We claim:

1. A recombinant adeno-associated virus (rAAV) vector comprising an AAV8 capsid and a codon-optimized sequence encoding a human iduronate-2-sulfatase (I2S) enzyme.

2. A recombinant adeno-associated virus (rAAV) vector comprising an AAV9 capsid and a codon-optimized sequence encoding human iduronate-2 sulfatase (I2S) enzyme.

3. The rAAV vector of claim 1 or 2, wherein the codon-optimized sequence encoding a human I2S enzyme comprises a sequence having at least about 70%, 75%, 80%, 85%, 90%, 95% or 99% identity to SEQ ID NO: 6.

4. The rAAV vector of claim 3, wherein the codon-optimized sequence encoding a human I2S enzyme comprises a sequence identical to SEQ ID NO: 11 or 12.

5. The rAAV vector of claim 1, wherein the vector further comprises a liver-specific promoter.

6. The rAAV vector of claim 5, wherein the liver-specific promoter is transthyretin promoter (TTR).

7. The rAAV vector of claim 5 or 6, wherein the vector further comprises a 5’ and a 3’ inverted terminal repeat (ITR), an intron upstream of the I2S sequence, and a cis-acting regulatory module (CRM).

8. The rAAV vector of claim 2, wherein the vector further comprises a ubiquitous promoter.

9. The rAAV vector of claim 8, wherein the vector further comprises a 5’ and a 3’ inverted terminal repeat, an intron upstream of the I2S sequence, and a cis-acting regulatory module (CRM).

10. The rAAV vector of any one of the preceding claims, wherein the rAAV vector comprises a sulfatase modifying factor 1 (SUMF1).

11. The rAAV vector of claim 10, wherein the SUMF1 is preceded by an internal ribosome entry site (IRES).

12. The rAAV vector of any one of the preceding claims, wherein the vector further comprises a WPRE sequence.

13. The rAAV vector of claim 7 or 9, wherein the intron is a minute virus of mice (MVM) or SV40 intron.

14. The rAAV vector of claim 7 or 9, wherein the CRM is liver-specific CRM.

15. The rAAV vector of claim 7 or 9, wherein the CRM is a neuronal-specific CRM.

16. The rAAV vector of claim 7 or 9, wherein the CRM is CRM8.

17. The rAAV vector of claim 7 or 9, wherein the vector comprises at least three CRMs.

18. A recombinant adeno-associated virus (rAAV) comprising an AAV8 capsid and an rAAV vector, said vector comprising:

a. a 5' inverted terminal repeat (ITR);

b. a cis-acting regulatory module (CRM);

c. a liver specific promoter;

d. a minute virus of mice (MVM);

e. a sequence encoding a human iduronate-2-sulfatase (I2S) enzyme;

f. a woodchuck hepatitis virus posttranscriptional regulatory element (WPRE); and

g. a 3' ITR.

19. The rAAV of claim 18, wherein the sequence encoding a human I2S enzyme is a wild type sequence or a codon-optimized sequence.

20. The rAAV of claim 19, wherein the sequence encoding a human I2S enzyme is a codon-optimized sequence having at least 70%, 75%, 80%, 85%, 90%, 95%, or 99% identity with SEQ ID NO: 6.

21. The rAAV of claim 18, further comprising a sequence encoding a sulfatase modifying factor 1 (SUMF1) and an internal ribosome entry site (IRES).

22. A recombinant adeno-associated virus (rAAV) comprising an AAV9 capsid and an rAAV vector, said vector comprising:

a. a 5' inverted terminal repeat (ITR);

b. a cis-acting regulatory module (CRM);

c. a ubiquitous promoter;

d. a minute virus of mice (MVM);

e. a sequence encoding a human iduronate-2-sulfatase (I2S) enzyme;

f. a woodchuck hepatitis virus posttranscriptional regulatory element(WPRE); and

g. a 3' ITR.

23. The rAAV of claim 22, wherein the sequence encoding a human I2S enzyme is a wild type sequence or a codon-optimized sequence.

