titers (Table 2). Thus, AAV-Rh74 and related vectors can be produced in large amounts for more prevalent clinical diseases.

[0008a] In one aspect there is provided a method for delivering or transferring a heterologous polynucleotide sequence into a mammal or a cell of a mammal, comprising administering an adeno-associated virus (AAV) vector, said vector comprising a heterologous polynucleotide sequence, to said mammal or a cell of said mammal, thereby delivering or transferring the heterologous polynucleotide sequence into the mammal or cell of the mammal.

[0008b] In another aspect there is provided use of an adeno-associated virus (AAV) vector in the manufacture of a medicament for treating a mammal deficient in protein expression or function, said vector comprising a heterologous polynucleotide encoding a polypeptide that can correct for the deficient protein expression or function, wherein the heterologous polynucleotide sequence is operably linked to an expression control element conferring transcription of said heterologous polynucleotide sequence; and wherein said vector is to be administered to a mammal wherein said polypeptide is expressed in the mammal.

[0008] In accordance with the invention, there are provided methods for delivering or transferring a heterologous polynucleotide sequence into a mammal or a cell of a mammal. In one embodiment, a method includes administering an adeno-associated virus (AAV) vector that includes a heterologous polynucleotide sequence to a mammal or a cell of a mammal under suitable conditions to deliver or transfer the heterologous polynucleotide sequence into the mammal or the cell of a mammal, thereby delivering or transferring the heterologous polynucleotide. In one aspect, the method allows transfer/delivery of the heterologous polynucleotide into the mammal and/or cell. In another aspect, the method allows transfer/delivery of the heterologous polynucleotide into the mammal and/or cell, and subsequent transcription of the heterologous polynucleotide thereby forming a transcript. In a further aspect, the method allows transfer/delivery of the heterologous polynucleotide into the cell, subsequent transcription to form a transcript and subsequent translation to form a gene product (protein). In particular, for example, in the latter two aspects a heterologous polynucleotide sequence is operably linked to an expression control element conferring transcription of the heterologous polynucleotide sequence, and optionally subsequent translation of the transcript.

Description of Drawings

[0009] **Figure 1** shows human factor IX (FIX) plasma levels in C57BL/6 mice (n=5 per group) injected via the tail vein with AAV vectors expressing the FIX transgene under the

control of a liver-specific promoter. Vector dose 2.5^{10} vector genomes per mouse. FIX transgene product (FIX protein) plasma levels were measured by ELISA at weeks 1, 2, and 4 post gene transfer. AAV-Rh74 conferred the highest levels of FIX transgene expression.

[0010] Figure 2 shows canine FIX plasma levels in hemophilia B dogs after the delivery of 3^{12} vector genomes per kilogram (kg) of weight. AAV vectors were infused intravenously (IV) though the saphenous vein and FIX levels were monitored by ELISA. Expression of the therapeutic FIX transgene was driven by a liver specific promoter. AAV8 and AAV-Rh74 vectors performed roughly equally in hemophilia B dogs and were both superior to AAV6.

[0011] Figure 3 shows AAV-Rh74 VP1, VP2, and VP3 amino acid sequences and, for VP1, polynucleotide (DNA) sequence (SEQ ID NOs:1-4).

[0012] Figure 4 shows administration of AAV8 and AAVrh74 vector expressing human Factor IX (FIX) (under the control of a liver-specific promoter) to rhesus macaques, a non-human primate, and expression of FIX in the animals. Animals receiving the AAVrh74-FIX vectors (last two bars towards the right margin) expressed the FIX transgene at higher levels compared to the other groups of animals injected at the same dose.

What is Claimed:

1. A method for delivering or transferring a heterologous polynucleotide sequence into a mammal or a cell of a mammal, comprising administering an adeno-associated virus (AAV) vector, said vector comprising a heterologous polynucleotide sequence, to said mammal or a cell of said mammal, thereby delivering or transferring the heterologous polynucleotide sequence into the mammal or cell of the mammal.

2. The method of claim 1, wherein the heterologous polynucleotide sequence is operably linked to an expression control element conferring transcription of said heterologous polynucleotide sequence.

