation site sequence comprises a mutation that prevents packaging of a bacteriophage nucleic acid molecule into said non-replicative transduction particle; and

a reporter nucleic acid molecule comprising a second bacteriophage packaging initiation site sequence, wherein said second bacteriophage packaging initiation site sequence lacks said mutation and facilitates the packaging of a replica of said reporter nucleic acid molecule into said non-replicative transduction particle, wherein said replica of said reporter nucleic acid molecule forms a replicon for packaging into said non-replicative transduction particle.

43. The bacterial cell packaging system of claim 42, wherein said reporter nucleic acid molecule is operatively linked to a promoter.

44. The bacterial cell packaging system of claim 43, wherein said promoter is selected for contributing to reactivity of a reporter molecule expressed from said reporter nucleic acid molecule in said bacterial cell.

45. The bacterial cell packaging system of claim 42, wherein said reporter nucleic acid molecule comprises an origin of replication.

46. The bacterial cell packaging system of claim 42, wherein said replicon comprises a concatamer amenable to packaging into said non-replicative transduction particle.

47. The bacterial cell packaging system of claim 42, wherein said first and said second bacteriophage packaging initiation site sequences each comprise a packaging initiation site sequence from a small terminase gene.

48. The bacterial cell packaging system of claim 42, wherein said first and said second bacteriophage packaging initiation site sequences each comprise a pac-site sequence from a pacA gene of the Enterobacteriaceae bacteriophage P1.

49. The bacterial cell packaging system of claim 42, wherein said first bacteriophage packaging initiation site sequence comprises SEQ ID NO:2.

50. The bacterial cell packaging system of claim 42, wherein said second bacteriophage packaging initiation site sequence comprises SEQ ID NO:1.

51. The bacterial cell packaging system of claim 42, wherein said replicon comprises an Enterobacteriaceae bacteriophage P1 lytic replicon.

52. The bacterial cell packaging system of claim 51, wherein said replicon comprises a C1 repressor-controlled P53 promoter, a promoter P53 antisense, a repL gene, and an in-frame deletion of a kilA gene.

53. The bacterial cell packaging system of claim 42, wherein said replicon comprises the sequence of SEQ ID NO:3.

54. The bacterial cell packaging system of claim 42, wherein said first and said second bacteriophage packaging initiation site sequences each comprise a pac-site sequence from a small terminase (terS) gene of an *S. aureus* bacteriophage φ11 or φ80α.

55. The bacterial cell packaging system of claim 42, wherein said replicon is derived from a *S. aureus* pT181 plasmid origin of replication.

56. The bacterial cell packaging system of claim 42, wherein said replicon comprises the sequence of SEQ ID NO:5.

57. The bacterial cell packaging system of claim 42, wherein said first bacteriophage packaging initiation site sequence comprises the sequence of SEQ ID NO:2.

58. The bacterial cell packaging system of claim 42, wherein said second bacteriophage packaging initiation site sequence comprises the sequence of SEQ ID NO:1.

59. The bacterial cell packaging system of claim 42, wherein said packaging initiation site sequence comprises a pac-site.

60. The bacterial cell packaging system of claim 42, wherein said packaging initiation site sequence comprises a cos-site.

61. The bacterial cell packaging system of claim 42, wherein said packaging initiation site sequence comprises a concatamer junction.

62. The bacterial cell packaging system of claim 42, wherein said mutation in said first bacteriophage packaging initiation site sequence comprises a silent mutation.

63. The bacterial cell packaging system of claim 42, wherein said mutation in said first bacteriophage packaging initiation site sequence prevents cleavage of said packaging initiation sequence.

64. The bacterial cell packaging system of claim 42, further comprising a plasmid comprising said reporter nucleic acid molecule.

65. The bacterial cell packaging system of claim 42, wherein said bacteriophage comprises Enterobacteriaceae bacteriophage P1.

66. The bacterial cell packaging system of claim 42, wherein said bacteriophage comprises the *S. aureus* bacteriophage φ11 or φ80α.

67. The bacterial cell packaging system of claim 42, wherein said bacterial cell comprises an *E. coli* cell.

68. The bacterial cell packaging system of claim 42, wherein said bacterial cell comprises an *S. aureus* cell.

69. The bacterial cell packaging system of claim 42, wherein said bacterial cell comprises a Gram-negative bacterial cell.

70. The bacterial cell packaging system of claim 42, wherein said bacterial cell comprises a Gram-positive bacterial cell.

71. The bacterial cell packaging system of claim 42, wherein said reporter nucleic acid molecule comprises a reporter gene.

72. The bacterial cell packaging system of claim 71, wherein said reporter gene encodes a detectable marker and/or a selectable marker.

73. The bacterial cell packaging system of claim 71, wherein said reporter gene is selected from the group consisting of: genes encoding enzymes mediating luminescence reactions (luxA, luxB, luxAB, luc, ruc, nluc), genes encoding enzymes mediating colorimetric reactions (lacZ, HRP), genes encoding fluorescent proteins (GFP, eGFP, YFP, RFP, CFP, BFP, mCherry, near-infrared fluorescent proteins), nucleic acid molecules encoding affinity peptides (His-tag, 3X-FLAG), and genes encoding selectable markers (ampC, tet(M), CAT, erm).