24. The rAAV of claim 23, wherein the sequence encoding a human I2S enzyme is a codon-optimized sequence having at least 70%, 75%, 80%, 85%, 90%, 95%, or 99% identity with SEQ ID NO: 6.

25. The rAAV of claim 22, further comprising a sequence encoding a sulfatase modifying factor 1 (SUMF1) and an internal ribosome entry site (IRES).

26. The rAAV of any one of the preceding claims, wherein the rAAV vector does not comprise ApoB.

27. ~~A method of treating a subject having Hunter syndrome (MPS II), comprising administering to the subject in need thereof~~ Use of an rAAV of any one of the preceding claims in the manufacture of a medicament for treating a subject having Hunter syndrome (MPS II), wherein said rAAV is to be administered to the subject in need thereof.

28. ~~A method of treating a subject having Hunter syndrome (MPS II), comprising administering to the subject in need thereof~~ Use of a recombinant adeno-associated virus (rAAV) vector comprising an AAV8 or AAV9 capsid, and a promoter operably linked to a nucleic acid sequence that encodes iduronate-2-sulfatase (I2S), in the manufacture of a medicament for treating a subject having Hunter syndrome (MPS II), wherein said rAAV vector is to be administered to the subject in need thereof and wherein said rAAV vector to be administered~~administering~~ results in an increase in I2S enzymatic activity in the subject.

29. The ~~method~~use of claim 28, wherein the increase in I2S activity is detected in the serum of the subject.

30. The ~~method~~use of any one of claims 28-29, wherein the increase in I2S activity is detected in the liver of the subject.

31. The ~~method~~use of any one of claims 28-30, wherein the I2S activity is detected in the central nervous system (CNS).

32. The ~~method~~use of any one of claims 28-31, wherein the increase in I2S activity is detected in the brain of the subject.

33. The ~~method~~use of any one of claims 28-32, wherein the increase in I2S activity is detected in the hippocampus, thalamus, corpus callosum, cortex, cerebellum, or stratum of the brain.

34. The ~~method~~use of any one of claims 28-33, wherein the increase of I2S activity is detected in the kidney of the subject.

35. The ~~method~~use of any one of the claims 28-34, wherein the increase of I2S activity is maintained for at least 30, 60, 90, 120, 150, 180 days or more after a single administration.

36. The ~~method~~use of any one of the claims 28-35, wherein the level of I2S activity is measured by heparin sulfate assay.

37. The ~~method~~use of any one of the claims 28-35, wherein the level of I2S activity is measured by dermatan sulfate assay.

38. The ~~method~~use of any one of the claims 28-37, wherein the AAV to be administered~~administering the AAV~~ reduces the level of glycosaminoglycan (GAG) in the subject.

39. The ~~method~~use of claim 38, wherein the AAV to be administered~~administering the AAV~~ reduces the level of GAG in the serum of the subject.

40. The ~~method~~use of any one of claims 38-39, wherein the AAV to be administered~~administering the AAV~~ reduces the level of GAG in the liver of the subject.

41. The ~~method~~use of any one of claims 38-40, wherein the AAV to be administered~~administering the AAV~~ reduces the level of GAG in the kidney of the subject.

42. The ~~method~~use of any one of claims 38-41, wherein the AAV to be administered~~administering the AAV~~ reduces the level of GAG in the CNS of the subject.

43. The ~~method~~use of any one of claims 38-41, wherein the AAV to be administered~~administering the AAV~~ reduces the level of GAG in the brain of the subject.

44. The ~~method~~use of claim 43, wherein the AAV to be administered~~administering the AAV~~ reduces the level of GAG in in the hippocampus, thalamus, corpus callosum, cortex, cerebellum, or stratum of the brain.

45. The ~~method~~use of any one of claims 28-44, wherein the AAV is to be administered intravenously.

46. The ~~method~~use of any one of claims 30-44, wherein the AAV is to be administered intrathecally.

47. The ~~method~~use of claim 45 or 46, wherein the AAV is to be administered at dose of about 5×10^9 vg.

48. The ~~method~~use of any one of claims 30-47, wherein the AAV to be administered~~administering of the rAAV~~ does not elicit immune response.

49. The rAAV vector of any one of the preceding claims for use in medicine.