3. Use of an adeno-associated virus (AAV) vector in the manufacture of a medicament for ~~A method of~~ treating a mammal deficient in protein expression or function, ~~comprising: (a) providing adeno-associated virus (AAV) vector,~~ said vector comprising a heterologous polynucleotide encoding a polypeptide that can correct for the deficient protein expression or function, wherein the heterologous polynucleotide sequence is operably linked to an expression control element conferring transcription of said heterologous polynucleotide sequence; and ~~(b)~~ wherein said vector is to be administered ~~administering an amount of the AAV vector~~ to ~~the~~ a mammal wherein said polypeptide is expressed in the mammal.

4. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector comprises an AAV with a VP1 sequence having 90% or more sequence identity to:
MAADGYLPDWLEDNLSEGIREWWDLKPGAPKPKANQQKQDNGRGLVLPGYKYLGPFN
GLDKGEPVNAADAAALEHDKAYDQQLQAGDNPYLRYNHADAEFQERLQEDTSFGGNL
GRAVFQAKKRVLEPLGLVESPVKTAPGKKRPVEPSPQRSPDSSTGIGKKGQQPAKKRLNF
GQTGDSESVPDPQPIGEPPAGPSGLGSGTMAAGGGAPMADNNEGADGVGSSSGNWHCD
STWLGDRVITTSTRTWALPTYNNHLYKQISNGTSGGSTNDNTYFGYSTPWGYFDFNRFH
CHFSPRDWQRLINNNWGFRPKRLNFKLFNIQVKEVTQNEGTKTIANNLTSTIQVFTDSEY
QLPYVLGSAHQGCLPPFPADVFMIPQYGYLTLNNGSQAVGRSSFYCLEYFPSQMLRTGN
NFEFSYNFEDVPFHSSYAHSQSLDRLMNPLIDQYLYYLSRTQSTGGTAGTQQLLFSQAGP
NNMSAQAKNWLPGPCYRQQRVSTTLSQNNNSNFAWTGATKYHLNGRDSLVNPGVAM
ATHKDDEERFFPSSGVLMFGKQGAGKDNVDYSSVMLTSEEEIKTTNPVATEQYGVVAD
NLQQQNAAPIVGAVNSQGALPGMVWQNRDVYLQGPIWAKIPHTDGNFHPSPLMGGFGL
KHPPPQILIKNTPVPADPPTTFNQAKLASFITQYSTGQVSVEIEWELQKENSKRWNPEIQY
TSNYYKSTNVDFAVNTEGTYSEPRPIGTRYLTRNL, or 1-50 amino acid substitutions, deletions or additions thererto;
a VP2 sequence having 90% or more sequence identity to:
TAPGKKRPVEPSPQRSPDSSTGIGKKGQQPAKKRLNFGQTGDSESVPDPQPIGEPPAGPSG
LG