74. The bacterial cell packaging system of claim 71, wherein said reporter nucleic acid molecule comprises an aptamer.

75. The bacterial cell packaging system of claim 42, wherein said replicon is packaged into said non-replicative transduction particle by bacteriophage packaging machinery.

76. The bacterial cell packaging system of claim 42, wherein said reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in said reporter nucleic acid molecule.

77. The bacterial cell packaging system of claim 76, wherein said nucleic acid transcript sequence is complementary to a cellular transcript.

78. The bacterial cell packaging system of claim 42, wherein said nucleic acid transcript sequence comprises a cis-repressing sequence.

79. The bacterial cell packaging system of any one of claims 42-78, wherein said replica of said reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in said replica of said reporter nucleic acid molecule.

80. The bacterial cell packaging system of claim 79, wherein said nucleic acid transcript sequence is complementary to a cellular transcript.

81. The bacterial cell packaging system of claim 79, wherein said nucleic acid transcript sequence comprises a cis-repressing sequence.

82. A method for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, comprising:

providing conditions to said bacterial cell of any of the claims 42-75 that induce a lytic phase of said bacteriophage to produce non-replicative transduction particles packaged with said reporter nucleic acid molecule; and

isolating said non-replicative transduction particle comprising said reporter nucleic acid molecule.

83. The method of claim 82, wherein said non-replicative transduction particle does not contain a replicated bacteriophage genome.

84. The method of claim 82, wherein said induction of said lytic phase triggers excision of said genomic island nucleic acid molecule from said genome of said bacterial cell.

85. A composition comprising said non-replicative transduction particle comprising a replica of said reporter nucleic acid molecule produced from said method of any one of claims 82-84.

86. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, said bacterial cell comprising:

a lysogenized bacteriophage genome comprising a first bacteriophage gene comprising a deletion of a packaging initiation site sequence of said first bacteriophage gene that prevents packaging of a bacteriophage nucleic acid molecule into said non-replicative transduction particle; and

a reporter nucleic acid molecule comprising a second bacteriophage gene comprising a second packaging initiation site sequence that facilitates the packaging a replica of said reporter nucleic acid molecule into said non-replicative transduction particle, wherein said second bacteriophage gene encodes a protein, wherein said replica of said reporter nucleic acid molecule forms a replicon for packaging into said non-replicative transduction particle.

87. The bacterial cell packaging system of claim 86, wherein said reporter nucleic acid molecule is operatively linked to a promoter.

88. The bacterial cell packaging system of claim 87, wherein said promoter is selected for contributing to reactivity of a reporter molecule expressed from said reporter nucleic acid molecule in said bacterial cell.

89. The bacterial cell packaging system of claim 86, wherein said reporter nucleic acid comprises an origin of replication.

90. The bacterial cell packaging system of claim 86, wherein said replicon comprises a concatamer amenable to packaging into said non-replicative transduction particle.

91. The bacterial cell packaging system of claim 74, wherein said first and said second bacteriophage genes each comprises a pacA gene of the Enterobacteriaceae bacteriophage P1 and comprise said packaging initiation site sequence.

92. The bacterial cell packaging system of claim 87, wherein said first bacteriophage gene comprises the sequence of SEQ ID NO:6.

93. The bacterial cell packaging system of claim 87, wherein said second bacteriophage gene comprises the sequence SEQ ID NO:7.

94. The bacterial cell packaging system of claim 86, wherein said replicon comprises an Enterobacteriaceae bacteriophage P1 lytic replicon.

95. The bacterial cell packaging system of claim 94, wherein said replicon comprises a C1 repressor-controlled P53 promoter, a promoter P53 antisense, a repL gene, and an in-frame deletion of a kilA gene.

96. The bacterial cell packaging system of claim 86, wherein said replicon comprises the sequence of SEQ ID NO:3.

97. The bacterial cell packaging system of claim 86, wherein said first and said second bacteriophage genes each comprises a small terminase (terS) gene comprising said packaging initiation site sequence.

98. The bacterial cell packaging system of claim 97, wherein said terS gene is a *S. aureus* bacteriophage φ11 or φ80α terS gene.

99. The bacterial cell packaging system of claim 86, wherein said first bacteriophage gene comprises the sequence of SEQ ID NO:8.

100. The bacterial cell packaging system of claim 86, wherein said second bacteriophage gene comprises the sequence of SEQ ID NO:9.

101. The bacterial cell packaging system of claim 86, wherein said replicon is derived from a *S. aureus* pT181 plasmid origin of replication.

102. The bacterial cell packaging system of claim 86, wherein said replicon comprises the sequence of SEQ ID NO:5.

103. The bacterial cell packaging system of claim 86, wherein said packaging initiation site sequence of said second bacteriophage gene comprises a pac-site.

104. The bacterial cell packaging system of claim 86, wherein said packaging initiation site sequence of said second bacteriophage gene comprises a cos-site.

