We claim:

1. An adeno-associated virus (AAV) capsid variant comprising an amino acid sequence at least 95% identical to amino acids 203-742 of SEQ ID NO: 981, wherein the amino acid sequence comprises SPHSKA (SEQ ID NO: 941) in variable region IV (VR-IV).

2. The AAV capsid variant of claim 1, wherein the amino acid sequence of SPHSKA (SEQ ID NO: 941) is present immediately subsequent to amino acid 455, numbered according to SEQ ID NO: 981.

3. An adeno-associated virus (AAV) capsid variant comprising an amino acid sequence at least 95% identical to amino acids 203-742 of SEQ ID NO: 982, wherein the amino acid sequence comprises HDSPHK (SEQ ID NO: 2) in variable region IV (VR-IV).

4. The AAV capsid variant of claim 3, wherein the amino acid sequence of HDSPHK (SEQ ID NO: 2) is present immediately subsequent to amino acid 453, numbered according to SEQ ID NO: 982.

5. An adeno-associated virus (AAV) capsid variant, comprising an amino acid sequence having the following formula: [N1]-[N2]-[N3], wherein:

(i) [N1] comprises X1, X2, and X3, wherein at least one of X1, X2, or X3 is G;

(ii) [N2] comprises the amino acid sequence of SPH; and

(iii) [N3] comprises X4, X5, and X6, wherein at least one of X4, X5, or X6 is K or R;

wherein [N1]-[N2]-[N3] is present from N-terminus to C-terminus, immediately subsequent to position 452, numbered according to SEQ ID NO: 138; and

wherein the AAV capsid variant comprises an amino acid sequence at least 95% identical to the amino acid sequence of positions 203-736 of SEQ ID NO: 138.

6. The AAV capsid variant of claim 5, wherein:

(a) position X4 of [N3] is: K, S, A, V, T, G, F, W, V, N, or R;

(b) position X5 of [N3] is: S, K, T, F, I, L, Y, H, M, or R; and/or

(c) position X6 of [N3] is: G, A, R, M, I, N, T, Y, D, P, V, L, E, W, N, Q, K, or S.

7. The AAV capsid variant of claim 5 or 6, wherein:

(a) position X1 of [N1] is: G, V, R, D, E, M, T, I, S, A, N, L, K, H, P, W, or C;

(b) position X2 of [N1] is: H, S, V, L, N, D, R, P, G, T, I, A, E, Y, M, or Q; and/or

(c) position X3 of [N1] is: D, G, C, L, E, Y, H, V, A, N, P, or S.

8. The AAV capsid variant of any one of claims 5-7, wherein:

(i) [N3] comprises KSG, SKA, ARM, VKS, ASR, VKI, KKN, VRM, RKA, KTS, KFG, KIG, KLG, KTT, KTY, KYG, SKD, SKP, TRG, VRG, KRG, GAR, KSA, KSR, SKL, SRA, SKR, SLR, SRG, SSR, FLR, SKW, SKS, WKA, VRR, SKV, SKT, SKG, GKA, TKA, NKA, SKL, SKN, AKA, KTG, KSL, KSE, KSV, KSW, KSN, KHG, KSQ, KSK, KLW, WKG, KMG, KMA, or RSG; and/or

(ii) [N1] comprises GHD, GSG, GQD, VSG, CSG, GRG, CSH, GQS, GSH, RVG, GSC, GLL, GDD, GHE, GNY, MSG, RNG, TSG, ISG, GPG, ESG, SSG, GNG, ASG, NSG, LSG, GGG, KSG, HSG, GTG, PSG, GSV, RSG, GIG, WSG, DSG, IDG, GLG, DAG, DGG, MEG, ENG, GSA, KNG, KEG, AIG, GYD, GHG, GRD, GND, GPD, GMG, GQV, GHN, GHP, or GHS.

9. The AAV capsid variant of any one of claims 5-8, wherein:

(i) [N2]-[N3] comprises SPHKSG (SEQ ID NO: 946), SPHSKA (SEQ ID NO: 941), SPHARM (SEQ ID NO: 947), SPHVKS (SEQ ID NO: 948), SPHASR (SEQ ID NO: 949), SPHVKI (SEQ ID NO: 950), SPHKKN (SEQ ID NO: 954), SPHVRM (SEQ ID NO: 955), SPHRKA (SEQ ID NO: 956), SPHKFG (SEQ ID NO: 957), SPHKIG (SEQ ID NO: 958), SPHKLG (SEQ ID NO: 959), SPHKTS (SEQ ID NO: 963), SPHKTT (SEQ ID NO: 964), SPHKTY (SEQ ID NO: 965), SPHKYG (SEQ ID NO: 966), SPHSKD (SEQ ID NO: 967), SPHSKP (SEQ ID NO: 968), SPHTRG (SEQ ID NO: 972), SPHVRG (SEQ ID NO: 973), SPHKRG (SEQ ID NO: 974), SPHGAR (SEQ ID NO: 975), SPHKSA (SEQ ID NO: 977), SPHKSR (SEQ ID NO: 951), SPHSKL (SEQ ID NO: 960), SPHSRA (SEQ ID NO: 969), SPHSKR (SEQ ID NO: 978), SPHSLR (SEQ ID NO: 952), SPHSRG (SEQ ID NO: 961), SPHSSR (SEQ ID NO: 970), SPHFLR (SEQ ID NO: 979), SPHSKW (SEQ ID NO: 953), SPHSKS (SEQ ID NO: 962), SPHWKA (SEQ ID NO: 971), SPHVRR (SEQ ID NO: 980), SPHSKT (SEQ ID NO: 4731), SPHSKG (SEQ ID NO: 4732), SPHGKA (SEQ ID NO: 4733), SPHNKA (SEQ ID NO: 4734), SPHSKN (SEQ ID NO: 4735), SPHAKA (SEQ ID NO: 4736), SPHSKV (SEQ ID NO: 4737), SPHKTG (SEQ ID NO: 4738), SPHTKA (SEQ ID NO: 4739), SPHKSL (SEQ ID NO: 4740), SPHKSE (SEQ ID NO: 4741), SPHKSV (SEQ ID NO: 4742), SPHKSW (SEQ ID NO: 4743), SPHKSN (SEQ ID NO: 4744), SPHKHG (SEQ ID NO: 4745), SPHKSQ (SEQ ID NO: 4746), SPHKSK (SEQ ID NO: 4747), SPHKLW (SEQ ID NO: 4748), SPHWKG (SEQ ID NO: 4749), SPHKMG (SEQ ID NO: 4750), SPHKMA (SEQ ID NO: 4751), or SPHRSG (SEQ ID NO: 976);