SGTMAAGGGAPMADNNEGADGVGSSSGNWHCDSTWLGDRVITTSTRTWALPTYNNHL
YKQISNGTSGGSTNDNTYFGYSTPWGYFDFNRFHCHFSPRDWQRLINNNWGFRPKRLNF
KLFNIQVKEVTQNEGTKTIANNLTSTIQVFTDSEYQLPYVLGSAHQGCLPPFPADVFMIPQ
YGYLTLNNGSQAVGRSSFYCLEYFPSQMLRTGNNFEFSYNFEDVPFHSSYAHSQSLDRL
MNPLIDQYLYYLSRTQSTGGTAGTQQLLFSQAGPNNMSAQAKNWLPGPCYRQQRVSTT
LSQNNNSNFAWTGATKYHLNGRDSLVNPGVAMATHKDDEERFFPSSGVLMFGKQGAG
KDNVDYSSVMLTSEEEIKTTNPVATEQYGVVADNLQQQNAAPIVGAVNSQGALPGMV
WQNRDVYLQGPIWAKIPHTDGNFHPSPLMGGFGLKHPPPQILIKNTPVPADPPTTFNQAK
LASFITQYSTGQVSVEIEWELQKENSKRWNPEIQYTSNYYKSTNVDFAVNTEGTYSEPRPI
GTRYLTRNL, or 1-50 amino acid substitutions, deletions or additions thererto; and/or
a VP3 sequence having 90% or more sequence identity to:
MAAGGGAPMADNNEGADGVGSSSGNWHCDSTWLGDRVITTSTRTWALPTYNNHLYK
QISNGTSGGSTNDNTYFGYSTPWGYFDFNRFHCHFSPRDWQRLINNNWGFRPKRLNFKL
FNIQVKEVTQNEGTKTIANNLTSTIQVFTDSEYQLPYVLGSAHQGCLPPFPADVFMIPQYG
YLTLNNGSQAVGRSSFYCLEYFPSQMLRTGNNFEFSYNFEDVPFHSSYAHSQSLDRLMNP
LIDQYLYYLSRTQSTGGTAGTQQLLFSQAGPNNMSAQAKNWLPGPCYRQQRVSTTLSQ
NNNSNFAWTGATKYHLNGRDSLVNPGVAMATHKDDEERFFPSSGVLMFGKQGAGKDN
VDYSSVMLTSEEEIKTTNPVATEQYGVVADNLQQQNAAPIVGAVNSQGALPGMVWQNR
DVYLQGPIWAKIPHTDGNFHPSPLMGGFGLKHPPPQILIKNTPVPADPPTTFNQAKLASFI
TQYSTGQVSVEIEWELQKENSKRWNPEIQYTSNYYKSTNVDFAVNTEGTYSEPRPIGTRY
LTRNL, or 1-50 amino acid substitutions, deletions or additions thererto.

5. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector comprises an AAV with a VP1, VP2, or VP3 sequence having 95% or more identity to one or more VP1, VP2, or VP3 sequences set forth in Figure 3.

6. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector comprises a VP1, VP2, or VP3 sequence having 96% or more identity to one or more VP1, VP2, or VP3 sequences set forth in Figure 3.

7. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector comprises a VP1, VP2, or VP3 sequence having 97% or more identity to one or more VP1, VP2, or VP3 sequences set forth in Figure 3.

8. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector comprises a VP1, VP2, or VP3 sequence having 98% or more identity to one or more VP1, VP2, or VP3 sequences set forth in Figure 3.

9. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector comprises a VP1, VP2, or VP3 sequence having 99% or more identity to one or more VP1, VP2, or VP3 sequences set forth in Figure 3.

10. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector comprises a VP1, VP2, or VP3 sequence having 99.5% or more identity to one or more VP1, VP2, or VP3 sequences set forth in Figure 3.

11. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector comprises a VP1, VP2, or VP3 sequence of AAV-Rh74 set forth in Figure 3, an AAV vector related to AAV-Rh74 or AAV-Rh74.

12. The method or use of claims 1 or 3, wherein said heterologous polynucleotide sequence, or said protein, is expressed at levels having a therapeutic effect on the mammal.

13. The method or use of claims 1 or 3, wherein said adeno-associated virus (AAV) vector has increased tropism for hepatocytes compared to AAV2 or AAV8.

14. The method or use of claims 1 or 3, wherein said heterologous polynucleotide sequence or said protein is expressed in a cell, tissue or organ of said mammal.

15. The method or use of claim 14, wherein the cell comprises a secretory cell.

16. The method or use of claim 14, wherein the cell comprises an endocrine cell.

17. The method or use of claim 14, wherein the cell comprises hepatocyte, a neural cell, a glial cell, a retinal cell, an epithelial cell, a lung cell or a totipotent, pluripotent or multipotent stem cell.

18. The method or use of claim 14, wherein the tissue or organ of said mammal comprises liver, brain, central nervous system, spinal cord, eye, retina or lung.

19. The method or use of claims 1 or 3, wherein the mammal produces an insufficient amount of a protein, or a defective or aberrant protein.