105. The bacterial cell packaging system of claim 86, wherein said packaging initiation site sequence of said second bacteriophage gene comprises a concatamer junction.

106. The bacterial cell packaging system of claim 86, further comprising a plasmid comprising said reporter nucleic acid molecule.

107. The bacterial cell packaging system of claim 86, wherein said second bacteriophage gene is operatively linked to a promoter.

108. The bacterial cell packaging system of claim 107, wherein said promoter is an inducible promoter or a constitutive promoter.

109. The bacterial cell packaging system of claim 86, wherein said bacteriophage comprises the Enterobacteriaceae bacteriophage P1.

110. The bacterial cell packaging system of claim 86, wherein said bacteriophage comprises the *S. aureus* bacteriophage φ80α or bacteriophage φ11.

111. The bacterial cell packaging system of claim 86, wherein said bacterial cell comprises an *E. coli* cell.

112. The bacterial cell packaging system of claim 86, wherein said bacterial cell comprises an *S. aureus* cell.

113. The bacterial cell packaging system of claim 86, wherein said bacterial cell comprises a Gram-negative cell.

114. The bacterial cell packaging system of claim 86, wherein said bacterial cell comprises a Gram-positive cell.

115. The bacterial cell packaging system of claim 86, wherein said reporter nucleic acid molecule comprises a reporter gene.

116. The bacterial cell packaging system of claim 115, wherein said reporter gene encodes a detectable and/or a selectable marker.

117. The bacterial cell packaging system of claim 62, wherein said reporter gene is selected from the group consisting of genes encoding enzymes mediating luminescence reactions (luxA, luxB, luxAB, luc, ruc, nluc), genes encoding enzymes mediating colorimetric reactions (lacZ, HRP), genes encoding fluorescent proteins (GFP, eGFP, YFP, RFP, CFP, BFP, mCherry, near-infrared fluorescent proteins), nucleic acid molecules encoding affinity peptides (His-tag, 3X-FLAG), and genes encoding selectable markers (ampC, tet(M), CAT, erm).

118. The bacterial cell packaging system of claim 86, wherein said reporter nucleic acid molecule comprises an aptamer.

119. The bacterial cell packaging system of claim 86, wherein said replicon is packaged into said non-replicative transduction particle by bacteriophage packaging machinery.

120. The bacterial cell packaging system of claim 86, wherein said reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in said reporter nucleic acid molecule.

121. The bacterial cell packaging system of claim 120, wherein said nucleic acid transcript sequence is complementary to a cellular transcript.

122. The bacterial cell packaging system of claim 86, wherein said nucleic acid transcript sequence comprises a cis-repressing sequence.

123. The bacterial cell packaging system of any one of claims 86-122, wherein said replica of said reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in said replica of said reporter nucleic acid molecule.

124. The bacterial cell packaging system of claim 123, wherein said nucleic acid transcript sequence is complementary to a cellular transcript.

125. The bacterial cell packaging system of claim 123, wherein said nucleic acid transcript sequence comprises a cis-repressing sequence.

126. A method for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, comprising:

providing conditions to said bacterial cell of any of the claims 86-125 that induce a lytic phase of said bacteriophage to produce non-replicative transduction particles packaged with said reporter nucleic acid molecule; and

isolating said non-replicative transduction particle comprising said reporter nucleic acid molecule.

127. The method of claim 126, wherein said non-replicative transduction particle does not contain a replicated bacteriophage genome.

128. The method of claim 126, wherein said induction of said lytic phase triggers excision of said genomic island nucleic acid molecule from said genome of said bacterial cell.

129. A composition comprising said non-replicative transduction particle comprising a replica of said reporter nucleic acid molecule produced from said method of any one of claims 126-128.

130. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, said bacterial cell comprising:

a lysogenized bacteriophage genome lacking a packaging gene and comprising genes that encode proteins that form said non-replicative transduction particle; and

a genomic island nucleic acid molecule comprising a reporter nucleic acid molecule and a packaging gene.

131. The bacterial cell packaging system of claim 130, wherein said packaging gene comprises a small terminase (terS) gene.

132. The bacterial cell packaging system of claim 131, wherein said terS gene comprises a *S. aureus* bacteriophage φ80α terS gene or a bacteriophage φ11 terS gene.

133. The bacterial cell packaging system of claim 131, wherein said terS gene comprises the sequence of SEQ ID NO:9.

134. The bacterial cell packaging system of claim 130, wherein said genomic island nucleic acid molecule comprises a SaPIbov2 genomic island nucleic acid molecule.

135. The bacterial cell packaging system of claim 130, wherein said genomic island nucleic acid molecule is selected from the group consisting of a SaPI, a SaPI1, a SaPI2, a SaPIbov1 and a SaPibov2 genomic island nucleic acid molecule.

136. The bacterial cell packaging system of claim 98, wherein said reporter nucleic acid molecule is operatively linked to a promoter.

137. The bacterial cell packaging system of claim 98, wherein said reporter nucleic acid molecule comprises an origin of replication.