(ii) [N1]-[N2] comprises GHDSPH (SEQ ID NO: 4784), GSGSPH (SEQ ID NO: 4695), GQDSPH (SEQ ID NO: 4785), VSGSPH (SEQ ID NO: 4786), CSGSPH (SEQ ID NO: 4787), GRGSPH (SEQ ID NO: 4788), CSHSPH (SEQ ID NO: 4789), GQSSPH (SEQ ID NO: 4790), GSHSPH (SEQ ID NO: 4791), GDDSPH (SEQ ID NO: 4792), GHESPH (SEQ ID NO: 4793), GNYSPH (SEQ ID NO:

4794), RVGSPH (SEQ ID NO: 4795), GSCSPH (SEQ ID NO: 4796), GLLSPH (SEQ ID NO: 4797), MSGSPH (SEQ ID NO: 4798), RNGSPH (SEQ ID NO: 4799), TSGSPH (SEQ ID NO: 4800), ISGSPH (SEQ ID NO: 4801), GPGSPH (SEQ ID NO: 4802), ESGSPH (SEQ ID NO: 4803), SSGSPH (SEQ ID NO: 4804), GNGSPH (SEQ ID NO: 4805), ASGSPH (SEQ ID NO: 4806), NSGSPH (SEQ ID NO: 4807), LSGSPH (SEQ ID NO: 4808), GGGSPH (SEQ ID NO: 4809), KSGSPH (SEQ ID NO: 4810), HSGSPH (SEQ ID NO: 4811), GTGSPH (SEQ ID NO: 4812), PSGSPH (SEQ ID NO: 4813), GSVSPH (SEQ ID NO: 4814), RSGSPH (SEQ ID NO: 4815), GIGSPH (SEQ ID NO: 4816), WSGSPH (SEQ ID NO: 4817), DSGSPH (SEQ ID NO: 4818), IDGSPH (SEQ ID NO: 4819), GLGSPH (SEQ ID NO: 4820), DAGSPH (SEQ ID NO: 4821), DGGSPH (SEQ ID NO: 4822), MEGSPH (SEQ ID NO: 4823), ENGSPH (SEQ ID NO: 4824), GSASPH (SEQ ID NO: 4825), KNGSPH (SEQ ID NO: 4826), KEGSPH (SEQ ID NO: 4827), AIGSPH (SEQ ID NO: 4828), GYDSPH (SEQ ID NO: 4829), GHGSPH (SEQ ID NO: 4830), GRDSPH (SEQ ID NO: 4831), GNDSPH (SEQ ID NO: 4832), GPDSPH (SEQ ID NO: 4833), GMGSPH (SEQ ID NO: 4834), GQVSPH (SEQ ID NO: 4835), GHNSPH (SEQ ID NO: 4836), GHPSPH (SEQ ID NO: 4837), or GHSSPH (SEQ ID NO: 4838); and/or