20. The method or use of claim 19, wherein the protein comprises CFTR (cystic fibrosis transmembrane regulator protein), a blood coagulation (clotting) factor (Factor XIII, Factor IX, Factor X, Factor VIII, Factor VIIa, protein C, etc.) a gain of function blood coagulation factor, an antibody, retinal pigment epithelium-specific 65 kDa protein (RPE65), erythropoietin, LDL receptor, lipoprotein lipase, ornithine transcarbamylase, β-globin, α-globin, spectrin, α-antitrypsin, adenosine deaminase (ADA), a metal transporter (ATP7A or ATP7), sulfamidase, an enzyme involved in lysosomal

storage disease (ARSA), hypoxanthine guanine phosphoribosyl transferase, β-25 glucocerebrosidase, sphingomyelinase, lysosomal hexosaminidase, branched-chain keto acid dehydrogenase, a hormone, a growth factor, insulin-like growth factor 1 or 2, platelet derived growth factor, epidermal growth factor, nerve growth factor, neurotrophic factor -3 and -4, brain-derived neurotrophic factor, glial derived growth factor, transforming growth factor α and β, a cytokine, α-interferon, β-interferon, interferon-γ, interleukin-2, interleukin-4, interleukin 12, granulocyte-macrophage colony stimulating factor, lymphotoxin, a suicide gene product, herpes simplex virus thymidine kinase, cytosine deaminase, diphtheria toxin, cytochrome P450, deoxycytidine kinase, tumor necrosis factor, a drug resistance protein, a tumor suppressor protein (*e.g.*, p53, Rb, Wt-1, NF1, Von Hippel–Lindau (VHL), adenomatous polyposis coli (APC)), a peptide with immunomodulatory properties, a tolerogenic or immunogenic peptide or protein Tregitope or hCDR1, insulin, glucokinase, guanylate cyclase 2D (LCA-GUCY2D), Rab escort protein 1 (Choroideremia), LCA 5 (LCA-Lebercilin), ornithine ketoacid aminotransferase (Gyrate Atrophy), Retinoschisin 1 (X-linked Retinoschisis), USH1C (Usher's Syndrome 1C), X-linked retinitis pigmentosa GTPase (XLRP), MERTK (AR forms of RP: retinitis pigmentosa), DFNB1 (Connexin 26 deafness), ACHM 2, 3 and 4 (Achromatopsia), PKD-1 or PKD-2 (Polycystic kidney disease), TPP1, CLN2, a gene product implicated in lysosomal storage diseases (e.g., sulfatases, N-acetylglucosamine-1-phosphate transferase, cathepsin A, GM2-AP, NPC1, VPC2, a sphingolipid activator protein, or one or more zinc finger nucleases for genome editing, or donor sequences used as repair templates for genome editing.

21. The method or use of claims 1 or 3, wherein the heterologous polynucleotide sequence comprises a gene encoding a polypeptide, peptide or a protein.

22. The method or use of claim 21, wherein the gene encodes a therapeutic peptide or protein.

23. The method or use of claim 21, wherein the gene comprises or encodes CFTR (cystic fibrosis transmembrane regulator protein), a blood coagulation (clotting) factor (Factor XIII, Factor IX, Factor X, Factor VII, Factor VIIa, protein C, etc.) a gain of function blood coagulation factor, an antibody, retinal pigment epithelium-specific 65 kDa protein (RPE65), erythropoietin, LDL receptor, lipoprotein lipase, ornithine transcarbamylase, β-globin, α-globin, spectrin, α-antitrypsin, adenosine deaminase (ADA), a metal transporter (ATP7A or ATP7), sulfamidase, an enzyme involved in lysosomal storage disease (ARSA), hypoxanthine guanine phosphoribosyl transferase, β-25 glucocerebrosidase, sphingomyelinase, lysosomal hexosaminidase, branched-chain keto acid dehydrogenase, a hormone, a growth factor, insulin-like growth factor 1 or 2, platelet derived growth factor, epidermal growth factor, nerve growth factor, neurotrophic factor -3 and -4, brain-derived neurotrophic factor, glial derived growth factor, transforming growth factor α and β, a cytokine, α-interferon, β-interferon, interferon-γ, interleukin-2, interleukin-4, interleukin 12, granulocyte-