138. The bacterial cell packaging system of claim 130, wherein said bacteriophage comprises a *S. aureus* bacteriophage φ80α or bacteriophage φ11.

139. The bacterial cell packaging system of claim 130, wherein said bacterial cell comprises an *S. aureus* cell.

140. The bacterial cell packaging system of claim 130, wherein said genomic island nucleic acid molecule comprises an integrase gene and wherein said integrase gene encodes

an integrase protein for excising and integrating said genomic island nucleic acid molecule out of and into a bacterial genome of said bacterial cell.

141. The bacterial cell packaging system of claim 140, wherein said integrase gene comprises the sequence of SEQ ID NO:10.

142. The bacterial cell packaging system of claim 130, wherein said genomic island nucleic acid molecule is integrated into a bacterial genome of said bacterial cell.

143. The bacterial cell packaging system of claim 130, wherein said genomic island nucleic acid molecule can be replicated and forms molecule replicon that is amenable to packaging by the bacteriophage packaging machinery in said bacterial cell.

144. The bacterial cell packaging system of claim 143, wherein said nucleic acid molecule forms a concatamer.

145. The bacterial cell packaging system of claim 143, wherein said replicated genomic island nucleic acid molecule is capable of being packaged into said non-replicative transduction particle.

146. The bacterial cell packaging system of claim 130, wherein said packaging gene comprises a pac site sequence.

147. The bacterial cell packaging system of claim 130, wherein said packaging gene comprises a cos-site sequence.

148. The bacterial cell packaging system of claim 130, wherein said packaging gene comprises a concatamer junction.

149. The bacterial cell packaging system of claim 130, wherein said reporter nucleic acid molecule comprises a reporter gene.

150. The bacterial cell packaging system of claim 149, wherein said reporter gene encodes a selectable marker and/or a selectable marker.

151. The bacterial cell packaging system of claim 149, wherein said reporter gene is selected from the group consisting of enzymes mediating luminescence reactions (luxA, luxB, luxAB, luc, ruc, nluc), enzymes mediating colorimetric reactions (lacZ, HRP), fluorescent proteins (GFP, eGFP, YFP, RFP, CFP, BFP, mCherry, near-infrared fluorescent proteins), affinity peptides (His-tag, 3X-FLAG), and selectable markers (ampC, tet(M), CAT, erm).

152. The bacterial cell packaging system of claim 130, wherein said reporter nucleic acid molecule comprises an aptamer.

153. The bacterial cell packaging system of claim 130, wherein said genomic island nucleic acid molecule lacks an integrase gene.

154. The bacterial cell packaging system of claim 153, further comprising a bacterial gene comprising an integrase gene operatively linked to a promoter and wherein said integrase gene encodes an integrase protein for excising and integrating said genomic island nucleic acid molecule out of and into a bacterial genome of said bacterial cell.

155. The bacterial cell packaging system of claim 130, wherein said reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in said reporter nucleic acid molecule.

156. The bacterial cell packaging system of claim 155, wherein said nucleic acid transcript sequence is complementary to a cellular transcript.

157. The bacterial cell packaging system of claim 155, wherein said nucleic acid transcript sequence comprises a cis-repressing sequence.

158. The bacterial cell packaging system of any one of claims 130-157wherein said replica of said reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in said replica of said reporter nucleic acid molecule.

159. The bacterial cell packaging system of claim 158, wherein said nucleic acid transcript sequence is complementary to a cellular transcript.

160. The bacterial cell packaging system of claim 158, wherein said nucleic acid transcript sequence comprises a cis-repressing sequence.

161. A method for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, comprising:

providing conditions to said bacterial cell of any of the claims 130-160 that induce a lytic phase of said bacteriophage to produce non-replicative transduction particles packaged with said reporter nucleic acid molecule; and

isolating said non-replicative transduction particle comprising said reporter nucleic acid molecule.

162. The method of claim 161, wherein said non-replicative transduction particle does not contain a replicated bacteriophage genome.

163. The method of claim 161, wherein said induction of said lytic phase triggers excision of said genomic island nucleic acid molecule from said genome of said bacterial cell.

164. A composition comprising said non-replicative transduction particle comprising a replica of said reporter nucleic acid molecule produced from said method of any one of claims 161-163.

165. A method for detecting a presence or an absence of a bacterial cell in a sample, comprising:

introducing into a sample a non-replicative transduction particle comprising a reporter gene encoding a reporter molecule and lacking a bacteriophage genome under conditions such that said non-replicative transduction particle can transduce said bacterial cell and wherein said reporter gene can be expressed in said bacterial cell;

providing conditions for activation of said reporter molecule; and

detecting for a presence or an absence of a reporter signal transmitted from said expressed reporter molecule, wherein a presence of said reporter signal correctly indicates said presence of said bacterial cell.

166. The method of claim 165, wherein said method produces at least 80% specificity of detection with reference to a standard.

167. The method of claim 165, wherein said method produces at least 90% specificity of detection with reference to a standard.

168. The method of claim 165, wherein said method achieves at least 95% specificity of detection with reference to a standard.

169. The method of claim 165, wherein said method achieves at least 80% sensitivity of detection with reference to a standard.