(iii) [N1]-[N2]-[N3] comprises GHDSPHKSG (SEQ ID NO: 4698), GSGSPHSKA (SEQ ID NO: 4697), GSGSPHARM (SEQ ID NO: 4906), GSGSPHVKS (SEQ ID NO: 4907), GQDSPHKSG (SEQ ID NO: 4908), GSGSPHASR (SEQ ID NO: 4909), GSGSPHVKI (SEQ ID NO: 4910), GSGSPHKKN (SEQ ID NO: 4911), GSGSPHVRM (SEQ ID NO: 4912), VSGSPHSKA (SEQ ID NO: 4913), CSGSPHSKA (SEQ ID NO: 4914), GSGSPHRKA (SEQ ID NO: 4915), CSGSPHKTS (SEQ ID NO: 4916), CSHSPHKSG (SEQ ID NO: 4917), GQSSPHRSG (SEQ ID NO: 4918), GRGSPHASR (SEQ ID NO: 4919), GRGSPHSKA (SEQ ID NO: 4920), GSGSPHKFG (SEQ ID NO: 4921), GSGSPHKIG (SEQ ID NO: 4922), GSGSPHKLG (SEQ ID NO: 4923), GSGSPHKTS (SEQ ID NO: 4924), GSGSPHKTT (SEQ ID NO: 4925), GSGSPHKTY (SEQ ID NO: 4926), GSGSPHKYG (SEQ ID NO: 4927), GSGSPHSKD (SEQ ID NO: 4928), GSGSPHSKP (SEQ ID NO: 4929), GSGSPHTRG (SEQ ID NO: 4930), GSGSPHVRG (SEQ ID NO: 4931), GSHSPHKRG (SEQ ID NO: 4932), GSHSPHKSG (SEQ ID NO: 4933), VSGSPHASR (SEQ ID NO: 4934), VSGSPHGAR (SEQ ID NO: 4935), VSGSPHKFG (SEQ ID NO: 4936), GHDSPHKRG (SEQ ID NO: 4937), GDDSPHKSG (SEQ ID NO: 4938), GHESPHKSA (SEQ ID NO: 4939), GHDSPHKSA (SEQ ID NO: 4940), GNYSPHKIG (SEQ ID NO: 4941), GHDSPHKSR (SEQ ID NO: 4942), GSGSPHSKL (SEQ ID NO: 4943), GSGSPHSRA (SEQ ID NO: 4944), GSGSPHSKR (SEQ ID NO: 4945), GSGSPHSLR (SEQ ID NO: 4946), GSGSPHSRG (SEQ ID NO: 4947), GSGSPHSSR (SEQ ID NO: 4948), RVGSPHSKA (SEQ ID NO: 4949), GSCSPHRKA (SEQ ID NO: 4950), GSGSPHFLR (SEQ ID NO: 4951), GSGSPHSKW (SEQ ID NO: 4952), GSGSPHSKS (SEQ ID NO: 4953), GLLSPHWKA (SEQ ID NO: 4954), GSGSPHVRR (SEQ ID NO: 4955), GSGSPHSKV (SEQ ID NO: 4956), MSGSPHSKA (SEQ ID NO: 4957), RNGSPHSKA (SEQ ID NO:

4958), TSGSPHSKA (SEQ ID NO: 4959), ISGSPHSKA (SEQ ID NO: 4960), GPGSPHSKA (SEQ ID NO: 4961), GSGSPHSKT (SEQ ID NO: 4962), ESGSPHSKA (SEQ ID NO: 4963), SSGSPHSKA (SEQ ID NO: 4964), GNGSPHSKA (SEQ ID NO: 4965), ASGSPHSKA (SEQ ID NO: 4966), NSGSPHSKA (SEQ ID NO: 4967), LSGSPHSKA (SEQ ID NO: 4968), GGGSPHSKA (SEQ ID NO: 4969), KSGSPHSKA (SEQ ID NO: 4970), GGGSPHSKS (SEQ ID NO: 4971), GSGSPHSKG (SEQ ID NO: 4972), HSGSPHSKA (SEQ ID NO: 4973), GTGSPHSKA (SEQ ID NO: 4974), PSGSPHSKA (SEQ ID NO: 4975), GSVSPHGKA (SEQ ID NO: 4976), RSGSPHSKA (SEQ ID NO: 4977), GSGSPHTKA (SEQ ID NO: 4978), GIGSPHSKA (SEQ ID NO: 4979), WSGSPHSKA (SEQ ID NO: 4980), DSGSPHSKA (SEQ ID NO: 4981), IDGSPHSKA (SEQ ID NO: 4982), GSGSPHNKA (SEQ ID NO: 4983), GLGSPHSKS (SEQ ID NO: 4984), DAGSPHSKA (SEQ ID NO: 4985), DGGSPHSKA (SEQ ID NO: 4986), MEGSPHSKA (SEQ ID NO: 4987), ENGSPHSKA (SEQ ID NO: 4988), GSASPHSKA (SEQ ID NO: 4989), GNGSPHSKS (SEQ ID NO: 4990), KNGSPHSKA (SEQ ID NO: 4991), KEGSPHSKA (SEQ ID NO: 4992), AIGSPHSKA (SEQ ID NO: 4993), GSGSPHSKN (SEQ ID NO: 4994), GSGSPHAKA (SEQ ID NO: 4995), GHDSPHKIG (SEQ ID NO: 4996), GYDSPHKSG (SEQ ID NO: 4997), GHESPHKSG (SEQ ID NO: 4998), GHDSPHKTG (SEQ ID NO: 4999), GRGSPHKRG (SEQ ID NO: 5000), GQDSPHKSG (SEQ ID NO: 4908), GHDSPHKSL (SEQ ID NO: 5001), GHGSPHSKA (SEQ ID NO: 5002), GHDSPHKSE (SEQ ID NO: 5003), VSGSPHSKA (SEQ ID NO: 4913), GRDSPHKSG (SEQ ID NO: 5004), GNDSPHKSV (SEQ ID NO: 5005), GQDSPHKIG (SEQ ID NO: 5006), GHDSPHKSV (SEQ ID NO: 5007), GPDSPHKIG (SEQ ID NO: 5008), GPDSPHKSG (SEQ ID NO: 5009), GHDSPHKSW (SEQ ID NO: 5010), GHDSPHKSN (SEQ ID NO: 5011), GMGSPHSKT (SEQ ID NO: 5012), GHDSPHKHG (SEQ ID NO: 5013), GQVSPHKSG (SEQ ID NO: 5014), GDDSPHKSV (SEQ ID NO: 5015), GHNSPHKSG (SEQ ID NO: 5016), GNGSPHKRG (SEQ ID NO: 5017), GHDSPHKYG (SEQ ID NO: 5018), GHDSPHKSQ (SEQ ID NO: 5019), GNDSPHKIG (SEQ ID NO: 5020), GHDSPHKSK (SEQ ID NO: 5021), GHDSPHKLW (SEQ ID NO: 5022), GHPSPHWKG (SEQ ID NO: 5023), GHDSPHKMG (SEQ ID NO: 5024), GHDSPHKMA (SEQ ID NO: 5025), or GHSSPHRSG (SEQ ID NO: 5026).

