WHAT IS CLAIMED:

1. A nucleic acid encoding an acid α-glucosidase (GAA), 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:1-5.

2. A nucleic acid encoding 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:1-5 and comprises a poly-adenylation sequence that is CpG reduced compared to wild-type poly-adenylation sequence positioned 3'thereof.

3. A nucleic acid encoding GAA, wherein said nucleic acid contains from 0 CpG dinucleotides, 1 – 5 CpG dinucleotides, 5 – 10 CpG dinucleotides or 10 – 20 CpG dinucleotides.

4. A nucleic acid encoding GAA, wherein said nucleic acid has at least 92% sequence identity to a sequence selected from the group consisting of any of the sequences set forth as SEQ ID NOs:1-24.

5. The nucleic acid of any of claims 1 – 4, wherein said nucleic acid contains 0- 5 CpG dinucleotides.

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

7. An expression cassette comprising the nucleic acid of any of claims 1 – 2 and 3 – 6 operably linked to an expression control element.

8. The expression cassette of claim 7, wherein said expression control element is positioned 5' of said nucleic acid.

9. The expression cassette of claim 8, further comprising a poly-adenylation sequence positioned 3' of said nucleic acid.

10. The expression cassette of claims 8 or 9, wherein said expression control element or poly-adenylation sequence is CpG reduced compared to wild-type expression control element or polyadenylation sequence.

11. The expression cassette of any of claims 7 – 10, wherein said expression control element comprises an ApoE/hAAT enhancer/promoter sequence.

12. The expression cassette of any of claims 9 – 11, wherein said poly-adenylation sequence comprises a bovine growth hormone (bGH) polyadenylation sequence.

13. The expression cassette of claims 11 or 12, 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.

14. The expression cassette of any of claims 7 – 13, further comprising an intron positioned between the 3' end of said expression control element and the 5' end of said nucleic acid.

15. The nucleic acid sequence or expression cassette of any of claims 1 – 14, wherein said GAA comprises the sequence set forth as SEQ ID NO:25.

16. An adenovirus-associated virus (AAV) vector comprising the nucleic acid or expression cassette of any of claims 1 – 15.

17. The AAV vector of claim 16, 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.

18. The AAV vector of claim 17, further comprising an intron positioned 5' or 3' of said one or more ITRs.

19. The AAV vector of claim 17 or 18, wherein at least one or more of said ITRs or said intron is modified to have reduced CpGs.

20. The AAV vector of any of claims 16 – 19, wherein said AAV vector has a capsid serotype comprising a 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.

21. The AAV vector of any of claims 17 – 20, 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.

22. A pharmaceutical composition comprising a plurality of AAV vectors of any of claims 16 – 21 in a biologically compatible carrier or excipient.

23. The pharmaceutical composition of claim 22, further comprising empty AAV capsids.

24. The pharmaceutical composition of claim 23, wherein the ratio of said empty AAV capsids to said AAV vector is within or between 100:1-50:1, from 50:1-25:1, from 25:1-10:1, from 10:1-1:1, from 1:1-1:10, from 1:10-1:25, from 1:25-1:50, or from 1:50-1:100.

25. The pharmaceutical composition of any of claims 23 – 24, further comprising a surfactant.

26. The nucleic acid or expression cassette of any of claims 1 – 15, or the AAV vector of any of claims 16 – 21, or the pharmaceutical composition of any of claims 22 – 25 for use in therapy.

27. Use of the nucleic acid or expression cassette of any of claims 1 – 15, or the AAV vector of any of claims 16 – 21, or the pharmaceutical composition of any of claims 22 – 25 in the manufacture of a medicament for the treatment of glycogen storage disease (GSD) in a human, wherein the medicament is to be administered to said human, wherein said GAA is expressed in said human.

28. The use of claim 27, wherein said GSD is Pompe disease.

29. The use of claim 27, wherein said GSD is infantile onset Pompe disease.

30. The use of claim 27, wherein said GSD is late onset Pompe disease.

31. The use of claim 27, 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.

32. The use of any of claims 27 – 31, wherein said AAV vector is to be administered to said human intravenously, intraarterially, intra-cavity, intramucosally, or via catheter.

33. The use of any of claims 27 – 32, wherein said AAV vector is to be administered in a range from $1X10^{8}$ to $1X10^{14}$ vector genomes per kilogram (vg/kg) of the weight of said human.

34. A cell comprising the nucleic acid or expression cassette of any of claims 1 – 15.

35. A cell that produces the AAV vector of any of claims 16 – 21.

36. A method of producing the AAV vector of any of claims 16 – 21, comprising

a. introducing an AAV vector genome comprising said nucleic acid or expression cassette of any of claims 16 – 21 into a packaging helper cell; and

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

37. The cell of any of claims 34 or 35 or the method of claim 36, wherein said cell comprises mammalian cells.

38. The cell of any of claims 34 or 35 or the method of claim 36, wherein said cell provides AAV helper functions.

39. The cell of any of claims 34 or 35 or the method of claim 36, wherein said cell provides AAV Rep and/or Cap proteins.

40. The cell of any of claims 34 or 35 or the method of claim 36, wherein said cell comprises HEK-293 cells.