170. The method of claim 165, wherein said method achieves at least 85% sensitivity of detection with reference to a standard.

171. The method of claim 165, wherein said method achieves at least 90% sensitivity of detection with reference to a standard.

172. The method of claim 165, wherein said method achieves at least 95% sensitivity of detection with reference to a standard.

173. The method of claim 165, wherein said method achieves at least 95% specificity of detection and at least 90% sensitivity of detection with reference to a standard.

174. The method of any one of claims 166-173, wherein said standard is a Gold standard.

175. The method of claim 165, wherein said bacterial cell comprises a Methicillin Resistant *Staphylococcus aureus* (MRSA) cell.

176. The method of claim 165, wherein said bacterial cell comprises a Methicillin Sensitive *Staphylococcus aureus* (MSSA) cell.

177. The method of claim 165, wherein said reporter gene encodes a detectable or selectable marker.

178. The method of claim 165, wherein said reporter gene is selected from the group consisting of genes encoding enzymes mediating luminescence reactions (luxA, luxB, luxAB,

luc, ruc, nluc), genes encoding enzymes mediating colorimetric reactions (lacZ, HRP), genes encoding fluorescent proteins (GFP, eGFP, YFP, RFP, CFP, BFP, mCherry, near-infrared fluorescent proteins), nucleic acid molecules encoding affinity peptides (His-tag, 3X-FLAG), and genes encoding selectable markers (ampC, tet(M), CAT, erm).

179. The method of claim 165, wherein said reporter gene is operatively linked to a constitutive promoter.

180. The method of claim 165, wherein said reporter signal can be detected from a sample at a limit of detection (LoD) of less than 1,000 colony forming units (CFU).

181. The method of claim 165, wherein said reporter signal can be detected from a sample at a limit of detection (LoD) of less than 100 colony forming units (CFU).

182. The method of claim 165, wherein said reporter signal can be detected from a sample at a limit of detection (LoD) of less than 10 colony forming units (CFU).

183. The method of claim 182, wherein said reporter signal can be detected from a sample at a LoD less than five CFU.

184. The method of claim 183, wherein said reporter signal can be detected from a sample at a LoD of three or less CFU.

185. The method of claim 165, further comprising providing an antibiotic to said sample at a pre-determined concentration and detecting a presence or absence of said reporter signal to determine whether said bacterial cell is resistant or sensitive to said antibiotic.

186. The method of claim 165, further comprising providing varying pre-determined concentrations antibiotic to said sample and detecting the amount of said reporter signal to determine the minimum inhibitory concentration of said bacterial cell to said antibiotic.

187. A composition comprising:

a nucleic acid construct that encodes a nucleic acid reporter transcript that is capable of forming at least two conformations comprising:

a first conformation that prevents reporter expression comprising an intramolecular double stranded region comprising a first subsequence and a second subsequence, and

a second conformation that lacks said intramolecular double-stranded region and allows reporter gene expression,

wherein conversion between said first and second conformations is mediated by competitive binding of a cellular transcript to said first and/or said second subsequence.

188. The composition of claim 187, further comprising a non-replicative transduction particle comprising said nucleic acid construct.

189. The composition of claim 187, wherein said competitive binding of said cellular transcript to said first and/or said second subsequence results in said second conformation of said nucleic acid reporter construct.

190. The composition of claim 187, wherein said first subsequence or said second subsequence comprises a cis-repressing sequence.

191. The composition of claim 190, wherein said cis-repressing sequence comprises a sequence that is complementary or substantially complementary to a portion of said cellular transcript.

192. The composition of claim 187, wherein said first subsequence or said second subsequence comprises a reporter gene sequence.

193. The composition of claim 192, wherein said reporter gene sequence comprises a ribosome binding site.

194. The composition of claim 192, wherein said reporter gene sequence encodes a detectable molecule.

195. The composition of claim 194, wherein said detectable marker comprises a fluorescent molecule or an enzyme capable of mediating a luminescence or colorimetric reaction.

196. The composition of claim 192, wherein said reporter gene sequence encodes a selectable marker.

197. The composition of claim 196, wherein said selectable marker comprises an antibiotic resistance gene.

198. The composition of claim 187, wherein said first subsequence and said second subsequence are located cis to each other on said nucleic acid construct to form said intramolecular double stranded region.

199. The composition of claim 187, wherein said first subsequence and said second subsequence are complementary or substantially complementary to each other to form said intramolecular double stranded region.

200. The composition of claim 187, wherein said first subsequence or said second subsequence of said first conformation comprises a transcriptional enhancer sequence, and wherein said transcriptional enhancer sequence is upstream from a coding region of said reporter gene sequence.

201. The composition of claim 187, wherein said first conformation of said nucleic acid reporter transcript is capable of binding to a cleaving enzyme.

202. The composition of claim 187, wherein said first conformation of said nucleic acid reporter transcript is a target for degradation by a cellular enzyme.

203. The composition of claim 187, wherein said first conformation comprises a non-binding intramolecular region.

204. The composition of claim 203, wherein said non-binding intramolecular region is located 3' of said first subsequence and 5' of said second subsequence.