10. The AAV capsid variant of any one of claims 1-9, which further comprises:

(i) [N4], wherein [N4] comprises QNQQ (SEQ ID NO: 5028), WNQQ (SEQ ID NO: 5029), QYYV (SEQ ID NO: 5030), RRQQ (SEQ ID NO: 5031), GCGQ (SEQ ID NO: 5032), LRQQ (SEQ ID NO: 5033), RNQQ (SEQ ID NO: 5034), VNQQ (SEQ ID NO: 5035), FRLQ (SEQ ID NO: 5036), FNQQ (SEQ ID NO: 5037), LLQQ (SEQ ID NO: 5038), SNQQ (SEQ ID NO: 5039), RLQQ (SEQ ID NO: 5040), LNQQ (SEQ ID NO: 5041), QRKL (SEQ ID NO: 5042), LRRQ (SEQ ID NO: 5043), QRLR (SEQ ID NO: 5044), QRRL (SEQ ID NO: 5045), RRLQ (SEQ ID NO: 5046), RLRQ (SEQ ID NO: 5047), SKRQ (SEQ ID NO: 5048), QLYR (SEQ ID NO: 5049), QLTV (SEQ ID NO: 5050), QNKQ

(SEQ ID NO: 5051), KNQQ (SEQ ID NO: 5052), QKQQ (SEQ ID NO: 5053), QTQQ (SEQ ID NO: 5054), QNHQ (SEQ ID NO: 5055), QHQQ (SEQ ID NO: 5056), QNQH (SEQ ID NO: 5057), QHRQ (SEQ ID NO: 5058), LTQQ (SEQ ID NO: 5059), QNQW (SEQ ID NO: 5060), QNTH (SEQ ID NO: 5061), RRRQ (SEQ ID NO: 5062), QYQQ (SEQ ID NO: 5063), QNDQ (SEQ ID NO: 5064), QNRH (SEQ ID NO: 5065), RDQQ (SEQ ID NO: 5066), PNLQ (SEQ ID NO: 5067), HVRQ (SEQ ID NO: 5068), PNQH (SEQ ID NO: 5069), HNQQ (SEQ ID NO: 5070), QSQQ (SEQ ID NO: 5071), QPAK (SEQ ID NO: 5072), QNLA (SEQ ID NO: 5073), QNQL (SEQ ID NO: 5074), QGQQ (SEQ ID NO: 5075), LNRQ (SEQ ID NO: 5076), QNPP (SEQ ID NO: 5077), QNLQ (SEQ ID NO: 5078), QDQE (SEQ ID NO: 5079), QDQQ (SEQ ID NO: 5080), HWQQ (SEQ ID NO: 5081), PNQQ (SEQ ID NO: 5082), PEQQ (SEQ ID NO: 5083), QRTM (SEQ ID NO: 5084), LHQH (SEQ ID NO: 5085), QHRI (SEQ ID NO: 5086), QYIH (SEQ ID NO: 5087), QKFE (SEQ ID NO: 5088), QFPS (SEQ ID NO: 5089), QNPL (SEQ ID NO: 5090), QAIK (SEQ ID NO: 5091), QNRQ (SEQ ID NO: 5092), QYQH (SEQ ID NO: 5093), QNPQ (SEQ ID NO: 5094), QHQL (SEQ ID NO: 5095), QSPP (SEQ ID NO: 5096), QAKL (SEQ ID NO: 5097), KSQQ (SEQ ID NO: 5098), QDRP (SEQ ID NO: 5099), QNLG (SEQ ID NO: 5100), QAFH (SEQ ID NO: 5101), QNAQ (SEQ ID NO: 5102), HNQL (SEQ ID NO: 5103), QKLN (SEQ ID NO: 5104), QNVQ (SEQ ID NO: 5105), QAQQ (SEQ ID NO: 5106), QTPP (SEQ ID NO: 5107), QPPA (SEQ ID NO: 5108), QERP (SEQ ID NO: 5109), QDLQ (SEQ ID NO: 5110), QAMH (SEQ ID NO: 5111), QHPS (SEQ ID NO: 5112), PGLQ (SEQ ID NO: 5113), QGIR (SEQ ID NO: 5114), QAPA (SEQ ID NO: 5115), QIPP (SEQ ID NO: 5116), QTQL (SEQ ID NO: 5117), QAPS (SEQ ID NO: 5118), QNTY (SEQ ID NO: 5119), QDKQ (SEQ ID NO: 5120), QNHL (SEQ ID NO: 5121), QIGM (SEQ ID NO: 5122), LNKQ (SEQ ID NO: 5123), PNQL (SEQ ID NO: 5124), QLQQ (SEQ ID NO: 5125), QRMS (SEQ ID NO: 5126), QGIL (SEQ ID NO: 5127), QDRQ (SEQ ID NO: 5128), RDWQ (SEQ ID NO: 5129), QERS (SEQ ID NO: 5130), QNYQ (SEQ ID NO: 5131), QRTC (SEQ ID NO: 5132), QIGH (SEQ ID NO: 5133), QGAI (SEQ ID NO: 5134), QVPP (SEQ ID NO: 5135), QVQQ (SEQ ID NO: 5136), LMRQ (SEQ ID NO: 5137), QYSV (SEQ ID NO: 5138), QAIT (SEQ ID NO: 5139), QKTL (SEQ ID NO: 5140), QLHH (SEQ ID NO: 5141), QNII (SEQ ID NO: 5142), QGHH (SEQ ID NO: 5143), QSKV (SEQ ID NO: 5144), QLPS (SEQ ID NO: 5145), IGKQ (SEQ ID NO: 5146), QAIH (SEQ ID NO: 5147), QHGL (SEQ ID NO: 5148), QFMC (SEQ ID NO: 5149), QNQM (SEQ ID NO: 5150), QHLQ (SEQ ID NO: 5151), QPAR (SEQ ID NO: 5152), QSLQ (SEQ ID NO: 5153), QSQL (SEQ ID NO: 5154), HSQQ (SEQ ID NO: 5155), QMPS (SEQ ID NO: 5156), QGSL (SEQ ID NO: 5157), QVPA (SEQ ID NO: 5158), HYQQ (SEQ ID NO: 5159), QVPS (SEQ ID NO: 5160), RGEQ (SEQ ID NO: 5161), PGQQ (SEQ ID NO: 5162), LEQQ (SEQ ID NO: 5163), QNQS (SEQ ID NO: 5164), QKVI (SEQ ID NO: 5165), QNND (SEQ ID NO: 5166), QSVH (SEQ ID NO: 5167), QPLG (SEQ ID NO: 5168), HNQE (SEQ ID NO: 5169), QIQQ (SEQ ID NO: 5170), QVRN (SEQ ID NO: 5171), PSNQ (SEQ

