**WHAT IS CLAIMED:**

1. A nucleic acid encoding an acid α-glucosidase (GAA), wherein said nucleic acid has greater than 86% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1-5.

2. The nucleic acid of claim 1, wherein said nucleic acid has greater than 87% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1-5.

3. A nucleic acid encoding a GAA, wherein said nucleic acid has greater than 87% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:6-15.

4. The nucleic acid of claim 3, wherein said nucleic acid has greater than 88% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:6-15.

5. The nucleic acid of claim 3, wherein said nucleic acid has greater than 89% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:6-15.

6. The nucleic acid of claim 3, wherein said nucleic acid has greater than 90% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:6-15.

7. The nucleic acid of claim 3, wherein said nucleic acid has greater than 91% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:6-15.

8. A nucleic acid encoding a GAA, wherein said nucleic acid has greater than 91% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:16-24.

9. The nucleic acid of any of claims 1 – 8, wherein said nucleic acid contains less than 127 CpG dinucleotides.

10. A nucleic acid encoding a GAA, wherein said nucleic acid contains less than 127 CpG dinucleotides.

11. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains less than 126 CpG dinucleotides.

12. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 126 – 120 CpG dinucleotides.

13. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 120 – 110 CpG dinucleotides.

14. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 110 – 100 CpG dinucleotides.

15. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 100 – 90 CpG dinucleotides.

16. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 90 – 80 CpG dinucleotides.

17. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 80 – 70 CpG dinucleotides.

18. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 70 – 60 CpG dinucleotides.

19. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 60 – 50 CpG dinucleotides.

20. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 50 – 40 CpG dinucleotides.

21. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 40 – 30 CpG dinucleotides.

22. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 30 – 20 CpG dinucleotides.

23. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains less than 20 CpG dinucleotides.

24. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 20 – 10 CpG dinucleotides.

25. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains less than 10 CpG dinucleotides.

26.The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains from about 10 – 5 CpG dinucleotides.

27. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains 5 CpG dinucleotides.

28.The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains 4 CpG dinucleotides.

29. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains 3 CpG dinucleotides.

30. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains 2 CpG dinucleotides.

31. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains 1 CpG dinucleotide.

32. The nucleic acid of any of claims 1 – 10, wherein said nucleic acid contains 0 CpG dinucleotides.

33. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 92% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

34. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 93% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

35. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 94% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

36. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 95% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

37. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 96% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

38. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 97% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

39. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 98% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

40. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 99% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

41. The nucleic acid of any of claims 1 – 32, wherein said nucleic acid has greater than 99.5% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1- 24.

42. A nucleic acid encoding a GAA selected from the group consisting of SEQ ID NOs:1-24.

43. An expression cassette comprising the nucleic acid of any of claims 1 – 7 and 9 – 42 operably linked to an expression control element.

44.The expression cassette of claim 43, wherein said expression control element is positioned 5’ of said nucleic acid.

45.The expression cassette of claim 44, further comprising a poly-adenylation sequence positioned 3’ of said nucleic acid.

46. The expression cassette of claims 44 or 45, wherein said expression control element or poly-adenylation sequence is CpG reduced compared to wild-type expression control element or polyadenylation sequence.

47. The expression cassette of any of claims 43 – 46, wherein said expression control element comprises an ApoE/hAAT enhancer/promoter sequence.

48. The expression cassette of any of claims 45 – 47, wherein said poly-adenylation sequence comprises a bovine growth hormone (bGH) polyadenylation sequence.

49. The expression cassette of claims 47 or 48, wherein said ApoE/hAAT enhancer/promoter sequence or bGH polyadenylation sequence is CpG reduced compared to wild-type ApoE/hAAT enhancer/promoter sequence or bGH polyadenylation sequence.

50. The expression cassette of claim 49, wherein said wild-type bGH polyadenylation sequence comprises the sequence of SEQ ID NO:27.

51. The expression cassette of claim 49, wherein said wild-type ApoE/hAAT enhancer/promoter sequence comprises the sequence of SEQ ID NO:28 or 29.

52. The expression cassette of claim 49, wherein said CpG reduced bGH polyadenylation sequence comprises the sequence of SEQ ID NO:26.

53. The expression cassette of any of claims 43 – 52, further comprising an intron positioned between the 3' end of said expression control element and the 5' end of said nucleic acid.

54. The nucleic acid sequence or expression cassette of any of claims 1 – 53, wherein said GAA comprises the sequence set forth as SEQ ID NO:25.

55. An adenovirus-associated virus (AAV) vector comprising the nucleic acid or expression cassette of any of claims 1 – 54.

56. The AAV vector of claim 55, wherein said AAV vector comprises:
a) one or more of an AAV capsid, and

b) one or more AAV inverted terminal repeats (ITRs), wherein said AAV ITR(s) flanks the 5' or 3' terminus of said nucleic acid or said expression cassette.

57. The AAV vector of claim 56, further comprising an intron positioned 5' or 3' of said one or more ITRs.

58. The AAV vector of claim 56 or 57, wherein at least one or more of said ITRs or said intron is modified to have reduced CpGs.

59. The AAV vector of any of claims 55 – 58, wherein said AAV vector has a capsid serotype comprising a modified or variant AAV VP1, VP2 and/or VP3 capsid having 90% or more sequence identity to AAV1, AAV2, AAV3, AAV4, AAV5, AAV6, AAV7, AAV8, AAV9, AAV10, AAV11, Rh10, Rh74, AAV3B, AAV-2i8 or SEQ ID NO:30, 31 or 32 VP1, VP2 and/or VP3 sequences, or a capsid having 95% or more sequence identity to AAV1, AAV2, AAV3, AAV4, AAV5, AAV6, AAV7, AAV8, AAV9, AAV10, AAV11, AAV12, Rh10, Rh74, AAV3B, AAV-2i8, or SEQ ID NO:30, 31 or 32 VP1, VP2 and/or VP3 sequences, or a capsid having 100% sequence identity to AAV1, AAV2, AAV3, AAV4, AAV5, AAV6, AAV7, AAV8, AAV9, AAV10, AAV11, Rh10, Rh74, AAV3B, AAV-2i8, or SEQ ID NO:30, 31 or 32 VP1, VP2 and/or VP3 sequences.