205. The composition of claim 203, wherein said non-binding intramolecular region comprises a sequence YUNR, wherein Y is a pyrimidine, U is a Uracil, N is any nucleotide, and R is a purine.

206. The composition of claim 187, wherein said first subsequence or said second subsequence comprises a modified sequence of said cellular transcript.

207. The composition of claim206, wherein said modified sequence comprises a nucleotide substitution.

208. The composition of claim206, wherein said modified sequence comprises a sequence insertion, a deletion or an inversion of said cellular transcript.

209. A composition comprising:

a nucleic acid construct that encodes a nucleic acid reporter transcript comprising a gene reporter sequence and that is capable of forming at least two conformations of said nucleic acid reporter transcript,

a first unstable conformation that prevents translation of said reporter gene sequence in said nucleic acid reporter transcript, and

a second stable conformation resulting from binding of said first unstable conformation with a cellular transcript, said second stable secondary conformation allowing translation of said reporter gene sequence of said nucleic acid reporter transcript.

210. The composition of claim 209, further comprising a non-replicative transduction particle comprising said nucleic acid construct.

211. The composition of claim 209, wherein said cellular transcript binds at a 3'UTR sequence of said nucleic acid reporter transcript.

212. The composition of claim 209, wherein said second stable secondary conformation is formed by cleavage of a portion of a sequence of said first unstable secondary conformation.

213. The composition of claim 209, wherein said reporter gene sequence encodes a detectable molecule.

214. The composition of claim 213, wherein said detectable marker comprises a fluorescent molecule or an enzyme capable of mediating a luminescence or colorimetric reaction.

215. The composition of claim 209, wherein said reporter gene sequence encodes a selectable marker.

216. The composition of claim 215, wherein said selectable marker comprises an antibiotic resistance gene.

217. A composition comprising:

a nucleic acid construct that encodes a nucleic acid reporter transcript comprising a reporter gene sequence and that is capable of forming at least two conformations of said nucleic acid reporter transcript, comprising:

a first conformation that prevents further transcription of said nucleic acid construct, and

a second conformation formed upon binding of said first conformation with a cellular transcript, wherein said second conformation allows transcription of said nucleic acid construct.

218. The composition of claim 217, further comprising a non-replicative transduction particle comprising said nucleic acid construct.

219. The composition of claim 217, wherein said nucleic acid reporter transcript comprises a cis-repressing sequence.

220. The composition of claim 218, wherein said nucleic acid reporter transcript comprises a reporter gene sequence.

221. The composition of claim 220, wherein said first conformation forms from a binding of said cis-repressing sequence to said reporter gene sequence.

222. The composition of claim 221, wherein said first conformation is a substrate for a cleaving enzyme.

223. The composition of claim 218, wherein said first conformation of said nucleic acid reporter transcript comprises a sequence that forms a transcription termination structure.

224. The composition of claim 223, wherein binding of said cellular transcript to said sequence that forms a transcription termination structure results in cleavage of a portion of said nucleic acid reporter transcript and formation of said second conformation.

225. A vector comprising a regulatory sequence operably linked to a nucleic acid sequence that encodes said nucleic acid reporter transcript of claims 187-224.

226. A method for detecting a target transcript in a cell, comprising:

introducing into said cell said nucleic acid reporter construct of claims 187-224; and

detecting the presence or absence of an output signal from said cell, wherein said presence of said output signal indicates the presence of the target transcript in said cell.

227. The method of claim 226, further comprising detecting a presence of a bacterial cell based on detecting said presence of said target transcript.

228. A method for detecting a presence of a bacterial cell in a sample comprising:

introducing into said sample said nucleic acid reporter construct of claims 187-224; and

detecting the presence or absence of an output signal from said sample, wherein said presence of said output signal indicates the presence of the bacterial cell in said sample.

229. A kit, comprising:

a compartment for holding a sample comprising a cell and said nucleic acid reporter construct of claims 187-224; and

instructions for detecting the presence or absence of an output signal from said sample, wherein the presence of the output signal indicates the presence of a target transcript in said cell.

230. A composition, comprising:

a non-replicative transduction particle comprising a nucleic acid reporter construct, the nucleic acid reporter construct comprising a first promoter operatively linked a reporter gene, wherein said first promoter is capable of being induced by an inducer protein endogenous in a bacterial cell.

231. A method for detecting a presence of a bacterial cell in a sample comprising:

contacting said sample with a non-replicative transduction particle comprising nucleic acid reporter construct comprising a first promoter operatively linked to a reporter gene, wherein said first promoter is capable of being induced by an inducer protein endogenous to said bacterial cell; and

detecting the presence or absence of an output signal from said reporter gene, wherein said presence of said output signal indicates the presence of said bacterial cell in said sample.

232. The method of claim 231, wherein said first promoter is the same as an inducible promoter operatively linked to a target nucleic acid molecule in said bacterial cell.