ID NO: 5172), QVGH (SEQ ID NO: 5173), QRDI (SEQ ID NO: 5174), QMPN (SEQ ID NO: 5175), RGLQ (SEQ ID NO: 5176), PSLQ (SEQ ID NO: 5177), QRDQ (SEQ ID NO: 5178), QAKG (SEQ ID NO: 5179), QSAH (SEQ ID NO: 5180), QSTM (SEQ ID NO: 5181), QREM (SEQ ID NO: 5182), QYRA (SEQ ID NO: 5183), QRQQ (SEQ ID NO: 5184), QWQQ (SEQ ID NO: 5185), QRMN (SEQ ID NO: 5186), GDSQ (SEQ ID NO: 5187), QKIS (SEQ ID NO: 5188), PSMQ (SEQ ID NO: 5189), SPRQ (SEQ ID NO: 5190), MEQQ (SEQ ID NO: 5191), QYQN (SEQ ID NO: 5192), QIRQ (SEQ ID NO: 5193), QSVQ (SEQ ID NO: 5194), RSQQ (SEQ ID NO: 5195), QNKL (SEQ ID NO: 5196), QIQH (SEQ ID NO: 5197), PRQQ (SEQ ID NO: 5198), HTQQ (SEQ ID NO: 5199), QRQH (SEQ ID NO: 5200), RNQE (SEQ ID NO: 5201), QSKQ (SEQ ID NO: 5202), QNQP (SEQ ID NO: 5203), QSPQ (SEQ ID NO: 5204), QTRQ (SEQ ID NO: 5205), QNLH (SEQ ID NO: 5206), QNQE (SEQ ID NO: 5207), LNQP (SEQ ID NO: 5208), QNQD (SEQ ID NO: 5209), QNLL (SEQ ID NO: 5210), QLVI (SEQ ID NO: 5211), RTQE (SEQ ID NO: 5212), QTHQ (SEQ ID NO: 5213), QDQH (SEQ ID NO: 5214), QSQH (SEQ ID NO: 5215), VRQQ (SEQ ID NO: 5216), AWQQ (SEQ ID NO: 5217), QSVP (SEQ ID NO: 5218), QNIQ (SEQ ID NO: 5219), LDQQ (SEQ ID NO: 5220), PDQQ (SEQ ID NO: 5221), ESQQ (SEQ ID NO: 5222), QRQL (SEQ ID NO: 5223), QIIV (SEQ ID NO: 5224), QKQS (SEQ ID NO: 5225), QSHQ (SEQ ID NO: 5226), QFVV (SEQ ID NO: 5227), QSQP (SEQ ID NO: 5228), QNEQ (SEQ ID NO: 5229), INQQ (SEQ ID NO: 5230), RNRQ (SEQ ID NO: 5231), RDQK (SEQ ID NO: 5232), QWKR (SEQ ID NO: 5233), ENRQ (SEQ ID NO: 5234), QTQP (SEQ ID NO: 5235), QKQL (SEQ ID NO: 5236), RNQL (SEQ ID NO: 5237), ISIQ (SEQ ID NO: 5238), QTVC (SEQ ID NO: 5239), QQIM (SEQ ID NO: 5240), LNHQ (SEQ ID NO: 5241), QNQA (SEQ ID NO: 5242), QMIH (SEQ ID NO: 5243), RNHQ (SEQ ID NO: 5244), or QKMN (SEQ ID NO: 5245); and/or