60.The AAV vector of any of claims 56 – 59, wherein said ITRs comprise one or more ITRs of any of: AAV1, AAV2, AAV3, AAV4, AAV5, AAV6, AAV7, AAV8, AAV9, AAV10, AAV11, Rh10, Rh74 or AAV3B, AAV serotypes, or a combination thereof.

61. A pharmaceutical composition comprising a plurality of AAV vectors of any of claims 55 – 60 in a biologically compatible carrier or excipient.

62. The pharmaceutical composition of claim 61, further comprising empty AAV capsids.

63. The pharmaceutical composition of claim 62, wherein the ratio of said empty AAV capsids to said AAV vector is within or between about 100:1-50:1, from about 50:1-25:1, from about 25:1-10:1, from about 10:1-1:1, from about 1:1-1:10, from about 1:10-1:25, from about 1:25-1:50, or from about 1:50-1:100.

64. The pharmaceutical composition of claim 62, wherein the ratio of said empty AAV capsids to said AAV vector is about 2:1, 3:1, 4:1, 5:1, 6:1, 7:1, 8:1, 9:1, or 10:1.

65. The pharmaceutical composition of any of claims 62 – 64, further comprising a surfactant.

66. A method of treating a human in need of acid α-glucosidase (GAA), comprising:

(a) providing the nucleic acid or expression cassette of any of claims 1 – 54, or the AAV vector of any of claims 55 – 60, or the pharmaceutical composition of any of claims 61 – 65; and

(b) administering an amount of said nucleic acid, expression cassette, AAV vector, or

pharmaceutical composition to said human, wherein said GAA is expressed in said human.

67.The method of claim 66, wherein said human has Pompe disease.

68. The method of claim 66, wherein said human has infantile onset Pompe disease.

69. The method of claim 66, wherein said human has late onset Pompe disease.

70. The method of claim 66, wherein said human has a glycogen storage disease (GSD).

71.The method of claim 70, wherein said GSD is selected from: GSD type I (von Gierke's disease), GSD type III (Forbes-Cori disease), GSD type IV (Anderson disease, amylopectinosis), GSD type V (McArdle disease), GSD type VI (Hers disease), GSD type VII (Tarui disease), and a lethal congenital GSD of the heart.

72. The method of any of claims 66 – 71, wherein said AAV vector is administered to said human intravenously, intraarterially, intra-cavity, intramucosally, or via catheter.

73. The method of any of claims 66 – 72, wherein said GAA is expressed at increased levels, optionally greater than 1% of the levels, of GAA found in a human not in need of GAA.

74. The method of any of claims 66 – 73, wherein said AAV vector is administered in a range from about $1X10^{8}$ to about $1X10^{14}$ vector genomes per kilogram (vg/kg) of the weight of said human.

75. The method of any of claims 66 – 74, wherein said method reduces, decreases or inhibits one or more symptoms of said need of GAA or said disease; or prevents or reduces progression or worsening of one or more symptoms of said need of GAA or said disease; or stabilizes one or more symptoms of said need of GAA or said disease; or improves one or more symptoms of said need of GAA or said disease.

76. The method of claim 75, wherein said one or more symptoms is selected from the group consisting of: difficulty eating; not gaining weight; poor head control; poor neck control; breathing problems; lung infections; enlarged heart; thickening heart; heart defects; enlarged tongue; difficulty swallowing; enlarged liver; poor muscle strength; week muscle tone; weakness in the legs; weakness in the waist; weakness in the arms; shortness of breath; difficulty exercising; difficulty breathing while sleeping; curvature of the spine; and stiff joints.

77. A cell comprising the nucleic acid or expression cassette of any of claims 1 – 54.

78. A cell that produces the AAV vector of any of claims 55 – 60.

79. A method of producing the AAV vector of any of claims 55 – 60, comprising

a. introducing an AAV vector genome comprising said nucleic acid or expression cassette of any of claims 1 – 54 into a packaging helper cell; and

b. culturing said helper cell under conditions to produce said AAV vector.

80. A method of producing the AAV vector of any of 55 – 60, comprising

a. introducing said nucleic acid or expression cassette of claims 1 – 54 into a packaging helper cell; and

b. culturing said helper cells under conditions to produce said AAV vector.

81. The cell or method of any of claims 77 – 80, wherein said cell comprises mammalian cells.

82. The cell or method of any of claims 77 – 80, wherein said cell provides helper functions that package said vector into a viral particle.

83. The cell or method of any of claims 77 – 80, wherein said cell provides AAV helper functions.

84. The cell or method of any of claims 77 – 80, wherein said cell provides AAV Rep and/or Cap proteins.

85. The cell or method of any of claims 77 – 80, wherein said cell is stably or transiently transfected with polynucleotide(s) encoding Rep and/or Cap protein sequence(s).

86. The cell or method of any of claims 77 – 80, wherein said cell provides Rep78 and/or Rep68 proteins.

87. The cell or method of any of claims 77 – 80, wherein said cell is stably or transiently transfected with Rep78 and/or Rep68 proteins polynucleotide encoding sequence(s).

88. The cell or method of any of claims 77 – 80, wherein said cell comprises HEK-293 cells.