233. A composition, comprising:

a non-replicative transduction particle comprising a nucleic acid reporter construct, the nucleic acid reporter construct comprising a reporter gene that encodes a reporter molecule, the non-replicative transduction particle capable of entering a bacterial cell; and

a caged substrate that exogenous to said bacterial cell that once un-caged is capable of reacting to said reporter molecule in said cell.

234. A method for detecting a presence of a bacterial cell in a sample comprising:

contacting said sample with a caged substrate and a non-replicative transduction particle comprising a nucleic acid reporter construct, the nucleic acid reporter construct comprising a reporter gene that encodes a reporter molecule, the caged substrate exogenous to said cell that once un-caged is capable of binding to said reporter molecule in said bacterial cell; and

detecting the presence or absence of an output signal from said reporter molecule, wherein said presence of said output signal indicates the presence of said bacterial cell in said sample.

235. The method of claim 234, wherein a target enzyme in said cell binds said caged substrate to produce an un-caged substrate.

236. The method of claim 235, wherein said un-caged substrate reacts with said reporter molecule to produce said output signal.

237. A composition, comprising:

a non-replicative transduction particle comprising a nucleic acid reporter construct, the nucleic acid reporter construct encoding a switchable molecule capable of binding to a target molecule in a bacterial cell to form a complex; and

a substrate capable of penetrating said cell and binding said complex to produce a detectable signal from said cell.

238. A method for detecting a presence of a bacterial cell in a sample comprising:

contacting said sample with a substrate and a non-replicative transduction particle comprising a nucleic acid reporter construct encoding a switchable molecule, the switchable molecule capable of binding a target molecule in said cell to form a complex, the substrate capable of binding said complex to form a substrate-bound complex; and

detecting the presence or absence of an output signal from said substrate-bound complex, wherein said presence of said output signal indicates the presence of said bacterial cell in said sample.

239. The method of claim 238, wherein binding of said switchable molecule to said target molecule produces a conformational change in said switchable molecule.

240. The method of claim 239, wherein said conformational change in said switchable molecule allows said substrate to bind to said complex.

CLAIMS

1. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, said bacterial cell comprising:
   - a lysogenized bacteriophage genome comprising a first bacteriophage gene comprising a deletion of a packaging initiation site sequence of said first bacteriophage gene that prevents packaging of a bacteriophage nucleic acid molecule into said non-replicative transduction particle; and
   - a reporter nucleic acid molecule comprising a second bacteriophage gene comprising a second packaging initiation site sequence that facilitates the packaging a replica of said reporter nucleic acid molecule into said non-replicative transduction particle, wherein said second bacteriophage gene encodes a protein, wherein said replica of said reporter nucleic acid molecule forms a replicon for packaging into said non-replicative transduction particle.
2. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, said bacterial cell comprising:
   - a lysogenized bacteriophage genome lacking a bacteriophage gene encoding a packaging initiation site sequence, wherein deletion of said bacteriophage gene prevents packaging of a bacteriophage nucleic acid molecule into said non-replicative transduction particle; and
   - a reporter nucleic acid molecule comprising a second bacteriophage gene, wherein said second bacteriophage gene encodes a packaging initiation site sequence and facilitates the packaging a replica of said reporter nucleic acid molecule into said non-replicative transduction particle, wherein said second bacteriophage gene is capable of expressing a protein that is encoded by said gene, wherein said replica of said reporter nucleic acid molecule forms a replicon amenable to packaging into said non-replicative transduction particle.
3. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, said bacterial cell comprising:
   - a lysogenized bacteriophage genome comprising a first bacteriophage packaging initiation site sequence, wherein said first bacteriophage packaging initiation site sequence comprises a mutation that prevents packaging of a bacteriophage nucleic acid molecule into said non-replicative transduction particle; and

- a reporter nucleic acid molecule comprising a second bacteriophage packaging initiation site sequence, wherein said second bacteriophage packaging initiation site sequence lacks said mutation and facilitates the packaging of a replica of said reporter nucleic acid molecule into said non-replicative transduction particle, wherein said replica of said reporter nucleic acid molecule forms a replicon for packaging into said non-replicative transduction particle.

4. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, said bacterial cell comprising:

- a lysogenized bacteriophage genome lacking a packaging gene and comprising genes that encode proteins that form said non-replicative transduction particle; and
- a genomic island nucleic acid molecule comprising a reporter nucleic acid molecule and a packaging gene.

5. The bacterial cell packaging system of any of claims 1 to 4, wherein said reporter nucleic acid molecule is operatively linked to a promoter.

6. The bacterial cell packaging system of any of claims 1 to 4, wherein said reporter nucleic acid molecule comprises an origin of replication.

7. The bacterial cell packaging system of any of claims 1 to 3, wherein said replicon comprises a concatamer amenable to packaging into said non-replicative transduction particle.

8. The bacterial cell packaging system of claim 1 or claim 2, wherein said second bacteriophage gene comprises the sequence of SEQ ID NO:9.

9. The bacterial cell packaging system of claim 1, wherein said first bacteriophage gene comprises the sequence of SEQ ID NO:8.