(ii) [N0], wherein [N0] comprises TIN, SMN, TIM, YLS, GLS, MPE, MEG, MEY, AEW, CEW, ANN, IPE, ADM, IEY, ADY, IET, MEW, CEY, RIN, MEI, LEY, ADW, IEI, DIM, FEQ, MEF, CDQ, LPE, IEN, MES, AEI, VEY, IIN, TSN, IEV, MEM, AEV, MDA, VEW, AEQ, LEW, MEL, MET, MEA, IES, MEV, CEI, ATN, MDG, QEV, ADQ, NMN, IEM, ISN, TGN, QQQ, HDW, IEG, TII, TFP, TEK, EIN, TVN, TFN, SIN, TER, TSY, ELH, AIN, SVN, TDN, TFH, TVH, TEN, TSS, TID, TCN, NIN, TEH, AEM, AIK, TDK, TFK, SDQ, TEI, NTN, TET, SIK, TEL, TEA, TAN, TIY, TFS, TES, TTN, TED, TNN, EVH, TIS, TVR, TDR, TIK, NHI, TIP, ESD, TDL, TVP, TVI, AEH, NCL, TVK, NAD, TIT, NCV, TIR, NAL, VIN, TIQ, TEF, TRE, QGE, SEK, NVN, GGE, EFV, SDK, TEQ, EVQ, TEY, NCW, TDV, SDI, NSI, NSL, EVV, TEP, SEL, TWQ, TEV, AVN, GVL, TLN, TEG, TRD, NAI, AEN, AET, ETA, NNL.

11. The AAV capsid variant of claim 10, wherein [N0]-[N1]-[N2]-[N3]-[N4] comprises the amino acid sequence of any one of SEQ ID NOs: 2243, 2242, 2242-2886.

12. The AAV capsid variant of claim 10 or 11, which comprises from N-terminus to C-terminus [N0]-[N1]-[N2]-[N3]-[N4], wherein:

(i) [N0] is present immediately subsequent to position 449 and replaces positions 450-452, numbered according to the amino acid sequence of any one of SEQ ID NOs: 982, 981, or 138;

(ii) [N1] is present immediately subsequent to position 452 and replaces positions 453-455, numbered according to the amino acid sequence of SEQ ID NO: 138;

(iii) [N2] is present immediately subsequent to position 455, numbered according to the amino acid sequence of SEQ ID NO: 138;

(iv) [N3] is present immediately subsequent to [N2];

(v) [N4] is present immediately subsequent to position 455 and replaces positions 456-459, numbered according to the amino acid sequence of SEQ ID NO: 138;

(vi) [N2]-[N3]-[N4] corresponds to positions 456-465 of SEQ ID NO: 982 or 981;

(vii) [N1]-[N2]-[N3] corresponds to positions 453-461 of SEQ ID NO: 982 or 981; and/or

(viii) [N0]-[N1]-[N2]-[N3]-[N4] corresponds to positions 450-465 of SEQ ID NO: 982 or 981.

13. An adeno-associated (AAV) capsid variant comprising an amino acid sequence having the following formula: [N1]-[N2]-[N3] (SEQ ID NO: 6408), wherein:

(i) [N1] comprises positions X1, X2, and X3, wherein position X2 is an amino acid other than S and position X3 is an amino acid other than G;

(ii) [N2] comprises the amino acid sequence SPH; and

(iii) [N3] comprises positions X4, X5, and X6, wherein position X4 is K;

wherein [N1]-[N2]-[N3] is present from N-terminus to C-terminus, immediately subsequent to position 452, numbered according to SEQ ID NO: 982; and

wherein the AAV capsid variant comprises an amino acid sequence at least 95% identical to the amino acid sequence of positions 203-742 of SEQ ID NO: 982.

14. An adeno-associated virus (AAV) capsid variant comprising an amino acid sequence having the following formula: [N1]-[N2]-[N3] (SEQ ID NO: 6407), wherein:

(i) [N1] comprises positions X1, X2, and X3, wherein position X2 is S and position X3 is G;

(ii) [N2] comprises the amino acid sequence SPH; and

(iii) [N3] comprises positions X4, X5, and X6, wherein position X5 is K;

wherein [N1]-[N2]-[N3] is present from N-terminus to C-terminus, immediately subsequent to position 452, numbered according to SEQ ID NO: 981; and

wherein the AAV capsid variant comprises an amino acid sequence at least 95% identical to the amino acid sequence of positions 203-742 of SEQ ID NO: 981.

15. An adeno-associated virus (AAV) capsid variant comprising:

(a) the amino acid sequence of any one of the sequences provided in Tables 1, 2A, 2B, 9-11, or 13-19;

(b) an amino acid sequence comprising at least 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, or 17 consecutive amino acids from any one of the sequences provided in Tables 1, 2A, 2B, 9-11, or 13-19; or

(c) an amino acid sequence comprising at least one, two, or three but no more than four modifications, relative to the amino acid sequence of any one of the sequences provided in Tables 1, 2A, 2B, 9-11, or 13-19.

16. The AAV capsid variant of claim 15, wherein:

(A) (i) the at least 3 consecutive amino acids comprise HDS;

(ii) the at least 4 consecutive amino acids comprise HDSP (SEQ ID NO: 4702);

(iii) the at least 5 consecutive amino acids comprise HDSPH (SEQ ID NO: 4703); and/or

(iv) the at least 6 consecutive amino acids comprise HDSPHK (SEQ ID NO: 2); or

(B) (i) the at least 3 consecutive amino acids comprise SPH;

(ii) the at least 4 consecutive amino acids comprise SPHS (SEQ ID NO: 4700);

(iii) the at least 5 consecutive amino acids comprise SPHSK (SEQ ID NO: 4701); and/or

(iv) the at least 6 consecutive amino acids comprise SPHSKA (SEQ ID NO: 941).

