CLAIMS

1. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle (NRTP) for introduction into a bacterial cell, the packaging system comprising a host cell, comprising:

   - a bacteriophage genome comprising a first gene comprising a disruption, wherein in the absence of the disruption the first gene encodes a first essential component of a packaging-related enzymatic activity and comprises a first packaging initiation site sequence, wherein the packaging-related enzymatic activity recognizes the first packaging initiation site, wherein the disruption prevents recognition of the first packaging initiation site sequence by the essential packaging-related enzymatic activity, and wherein the disruption reduces the level of the essential packaging-related enzymatic activity; and
   - a reporter nucleic acid molecule comprising a reporter gene, a second gene encoding the first component of the essential packaging-related enzymatic activity, and a third gene encoding a second component of the essential packaging-related enzymatic activity, wherein the second gene comprises the non-disrupted first packaging initiation site sequence, wherein the first packaging initiation site sequence is configured to facilitate packaging of a replicon of the reporter nucleic acid molecule into the NRTP.

   The bacterial cell packaging system of claim 1, wherein the bacteriophage comprises a plurality of disrupted genes, wherein in the absence of the disruptions, each encodes an essential component of the packaging-related enzymatic activity and

2. wherein each of the plurality of disrupted genes on the bacteriophage is complemented by a functional, non-disrupted gene encoded by the reporter nucleic acid molecule.

3. The bacterial cell packaging system of any one of claims 1 to 2, wherein the disruption is via deletion, insertion, mutation, or replacement.

4. The bacterial cell packaging system of any one of claims 1 to 3, wherein the packaging-related enzymatic activity is a terminase activity.

5. The bacterial cell packaging system of any one of claims 1 to 4, wherein the second gene and the third gene are each terminase genes and

6. wherein the second gene and the third gene are operably linked to a conditional promoter.

7. The bacterial cell packaging system of claim 5, wherein the conditional promoter is a native promoter of a terminase gene of the bacteriophage genome.

8. The bacterial cell packaging system of any one of claims 5 or 6, wherein expression of the second gene or the third gene is inhibited in the absence of activation of the lytic cycle of the bacteriophage, and wherein expression of the second gene or the third gene is activated upon activation of the lytic cycle of the bacteriophage.

9. The bacterial cell packaging system of claims 5 to 7, wherein the second gene and the third gene are terminase genes native to the bacteriophage genome, and wherein the conditional promoter is a native promoter of the terminase genes.

10. The bacterial cell packaging system of any one of claims 1 to 8, wherein the bacteriophage genome comprises a reporter gene encoding a detectable marker or a selectable marker and wherein the reporter gene is operatively linked to a constitutive promoter.

11. The bacterial cell packaging system of claim 9, wherein the bacteriophage genome further comprises an antibiotic resistance gene.

12. The bacterial cell packaging system of claims 9 or 10, wherein the 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).

13. The bacterial cell packaging system of claim 10, wherein the antibiotic resistance gene is a kanamycin resistance gene.

14. The bacterial cell packaging system of any one of claims 1 to 12, wherein the disruption comprises an insertion into or replacement of the first packaging initiation site sequence with a gene encoding a selectable marker and wherein the gene encoding the selectable marker is operatively linked to a constitutive promoter.

15. The bacterial cell packaging system of any one of claims 1 to 13, wherein the disruption comprises an insertion into or replacement of the first packaging initiation site sequence with a gene encoding a detectable marker.

16. The bacterial cell packaging system of any one of claims 1 to 14, wherein the reporter nucleic acid molecule comprises an origin of replication.

17. The bacterial cell packaging system of any one of claims 1 to 15, wherein the replicon of the reporter nucleic acid molecule comprises a concatamer amenable to packaging into the non-replicative transduction particle.

18. The bacterial cell packaging system of any one of claims 1 to 16, wherein the non-disrupted first packaging initiation site sequence comprises a concatamer junction.

18. The bacterial cell packaging system of any one of claims 1 to 17, wherein the bacteriophage genome comprises an Enterobacteriaceae bacteriophage P1, or an S. aureus bacteriophage φ80α or a bacteriophage φ11, or

an E. faecalis bacteriophage φEF11.

19. The bacterial cell packaging system of any one of claims 1 to 18, wherein the reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in the reporter nucleic acid molecule.

20. The bacterial cell packaging system of any one of claims 1 to 19, wherein the replicon of the reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in the replica of the reporter nucleic acid molecule.

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

- providing conditions to the bacterial cell packaging system of any of the claims 1 to 20 that induce a lytic phase of the bacteriophage genome to produce non-replicative transduction particles packaged with the reporter nucleic acid molecule; and
- collecting the non-replicative transduction particle comprising the reporter nucleic acid molecule.

22. The method of claim 21, wherein the non-replicative transduction particle does not contain a replicated bacteriophage genome.

23. The method of any one of claims 21 to 22, wherein the non-replicative transduction particle comprises a portion of the bacteriophage genome due to recombination with the reporter nucleic acid molecule, and wherein the portion of the bacteriophage genome comprises the reporter gene.

24. A composition comprising the non-replicative transduction particle comprising a replicon of the reporter nucleic acid molecule produced from the method of any one of claims 21 to 23.

