

## CLAIMS

1. A method for reducing the levels of oxalate in a subject, the method comprising administering to the subject a pharmaceutical composition comprising a recombinant bacterium comprising one or more gene sequences encoding one or more oxalate catabolism enzymes operably linked to a directly or indirectly first promoter that is not associated with the oxalate catabolism enzyme gene in nature, thereby reducing the levels of oxalate in the subject.
2. The method of claim 1, wherein the recombinant bacterium has an oxalate consumption activity of at least about  $1\mu\text{mol}/1\times 10^9$  cell.
3. The method of claim 1 or claim 2, wherein the recombinant bacterium has an oxalate consumption activity of about 50 to about 600 mg/day under anaerobic conditions.
4. The method of claim 3, wherein the recombinant bacterium has an oxalate consumption activity of about 211 mg/day under anaerobic conditions.
5. The method of any one of the previous claims, wherein the recombinant bacterium has an oxalate consumption activity of about 211 mg/day under anaerobic conditions when administered to the subject three times per day.
6. The method of any one of claims 3-5, wherein the anaerobic conditions are conditions in the intestine and/or colon of the subject.
7. The method of any one of the previous claims, wherein the method reduces acute levels of oxalate in the subject by about two fold.
8. The method of any one of claims 1-6, wherein the method reduces acute levels of oxalate in the subject by about three fold.
9. The method of any one of claims 1-6, wherein the method reduces chronic levels of oxalate in the subject by about two fold.
10. The method of any one of claims 1-6, wherein the method reduces chronic levels of oxalate in the subject by about three fold.
11. The method of any one of claims 1-6, wherein the method reduces acute levels of oxalate in the subject to about 25 mg/day, about 30 mg/day, about 40 mg/day, about 50 mg/day, about 60 mg/day, about 70 mg/day, about 80 mg/day, about 90 mg/day, or about 100 mg/day.

12. The method of any one of claims 1-6, wherein the method reduces chronic levels of oxalate in the subject to about 25 mg/day, about 30 mg/day, about 40 mg/day, about 50 mg/day, about 60 mg/day, about 70 mg/day, about 80 mg/day, about 90 mg/day, or about 100 mg/day.
13. The method of any one of the previous claims, wherein the recombinant bacterium is of the genus *Escherichia*.
14. The method of claim 13, wherein the recombinant bacterium is of the species *Escherichia coli* strain Nissle.
15. The method of any one of the previous claims, wherein the pharmaceutical composition is administered orally.
16. The method of any one of the previous claims, wherein the subject is fed a meal within one hour of administering the pharmaceutical composition.
17. The method of any one of claims 1-15, wherein the subject is fed a meal concurrently with administering the pharmaceutical composition.
18. The method of any one of the previous claims, wherein the subject is a human subject.
19. The method of any one of the previous claims, wherein the one or more gene sequences comprise a *scaaE3* gene, an *frc* gene, and an *oxdC* gene.
20. The method of claim 19, wherein the *scaaE3* gene comprises a sequence having at least 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to, comprises, or consists of SEQ ID NO:3.
21. The method of claim 19 or claim 20, wherein the *frc* gene comprises a sequence having at least 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to, comprises, or consists of SEQ ID NO:1.
22. The method of any one of claims 19-21, wherein the *oxdC* gene comprises a sequence having at least 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to, comprises, or consists of SEQ ID NO:2.
23. The method of any one of the previous claims, wherein the recombinant bacterium further comprises a gene encoding an oxalate importer.