17. The AAV capsid variant of claim 15 or 16, wherein:

(i) the AAV capsid variant comprises the amino acid sequence of HDSPHK (SEQ ID NO: 2), or an amino acid sequence comprising at least one, two, or three but no more than four different amino acids relative to the amino acid sequence of HDSPHK (SEQ ID NO: 2);

(ii) the AAV capsid variant comprises an amino acid sequence encoded by: the nucleotide sequence of SEQ ID NO: 3; or a nucleotide sequence comprising at least one, two, three, four, five, six, or seven, but no more than ten different nucleotides relative to the nucleotide sequence of SEQ ID NO: 3; and/or

(iii) the nucleotide sequence encoding the AAV capsid variant comprises the nucleotide sequence of SEQ ID NO: 3; or a nucleotide sequence comprising at least one, two, three, four, five, six, or seven, but no more than ten different nucleotides relative to the nucleotide sequence of SEQ ID NO: 3.

18. The AAV capsid variant of claim 15 or 16, wherein:

(i) the AAV capsid variant comprises the amino acid sequence of SPHSKA (SEQ ID NO: 941), or an amino acid sequence comprising at least one, two, or three but no more than four different amino acids relative to the amino acid sequence of SPHSKA (SEQ ID NO: 941);

(ii) the AAV capsid variant comprises an amino acid sequence encoded by the nucleotide sequence of SEQ ID NO: 942; or a nucleotide sequence comprising at least one, two, three, four, five, six, or seven, but no more than ten different nucleotides relative to the nucleotide sequence of SEQ ID NO: 942; and/or

(iii) the nucleotide sequence encoding the AAV capsid variant comprises the nucleotide sequence of SEQ ID NO: 942; or a nucleotide sequence comprising at least one, two, three, four, five, six, or seven, but no more than ten different nucleotides relative to the nucleotide sequence of SEQ ID NO: 942.

19. The AAV capsid variant of any one of claims 15-18, wherein the amino acid sequence is present:

(i) in variable region IV (VR-IV), wherein VR-IV comprises positions 449-460, numbered according to SEQ ID NO: 138;

(ii) immediately subsequent to position 448, 449, 450, 451, 452, 453, 454, or 455, numbered according to the amino acid sequence of SEQ ID NO: 138;

(iii) immediately subsequent to position 453, numbered according to the amino acid sequence of SEQ ID NO: 138 or 982; and/or

(iv) immediately subsequent to position 455, numbered according to the amino acid sequence of SEQ ID NO: 138 or 981.

20. The AAV capsid variant of any one of claims 15-19, comprising:

(i) the amino acid sequence of HDSPHK (SEQ ID NO: 2), wherein the amino acid sequence is present immediately subsequent to position 453, numbered according to the amino acid sequence of SEQ ID NO: 138 or 982; or

(ii) the amino acid sequence of SPHSKA (SEQ ID NO: 941), wherein the amino acid sequence is present immediately subsequent to position 455, numbered according to the amino acid sequence of SEQ ID NO: 138 or 981.

21. The AAV capsid variant of any one of claims 1-20, which comprises:

(i) an amino acid sequence at least 98% identical to amino acids 203-742 of SEQ ID NO: 981 or SEQ ID NO: 982;

(ii) an amino acid sequence at least 95% or at least 98% identical to amino acids 138-742 of SEQ ID NO: 981 or SEQ ID NO: 982; and/or

(iii) an amino acid sequence at least 95% or at least 98% identical to SEQ ID NO: 981 or SEQ ID NO: 982.

22. The AAV capsid variant of any one of claims 1-21, which comprises:

(i) the amino acid sequence of amino acids 203-742 of SEQ ID NO: 981 or SEQ ID NO: 982;

(ii) the amino acid sequence of amino acids 138-742 of SEQ ID NO: 981 or SEQ ID NO: 982; and/or

(iii) the amino acid sequence of SEQ ID NO: 981 or SEQ ID NO: 982.

23. The AAV capsid variant of any one of claims 1-22, wherein the AAV capsid variant has an increased tropism for a brain cell or a brain tissue, relative to an AAV capsid protein comprising the amino acid sequence of SEQ ID NO: 138.

24. A polynucleotide encoding the AAV capsid variant of any one of claims 1-23, optionally wherein the polynucleotide comprises the nucleotide sequence of SEQ ID NO: 983 or SEQ ID NO: 984, or a nucleotide sequence at least 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto.

25. A peptide comprising:

(a) the amino acid sequence of any one of the sequences provided in Tables 1, 2A, 2B, 9-11, or 13-19;

(b) an amino acid sequence comprising at least 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, or 17 consecutive amino acids from any one of the sequences provided in Tables 1, 2A, 2B, 9-11, or 13-19; or

(c) an amino acid sequence comprising at least one, two, or three but no more than four different amino acids, relative to any one of the sequences provided in Tables 1, 2A, 2B, 9-11, or 13-19; or

(d) an amino acid sequence comprising at least one, two, or three but no more than four modifications, relative to the amino acid sequence of any one of the sequences provided in Tables 1, 2A, 2B, 9-11, or 13-19.

