CLAIMS

1. An adeno-associated virus (AAV) expression vector or a recombinant adeno-associated virus (rAAV) expression vector comprising a transgene operably linked to a promoter sequence, wherein the transgene encodes a variant light-activated ion channel polypeptide comprising an amino acid sequence having greater than 95% amino acid sequence identity to any one of SEQ ID NOs: 8, 9, or 10, which comprises a cysteine at a position corresponding to position 112 of SEQ ID NO:2 and either a cysteine at a position corresponding to position 139 or a glutamate at a position corresponding to position 94 in SEQ ID NO: 2, wherein any differences between the amino acid sequence of the variant and any one of SEQ ID NOs: 8, 9, or 10 is a conservative amino acid substitution, and wherein the light-activated ion channel polypeptide has at least one of a greater level of an ion flux and a greater level of proton flux compared to the light-activated ion channel polypeptide of SEQ ID NO:2 when expressed in a cell membrane and contacted with activating light.
2. The AAV expression vector or the rAAV expression vector of claim 1, wherein the transgene encodes a variant light-activated ion channel polypeptide comprising the amino acid sequence of any one of SEQ ID NOs: 8, 9, or 10, or an amino acid sequence having greater than 98% amino acid sequence identity thereto.
3. An adeno-associated virus (AAV) expression vector or a recombinant adeno-associated virus (rAAV) expression vector comprising a transgene operably linked to a promoter sequence, wherein the transgene encodes a light-activated ion channel polypeptide comprising the amino acid sequence of any one of SEQ ID NOs: 8, 9, or 10.
4. The AAV expression vector or the rAAV expression vector of claim 3, wherein the transgene encodes a light-activated ion channel polypeptide comprising the amino acid sequence of SEQ ID NO: 10.
5. A recombinant adeno-associated virus comprising a transgene operably linked to a promoter sequence, wherein the transgene encodes a light-activated ion channel polypeptide comprising the amino acid sequence of any one of SEQ ID NOs: 8, 9, or 10.

6. The AAV expression vector or the rAAV expression vector of any one of claims 1-4, or the virus of claim 5, wherein the AAV expression vector or the rAAV expression vector, or the virus, is an AAV1, AAV2, AAV3, AAV4, AAV5, AAV6, AAV7, AAV8, AAV9, AAV10, AAV11, or AAV12 expression vector or virus.
7. The AAV expression vector or the rAAV expression vector of any one of claims 1-4, or the virus of claim 5, wherein the AAV expression vector or the rAAV expression vector, or the virus, is an AAV2 expression vector or virus.
8. The AAV expression vector or the rAAV expression vector of any one of claims 1-4, 6 and 7, or the virus of any one of claims 5-7, wherein the promoter is a cytomegalovirus (CMV) promoter, a Rous sarcoma virus (RSV) promoter, an MMT promoter, an EF-1 alpha promoter, a UB6 promoter, a chicken beta-actin promoter, a CAG promoter, an RPE65 promoter or an opsin promoter.
9. A pharmaceutical composition comprising the AAV expression vector or the rAAV expression vector of any one of claims 1-4 and 6-8.
10. A pharmaceutical composition comprising the virus of any one of claims 5-8.
11. The pharmaceutical composition of claim 9 or 10 for use in a method of improving or restoring vision in a subject suffering from an ocular disease associated with photoreceptor loss or degeneration.
12. Use of the AAV expression vector or the rAAV expression vector of any one of claims 1-4 and 6-8, or the pharmaceutical composition of claim 9 or claim 10, in the manufacture of a medicament for improving or restoring vision in a subject suffering from an ocular disease associated with photoreceptor loss or degeneration.
13. The pharmaceutical composition for use of claim 11 or the use of claim 12, wherein the ocular disease is macular degeneration or retinitis pigmentosa.
14. The pharmaceutical composition for use of claim 11 or 13 or the use of claim 12 or 13, wherein said improving or restoring vision comprises any of the following: increasing light sensitivity, lowering the threshold light intensity required to elicit a photocurrent; and increasing visual evoked potential in the visual cortex.
15. The pharmaceutical composition of claim 9 or 10 for use in a method of treating retinitis pigmentosa or age-related macular degeneration in a subject.

16. Use of the AAV expression vector or the rAAV expression vector of any one of claims 1-4 and 6-8, or the pharmaceutical composition of claim 9 or 10, in the manufacture of a medicament for treating retinitis pigmentosa or age-related macular degeneration in a subject.
17. The pharmaceutical composition for use of any one of claims 11 and 13-15- or the use of any one of claims 12-14 and 16, wherein the AAV expression vector or the rAAV expression vector or the pharmaceutical composition is adapted for administration by intravitreal or subretinal injection.
18. An expression vector comprising a nucleic acid molecule encoding an isolated light–activated ion channel polypeptide comprising the amino acid sequence of any one of SEQ ID NOs: 3, 5, 6, and 8-10, wherein the light–activated ion channel polypeptide has at least one of a greater level of an ion flux and a greater level of proton flux compared to the light–activated ion channel polypeptide of SEQ ID NO:2 when expressed in a cell membrane and contacted with activating light.