CLAIMS

1. A bacterial cell packaging system for packaging a reporter nucleic acid molecule into a non-replicative transduction particle (NRTP) for introduction into a bacterial cell, the packaging system comprising a host cell, comprising:

   - a bacteriophage genome comprising a first gene comprising a disruption, wherein in the absence of the disruption the first gene encodes a first essential component of a packaging-related enzymatic activity and comprises a first packaging initiation site sequence, wherein the packaging-related enzymatic activity recognizes the first packaging initiation site, wherein the disruption prevents recognition of the first packaging initiation site sequence by the essential packaging-related enzymatic activity, and wherein the disruption reduces the level of the essential packaging-related enzymatic activity; and

   - a reporter nucleic acid molecule comprising a reporter gene, a second gene encoding the first component of the essential packaging-related enzymatic activity, and a third gene encoding a second component of the essential packaging-related enzymatic activity, wherein the second gene comprises the non-disrupted first packaging initiation site sequence, wherein the first packaging initiation site sequence is configured to facilitate packaging of a replicon of the reporter nucleic acid molecule into the NRTP.

2. The bacterial cell packaging system of claim 1, wherein the bacteriophage comprises a plurality of disrupted genes, wherein in the absence of the disruptions, each encodes an essential component of the packaging-related enzymatic activity and wherein each of the plurality of disrupted genes on the bacteriophage is complemented by a functional, non-disrupted gene encoded by the reporter nucleic acid molecule.

3. The bacterial cell packaging system of any one of claims 1 to 2, wherein the disruption is via deletion, insertion, mutation, or replacement.

4. The bacterial cell packaging system of any one of claims 1 to 3, wherein the packaging-related enzymatic activity is a terminase activity.

5. The bacterial cell packaging system of any one of claims 1 to 4, wherein the second gene and the third gene are each terminase genes and wherein the second gene and the third gene are operably linked to a conditional promoter.

6. The bacterial cell packaging system of claim 5, wherein the conditional promoter is a native promoter of a terminase gene of the bacteriophage genome.

7. The bacterial cell packaging system of any one of claims 5 or 6, wherein expression of the second gene or the third gene is inhibited in the absence of activation of the lytic cycle of the bacteriophage, and wherein expression of the second gene or the third gene is activated upon activation of the lytic cycle of the bacteriophage.

8. The bacterial cell packaging system of claims 5 to 7, wherein the second gene and the third gene are terminase genes native to the bacteriophage genome, and wherein the conditional promoter is a native promoter of the terminase genes.

9. The bacterial cell packaging system of any one of claims 1 to 8, wherein the bacteriophage genome comprises a reporter gene encoding a detectable marker or a selectable marker and wherein the reporter gene is operatively linked to a constitutive promoter.

10. The bacterial cell packaging system of claim 9, wherein the bacteriophage genome further comprises an antibiotic resistance gene.

11. The bacterial cell packaging system of claims 9 or 10, wherein the 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).

12. The bacterial cell packaging system of claim 10, wherein the antibiotic resistance gene is a kanamycin resistance gene.

13. The bacterial cell packaging system of any one of claims 1 to 12, wherein the disruption comprises an insertion into or replacement of the first packaging initiation site sequence with a gene encoding a selectable marker and wherein the gene encoding the selectable marker is operatively linked to a constitutive promoter.

14. The bacterial cell packaging system of any one of claims 1 to 13, wherein the disruption comprises an insertion into or replacement of the first packaging initiation site sequence with a gene encoding a detectable marker.

15. The bacterial cell packaging system of any one of claims 1 to 14, wherein the reporter nucleic acid molecule comprises an origin of replication.

16. The bacterial cell packaging system of any one of claims 1 to 15, wherein the replicon of the reporter nucleic acid molecule comprises a concatamer amenable to packaging into the non-replicative transduction particle.

17. The bacterial cell packaging system of any one of claims 1 to 16, wherein the non-disrupted first packaging initiation site sequence comprises a concatamer junction.

18. The bacterial cell packaging system of any one of claims 1 to 17, wherein the bacteriophage genome comprises an Enterobacteriaceae bacteriophage P1, or an S. aureus bacteriophage φ80α or a bacteriophage φ11, or an E. faecalis bacteriophage φEF11.

19. The bacterial cell packaging system of any one of claims 1 to 18, wherein the reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in the reporter nucleic acid molecule.

20. The bacterial cell packaging system of any one of claims 1 to 19, wherein the replicon of the reporter nucleic acid molecule comprises a nucleic acid transcript sequence that is complementary to a second sequence in the replica of the reporter nucleic acid molecule.

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

- providing conditions to the bacterial cell packaging system of any of the claims 1 to 20 that induce a lytic phase of the bacteriophage genome to produce non- replicative transduction particles packaged with the reporter nucleic acid molecule; and
- collecting the non-replicative transduction particle comprising the reporter nucleic acid molecule.

22. The method of claim 21, wherein the non-replicative transduction particle does not contain a replicated bacteriophage genome.

23. The method of any one of claims 21 to 22, wherein the non-replicative transduction particle comprises a portion of the bacteriophage genome due to recombination with the reporter nucleic acid molecule, and wherein the portion of the bacteriophage genome comprises the reporter gene.

24. A composition comprising the non-replicative transduction particle comprising a replicon of the reporter nucleic acid molecule produced from the method of any one of claims 21 to 23.