26. An AAV particle comprising the AAV capsid variant of any one of claims 1-23, an AAV capsid variant encoded by the polynucleotide of claim 24, or an AAV capsid variant comprising the peptide of claim 25.

27. The AAV particle of claim 26, which comprises a nucleotide sequence encoding a payload, wherein the encoded payload comprises a protein, an antibody, an enzyme, or an inhibitory RNA agent.

28. The AAV particle of claim 27, which further comprises:

(i) a 5' inverted terminal repeat (ITR) and/or a 3' ITR;

(ii) a promoter operably linked to the nucleotide sequence encoding the payload;

(iii) an enhancer;

(iv) a Kozak sequence;

(v) an intron;

(vi) an exon;

(vii) a nucleotide sequence encoding a miR binding site; and/or

(v) a polyadenylation (polyA) sequence.

29. A vector comprising a polynucleotide encoding the AAV capsid variant of any one of claims 1-23, the polynucleotide of claim 24, or a polynucleotide encoding the peptide of claim 25.

30. A cell comprising the AAV capsid variant of any one of claims 1-23, the polynucleotide of claim 24, the peptide of claim 25, the AAV particle of any one of claims 26-28, or the vector of claim 29, optionally wherein the cell is:

(i) a mammalian cell or an insect cell;

(ii) a cell of a brain region or a spinal cord region, optionally a cell of the brain stem, hippocampus, or thalamus; and/or

(iii) a neuron, a sensory neuron, a motor neuron, an astrocyte, a glial cell, oligodendrocyte, or a muscle cell.

31. A method of making an AAV particle, comprising

(i) providing a host cell comprising a viral genome and a polynucleotide encoding the AAV capsid variant of any one of claims 1-23; and

(ii) incubating the host cell under conditions suitable to enclose the viral genome in the AAV capsid variant;

thereby making the AAV particle.

32. A pharmaceutical composition comprising the AAV particle of any one of claims 26-28, an AAV particle comprising the AAV capsid variant of any one of claims 1-23, or an AAV particle comprising the peptide of claim 25, and a pharmaceutically acceptable excipient.

33. The AAV particle of any one of claims 26-28, an AAV particle comprising the AAV capsid variant of any one of claims 1-23, an AAV particle comprising the peptide of claim 25, or the pharmaceutical composition of claim 32, for use in delivering a payload to a cell or tissue.

34. Use of the AAV particle of any one of claims 26-28, an AAV particle comprising the AAV capsid variant of any one of claims 1-23, an AAV particle comprising the peptide of claim 25, or the pharmaceutical composition of claim 32, in the manufacture of a medicament for delivering a payload to a cell or tissue.

35. The AAV particle or the pharmaceutical composition for use of claim 33 or the use of claim 34, wherein the cell is:

(i) a cell of a brain region or a spinal cord region, optionally a cell of the frontal cortex, sensory cortex, motor cortex, caudate, cerebellar cortex, cerebral cortex, brain stem, hippocampus, or thalamus;

(ii) a neuron, a sensory neuron, a motor neuron, an astrocyte, a glial cell, or an oligodendrocyte; and/or

(iii) within a subject, optionally wherein the subject has, has been diagnosed with having, or is at risk of having a neurological disorder, a neurodegenerative disorder, a neuro-oncological disorder, a muscular disorder, or a neuromuscular disorder.

36. The AAV particle of any one of claims 26-28, an AAV particle comprising the AAV capsid variant of any one of claims 1-23, an AAV particle comprising the peptide of claim 25, or the pharmaceutical composition of claim 32, for use in treating a subject having or diagnosed with having a neurological disorder, neurodegenerative disorder, muscular disorder, neuromuscular disorder, or neuro-oncological disorder .

37. Use of the AAV particle of any one of claims 26-28, an AAV particle comprising the AAV capsid variant of any one of claims 1-23, an AAV particle comprising the peptide of claim 25, or the pharmaceutical composition of claim 32, in the manufacture of a medicament for treating a subject having or diagnosed with having a neurological disorder, neurodegenerative disorder, muscular disorder, neuromuscular disorder, or neuro-oncological disorder.

38. The AAV particle or the pharmaceutical composition for use of claim 35 or 36 or the use of claim 35 or 37, wherein the neurological disorder, neurodegenerative disorder, muscular disorder, neuromuscular disorder, or neuro-oncological disorder is Huntington's Disease, Amyotrophic Lateral Sclerosis (ALS), Gaucher Disease, Dementia with Lewy Bodies, Parkinson's disease, Spinal Muscular Atrophy, Alzheimer's Disease, a leukodystrophy, Alexander disease, autosomal dominant leukodystrophy with autonomic diseases (ADLD), Canavan disease, cerebrotendinous xanthomatosis (CTX), metachromatic leukodystrophy (MLD), Pelizaeus-Merzbacher disease, Refsum disease, a cancer, a HER2/neu positive cancer, or a glioblastoma.

39. The AAV particle or pharmaceutical composition for use of any one of claims 33, 35, 36, or 38 or the use of any one of claims 34, 35, 37, or 38, wherein the AAV particle or the pharmaceutical composition is formulated for intravenous administration, intramuscular administration, intracerebral administration, intrathecal administration, intracerebroventricular administration, intraparenchymal administration, or intra-cisterna magna injection (ICM)