10. The bacterial cell packaging system of claim 1 or claim 2, wherein said first and said second bacteriophage genes each comprises a small terminase (terS) gene comprising said packaging initiation site sequence, optionally wherein said terS gene is a *S. aureus* bacteriophage φ11 or φ80α terS gene.

11. The bacterial cell packaging system of claim 3, wherein said first and said second bacteriophage packaging initiation site sequences each comprise a packaging initiation site sequence from a small terminase gene, or wherein said first and said second bacteriophage packaging initiation site sequences each comprise a pac-site

sequence from a small terminase (terS) gene of an *S. aureus* bacteriophage φ11 or φ80α.

12. The bacterial cell packaging system of claim 4, wherein said packaging gene comprises a small terminase (terS) gene, optionally wherein said terS gene comprises a *S. aureus* bacteriophage φ80α terS gene or a bacteriophage φ11 terS gene, or optionally wherein said terS gene comprises the sequence of SEQ ID NO:9.

13. The bacterial cell packaging system of any of claims 1 to 3, wherein said replicon is derived from a *S. aureus* pT181 plasmid origin of replication.

14. The bacterial cell packaging system of any of claims 1 to 3, wherein said replicon comprises the sequence of SEQ ID NO:5.

15. The bacterial cell packaging system of any of claims 1 to 4, wherein said packaging initiation site sequence of said second bacteriophage gene or said packaging gene comprises a pac-site.

16. The bacterial cell packaging system of any of claims 1 to 3, further comprising a plasmid comprising said reporter nucleic acid molecule.

17. The bacterial cell packaging system of claim 1 or 2, wherein said second bacteriophage gene is operatively linked to a promoter, optionally wherein said promoter is an inducible promoter or a constitutive promoter.

18. The bacterial cell packaging system of any of claims 1 to 4, wherein said bacteriophage comprises a *S. aureus* bacteriophage φ80α or a bacteriophage φ11.

19. The bacterial cell packaging system of any of claims 1 to 3, wherein said bacterial cell comprises:
an *E. coli* cell;
a Gram-negative cell; or
a Gram-positive cell.

20. The bacterial cell packaging system of any of claims 1 to 4, wherein said bacterial cell comprises an *S. aureus* cell.

21. The bacterial cell packaging system of any of claims 1 to 4, wherein said reporter nucleic acid molecule comprises a reporter gene,
optionally wherein said reporter gene encodes a detectable and/or a selectable marker, or optionally wherein said reporter gene is selected from the group consisting of genes encoding enzymes mediating luminescence reactions (luxA, luxB, luxAB, luc, ruc, nluc), genes encoding enzymes mediating colorimetric reactions (lacZ, HRP), genes encoding fluorescent proteins (GFP, eGFP, YFP, RFP, CFP, BFP, mCherry, near-

infrared fluorescent proteins), nucleic acid molecules encoding affinity peptides (His-tag, 3X-FLAG), and genes encoding selectable markers (ampC, tet(M), CAT, erm).

22. The bacterial cell packaging system of claim 4, wherein said genomic island nucleic acid molecule:

a) comprises a SaPIbov2 genomic island nucleic acid molecule;

b) is selected from the group consisting of a SaPI, a SaPI1, a SaPI2, a SaPIbov1 and a SaPibov2 genomic island nucleic acid molecule;

c) comprises an integrase gene and wherein said integrase gene encodes an integrase protein for excising and integrating said genomic island nucleic acid molecule out of and into a bacterial genome of said bacterial cell, optionally wherein said integrase gene comprises the sequence of SEQ ID NO:10;

d) is integrated into a bacterial genome of said bacterial cell;

e) can be replicated and forms molecule replicon that is amenable to packaging by the bacteriophage packaging machinery in said bacterial cell, optionally wherein said nucleic acid molecule forms a concatamer, or optionally wherein said replicated genomic island nucleic acid molecule is capable of being packaged into said non-replicative transduction particle; or

f) lacks an integrase gene, optionally further comprising a bacterial gene comprising an integrase gene operatively linked to a promoter and optionally wherein said integrase gene encodes an integrase protein for excising and integrating said genomic island nucleic acid molecule out of and into a bacterial genome of said bacterial cell.

23. A method for packaging a reporter nucleic acid molecule into a non-replicative transduction particle, comprising:

- providing conditions to said bacterial cell of any of the preceding claims that induce a lytic phase of said bacteriophage to produce non-replicative transduction particles packaged with said reporter nucleic acid molecule; and
- isolating said non-replicative transduction particle comprising said reporter nucleic acid molecule, optionally wherein said non-replicative transduction particle does not contain a replicated bacteriophage genome, or optionally wherein said induction of said lytic phase triggers excision of said genomic island nucleic acid molecule from said genome of said bacterial cell.

24. The method of claim 23, wherein said non-replicative transduction particle does not contain a replicated bacteriophage genome.

25. The method of claim 23, wherein said induction of said lytic phase triggers excision of said genomic island nucleic acid molecule from said genome of said bacterial cell.

26. A composition comprising said non-replicative transduction particle comprising a replica of said reporter nucleic acid molecule produced from said method of any of claims 23 to 25.