24. The method of claim 23, wherein the gene encoding the oxalate importer is an *oxlT* gene.
25. The method of claim 24, wherein the *oxlT* gene comprises a sequence having at least 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to, comprises, or consists of SEQ ID NO: 11.
26. The method of any one of the previous claims, wherein the recombinant bacterium further comprises an auxotrophy.
27. The method of claim 26, wherein the auxotrophy is a *thyA* auxotrophy.
28. The method of any one of the previous claims, wherein the recombinant bacterium further comprises a deletion in an endogenous phage.
29. The method of claim 26, wherein the endogenous phage comprises a sequence having at least 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to, comprises, or consists of SEQ ID NO: 63.
30. The method of any one of the previous claims, wherein the recombinant bacterium does not comprise a gene encoding for antibiotic resistance.
31. The method of any one of the previous claims, wherein the first promoter is an inducible promoter, optionally when the inducible promoter is a FNR promoter, optionally wherein the FNR promoter comprises a sequence having at least 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, or 99% identity to, comprises, or consists of any one of SEQ ID NOs: 13-29.
32. The method of any one of claims 1-17, wherein the recombinant bacterium is SYN5752, SYN7169, or SYN8802.
33. The method of any one of the previous claims, wherein the subject has hyperoxaluria.
34. The method of claim 33, wherein the hyperoxaluria is primary hyperoxaluria, dietary hyperoxaluria, or enteric hyperoxaluria.
35. The method of claim 33 or claim 34, wherein the subject has short bowel syndrome, chronic pancreatitis, inflammatory bowel disease (IBD), cystic fibrosis, kidney disease, and/or Roux-en-Y gastric bypass.

36. The method of any one of the previous claims, wherein the subject has urinary oxalate (Uox) levels of at least 70 mg/day prior to the administering.
37. The method of any one of the previous claims, wherein the subject exhibits a decrease in Uox levels of at least 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, or 80% after the administering.
38. The method of any one of the previous claims, wherein the subject has eGFR < 30 mL/min/1.73 m<sup>2</sup>, requires hemodialysis, or has systemic oxalosis prior to the administering.
39. The method of any one of the previous claims, wherein the recombinant bacteria is administered at a dose of about  $1 \times 10^{11}$  live recombinant bacteria, about  $3 \times 10^{11}$  live recombinant bacteria, about  $6 \times 10^{11}$  live recombinant bacteria, about  $1 \times 10^{12}$  live recombinant bacteria, or about  $2 \times 10^{12}$  live recombinant bacteria.
40. The method of any one of claims 1-38, wherein the recombinant bacteria is administered at a dose of about  $6 \times 10^{11}$  live recombinant bacteria.
41. The method of any one of claims 1-38, wherein the recombinant bacteria is administered at a dose of about  $2 \times 10^{12}$  live recombinant bacteria.
42. The method of any one of claims 1-38, wherein the recombinant bacteria is administered at a dose of about  $1 \times 10^{12}$  live recombinant bacteria.
43. The method of any one of claims 1-38, wherein the recombinant bacteria is administered at a dose of about  $1 \times 10^{11}$  live recombinant bacteria.
44. The method of any one of claims 1-38, wherein the recombinant bacteria is administered at a dose of about  $3 \times 10^{11}$  live recombinant bacteria.
45. The method of any one of the previous claims, wherein the administering is about  $5 \times 10^{11}$  live recombinant bacteria with meals three times per day.
46. The method of any one of the previous claims, further comprising administering a proton pump inhibitor (PPI) to the subject.
47. The method of claim 46, wherein the PPI is esomeprazole.

48. The method of claim 46 or 47, wherein the administering of the PPI is once a day.
49. A recombinant bacterium comprising one or more gene sequences encoding one or more oxalate catabolism enzymes operably linked to a directly or indirectly first promoter that is not associated with the oxalate catabolism enzyme gene in nature.
50. The recombinant bacterium of claim 49, wherein the recombinant bacterium has an oxalate consumption activity of at least about  $1\mu\text{mol}/1\times 10^9$  cell.
51. The recombinant bacterium of claim 49 or claim 50, wherein the recombinant bacterium has an oxalate consumption activity of about 50-600 mg/day under anaerobic conditions.
52. The recombinant bacterium of any one of claims 45-50, wherein the recombinant bacterium is SYN8802, SYN7169, or SYN5752.
53. The recombinant bacterium of claim 52, wherein the recombinant bacterium is SYN8802.