macrophage colony stimulating factor, lymphotoxin, a suicide gene product, herpes simplex virus thymidine kinase, cytosine deaminase, diphtheria toxin, cytochrome P450, deoxycytidine kinase, tumor necrosis factor, a drug resistance protein, a tumor suppressor protein (*e.g.*, p53, Rb, Wt-1, NF1, Von Hippel–Lindau (VHL), adenomatous polyposis coli (APC)), a peptide with immunomodulatory properties, a tolerogenic or immunogenic peptide or protein Tregitope or hCDR1, insulin, glucokinase, guanylate cyclase 2D (LCA-GUCY2D), Rab escort protein 1 (Choroideremia), LCA 5 (LCA-Lebercilin), ornithine ketoacid aminotransferase (Gyrate Atrophy), Retinoschisin 1 (X-linked Retinoschisis), USH1C (Usher's Syndrome 1C), X-linked retinitis pigmentosa GTPase (XLRP), MERTK (AR forms of RP: retinitis pigmentosa), DFNB1 (Connexin 26 deafness), ACHM 2, 3 and 4 (Achromatopsia), PKD-1 or PKD-2 (Polycystic kidney disease), TPP1, CLN2, a gene product implicated in lysosomal storage diseases (e.g., sulfatases, N-acetylglucosamine-1-phosphate transferase, cathepsin A, GM2-AP, NPC1, VPC2, a sphingolipid activator protein or one or more zinc finger nucleases for genome editing, or donor sequences used as repair templates for genome editing.

24. The method or use of claim 1, wherein the heterologous polynucleotide sequence comprises an inhibitory nucleic acid.

25. The method or use of claim 24, wherein the inhibitory nucleic acid comprises micro-RNA (miRNA), siRNA, shRNA, trans-splicing RNA, antisense RNA or triplex forming RNA.

26. The method or use of claim 24, wherein the inhibitory nucleic acid binds to a pathogenic gene, a transcript of a pathogenic gene, or a gene transcript associated with a polynucleotide repeat disease, a huntingtin (HTT) gene, a gene associated with dentatorubropallidolusyan atropy (atrophin 1, ATN1), androgen receptor on the X chromosome in spinobulbar muscular atrophy, human Ataxin-1, -2, -3, and -7, $Ca_v2.1$ P/Q voltage-dependent calcium channel is encoded by the (CACNA1A), TATA-binding protein, Ataxin 8 opposite strand, also known as ATXN8OS, Serine/threonine-protein phosphatase 2A 55 kDa regulatory subunit B beta isoform in spinocerebellar ataxia (type 1, 2, 3, 6, 7, 8, 12 17), *FMR1* (fragile X mental retardation 1) in fragile X syndrome, *FMR1* (fragile X mental retardation 1) in fragile X-associated tremor/ataxia syndrome, *FMR1* (fragile X mental retardation 2) or AF4/FMR2 family member 2 in fragile XE mental retardation; Myotonin-protein kinase (MT-PK) in myotonic dystrophy; Frataxin in Friedreich's ataxia; a mutant of superoxide dismutase 1 (SOD1) gene in amyotrophic lateral sclerosis; a gene involved in pathogenesis of Parkinson's disease and/or Alzheimer's disease; apolipoprotein B (APOB) and proprotein convertase subtilisin/kexin type 9 (PCSK9), hypercoloesterolemia; HIV Tat, human immunodeficiency virus transactivator of transcription gene, in HIV infection; HIV TAR, HIV TAR, human immunodeficiency virus transactivator response element gene, in HIV infection; C-C chemokine

receptor (CCR5) in HIV infection; Rous sarcoma virus (RSV) nucleocapsid protein in RSV infection, liver-specific microRNA (miR-122) in hepatitis C virus infection; p53, acute kidney injury or delayed graft function kidney transplant or kidney injury acute renal failure; protein kinase N3 (PKN3) in advance recurrent or metastatic solid malignancies; LMP2, LMP2 also known as proteasome subunit beta-type 9 (PSMB 9), metastatic melanoma; LMP7,also known as proteasome subunit beta-type 8 (PSMB 8), metastatic melanoma; MECL1 also known as proteasome subunit beta-type 10 (PSMB 10), metastatic melanoma; vascular endothelial growth factor (VEGF) in solid tumors; kinesin spindle protein in solid tumors, apoptosis suppressor B-cell CLL/lymphoma (BCL-2) in chronic myeloid leukemia; ribonucleotide reductase M2 (RRM2) in solid tumors; Furin in solid tumors; polo-like kinase 1 (PLK1) in liver tumors, diacylglycerol acyltransferase 1 (DGAT1) in hepatitis C infection, beta-catenin in familial adenomatous polyposis; beta2 adrenergic receptor, glaucoma; RTP801/Redd1 also known as DAN damage-inducible transcript 4 protein, in diabetic macular oedma (DME) or age-related macular degeneration; vascular endothelial growth factor receptor I (VEGFR1) in age-related macular degeneration or choroidal neivascularization, caspase 2 in non-arteritic ischaemic optic neuropathy; Keratin 6A N17K mutant protein in pachyonychia congenital; influenza A virus genome/gene sequences in influenza infection; severe acute respiratory syndrome (SARS) coronavirus genome/gene sequences in SARS infection; respiratory syncytial virus genome/gene sequences in respiratory syncytial virus infection; Ebola filovirus genome/gene sequence in Ebola infection; hepatitis B and C virus genome/gene sequences in hepatitis B and C infection; herpes simplex virus (HSV) genome/gene sequences in HSV infection, coxsackievirus B3 genome/gene sequences in coxsackievirus B3 infection; silencing of a pathogenic allele of a gene (allele-specific silencing) like torsin A (TOR1A) in primary dystonia, pan-class I and HLA-allele specific in transplant; or mutant rhodopsin gene (RHO) in autosomal dominantly inherited retinitis pigmentosa (adRP).

27. The method or use of claims 1 or 3, wherein the mammal has a lung disease (*e.g.*, cystic fibrosis), a bleeding disorder (*e.g.*, hemophilia A or hemophilia B with or without inhibitors), thalassemia, a blood disorder (*e.g.*, anemia), Alzheimer's disease, Parkinson's disease, Huntington's disease, amyotrophic lateral sclerosis (ALS), epilepsy, lysosomal storage diseases, a copper or iron accumulation disorders (*e.g.*, Wilson's or Menkes disease) lysosomal acid lipase deficiency, a neurological or neurodegenerative disorder, cancer, type 1 or type 2 diabetes, Gaucher's disease, Hurler's disease, adenosine deaminase deficiency, a metabolic defect (*e.g.*, glycogen storage diseases), a retinal degenerative disease (such as RPE65 deficiency, choroideremia, and other diseases of the eye), a disease of solid organs (*e.g.*, brain, liver, kidney, heart), or an infectious viral (*e.g.*, hepatitis B and C, HIV, etc.), bacterial or fungal disease.

28. The method or use of claims 1 or 3, wherein the expression control element comprises a constitutive or regulatable control element.

29. The method or use of claims 1 or 3, wherein the expression control element comprises a tissue-specific expression control element or promoter.

30. The method or use of claims 1 or 3, wherein the AAV vector is delivered intravenously, intraarterially, intramuscularly, subcutaneously, orally, by intubation, via catheter, dermally, intra-cranially, via inhalation, intra-cavity, or mucosally.

31. The method or use of claims 1 or 3, wherein the mammal is human.

32. The method or use of claims 1 or 3, wherein the mammal is sero-positive for an AAV serotype other than AAV-Rh74.

33. The method or use of claims 1 or 3, wherein the mammal is sero-positive for an AAV serotype AAV1, AAV2, AAV3, AAV4, AAV5, AAV6, AAV7, AAV8, AAV9, AAV10 or AAV11.

34. The method or use of claims 1 or 3, wherein the mammal is sero-negative for AAV-Rh74.

35. The method or use of claims 1 or 3, further comprising administering empty capsid AAV.

36. The method or use of claims 1 or 3, further comprising administering empty capsid AAV-Rh74.

37. The method or use of claim 4, wherein the VP1, VP2 or VP3 sequence has 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10, conservative, non-conservative, or conservative and non-conservative amino acid substitutions.

38. The method or use of claims 1 or 3, wherein the AAV comprises a pharmaceutical composition.

39. The method or use of claim 38, wherein the pharmaceutical composition comprises empty capsid AAV.

40. The method or use of claim 38, wherein the pharmaceutical composition comprises empty capsid AAV-Rh74.