CLAIMS

1. A viral vector comprising a vector genome, the vector genome comprising, in the 5’ to 3’ direction:
   i. a 5’ inverted terminal repeat (ITR);
   ii. a promoter;
   iii. a recombinant nucleotide sequence comprising a CYP4V2 coding sequence;
   iv. a polyadenylation (polyA) signal sequence; and
   v. a 3’ ITR.
2. The viral vector of claim 1, wherein the promoter is a VMD2 promoter.
3. The viral vector of claim 2, wherein the VMD2 promoter comprises a nucleotide sequence with greater than or about 90% identity to SEQ ID NO: 6.
4. The viral vector of claim 1, wherein the promoter is selected from the group consisting of a ProC2 promoter, a CYP4V2 promoter, and a RPE65 promoter.
5. The viral vector of claim 4, wherein the promoter comprises a nucleotide sequence with greater than or about 90% identity to SEQ ID NO: 6, SEQ ID NO: 7, or SEQ ID NO: 8.
6. The viral vector of any one of claims 1 to 5, wherein the promoter is effective to promote expression of CYP4V2 in RPE cells.
7. The viral vector of claim 1, wherein the promoter is a ubiquitous promoter.
8. The viral vector of claim 7, wherein the promoter is a cytomegalovirus (CMV) promoter, CBA promoter, or CAG promoter.
9. The viral vector of claim 1, wherein the promoter comprises a nucleic acid sequence selected from the group consisting of SEQ ID NOs: 55-80.
10. The viral vector of any one of claims 1 to 9, wherein the CYP4V2 coding sequence comprises a nucleotide sequence with greater than or about 90% identity to SEQ ID NO: 13, 14, 39, 41, 43, 45, 47, or 49.
11. The viral vector of any one of claims 1 to 10, wherein the CYP4V2 coding sequence comprises the nucleotide sequence of SEQ ID NO: 14.
12. The viral vector of any one of claims 1 to 11, wherein the polyA signal comprises a nucleotide sequence with greater than or about 90% identity to SEQ ID NO: 18 or 19.
13. The viral vector of any one of claims 1 to 12, wherein the polyA signal comprises the nucleotide sequence of SEQ ID NO: 18.
14. The viral vector of any one of claims 1 to 13, further comprising an intron sequence comprising a nucleotide sequence with greater than or about 90% identity to SEQ ID NO: 9, 10, or 11.
15. The viral vector of claim 14, wherein the intron sequence comprises the nucleotide sequence of SEQ ID NO: 9.

16. The viral vector of any one of claims 1 to 15, further comprising 1) a regulatory element comprising a hepatitis B virus or woodchuck hepatitis virus sequence and/or 2) a Kozak sequence positioned immediately upstream of the recombinant nucleotide sequence comprising the CYP4V2 coding sequence.

17. The viral vector of any one of claims 1 to 16, wherein the vector genome comprises, in the 5' to 3' direction, nucleotide sequences selected from the group consisting of:

i) SEQ ID NOs: 1, 2, 13, 18, and 22;
ii) SEQ ID NOs: 1, 3, 13, 18, and 22;
iii) SEQ ID NOs: 1, 4, 13, 18, and 22;
iv) SEQ ID NOs: 1, 5, 13, 18, and 22;
v) SEQ ID NOs: 1, 6, 13, 18, and 22;
vi) SEQ ID NOs: 1, 7, 13, 18, and 22;
vii) SEQ ID NOs: 1, 8, 13, 18, and 22;
viii) SEQ ID NOs: 1, 2, 14, 18, and 22;
ix) SEQ ID NOs: 1, 3, 14, 18, and 22;
x) SEQ ID NOs: 1, 4, 14, 18, and 22;
xi) SEQ ID NOs: 1, 5, 14, 18, and 22;
xii) SEQ ID NOs: 1, 6, 14, 18, and 22;
xiii) SEQ ID NOs: 1, 7, 14, 18, and 22;
xiv) SEQ ID NOs: 1, 8, 14, 18, and 22;
xv) SEQ ID NOs: 1, 2, 13, 19, and 22;
xvi) SEQ ID NOs: 1, 3, 13, 19, and 22;
xvii) SEQ ID NOs: 1, 4, 13, 19, and 22;
xviii) SEQ ID NOs: 1, 5, 13, 19, and 22;
xix) SEQ ID NOs: 1, 6, 13, 19, and 22;
xx) SEQ ID NOs: 1, 7, 13, 19, and 22;
xxi) SEQ ID NOs: 1, 8, 13, 19, and 22;
xxii) SEQ ID NOs: 1, 2, 14, 19, and 22;
xxiii) SEQ ID NOs: 1, 3, 14, 19, and 22;
xxiv) SEQ ID NOs: 1, 4, 14, 19, and 22;
xxv) SEQ ID NOs: 1, 5, 14, 19, and 22;
xxvi) SEQ ID NOs: 1, 6, 14, 19, and 22;
xxvii) SEQ ID NOs: 1, 7, 14, 19, and 22;
xxviii) SEQ ID NOs: 1, 8, 14, 19, and 22;
xxix) SEQ ID NOs:1, 2, 9, 13, 18, and 22;
xxx) SEQ ID NOs: 1, 3, 9, 13, 18, and 22;
xxxi) SEQ ID NOs: 1, 4, 9, 13, 18, and 22;

xxxii) SEQ ID NOs: 1, 5, 9, 13, 18, and 22;
xxxiii) SEQ ID NOs: 1, 6, 9, 13, 18, and 22;
xxxiv) SEQ ID NOs: 1, 7, 9, 13, 18, and 22;
xxxv) SEQ ID NOs: 1, 8, 9, 13, 18, and 22;
xxxvi) SEQ ID NOs: 1, 2, 9, 14, 18, and 22;
xxxvii) SEQ ID NOs: 1, 3, 9, 14, 18, and 22;
xxxviii) SEQ ID NOs: 1, 4, 9, 14, 18, and 22;
xxxix) SEQ ID NOs: 1, 5, 9, 14, 18, and 22;
xl) SEQ ID NOs: 1, 6, 9, 14, 18, and 22;
xli) SEQ ID NOs: 1, 7, 9, 14, 18, and 22;
xlii) SEQ ID NOs: 1, 8, 9, 14, 18, and 22;
xliii) SEQ ID NOs: 1, 2, 9, 13, 19, and 22;
xliv) SEQ ID NOs: 1, 3, 9, 13, 19, and 22;
xlv) SEQ ID NOs: 1, 4, 9, 13, 19, and 22;
xlvi) SEQ ID NOs: 1, 5, 9, 13, 19, and 22;
xlvii) SEQ ID NOs: 1, 6, 9, 13, 19, and 22;
xlviii) SEQ ID NOs: 1, 7, 9, 13, 19, and 22;
xlix) SEQ ID NOs: 1, 8, 9, 13, 19, and 22;
l) SEQ ID NOs: 1, 2, 9, 14, 19, and 22;
li) SEQ ID NOs: 1, 3, 9, 14, 19, and 22;
lii) SEQ ID NOs: 1, 4, 9, 14, 19, and 22;
liii) SEQ ID NOs: 1, 5, 9, 14, 19, and 22;
liv) SEQ ID NOs: 1, 6, 9, 14, 19, and 22;
lv) SEQ ID NOs: 1, 7, 9, 14, 19, and 22;
lvi) SEQ ID NOs: 1, 8, 9, 14, 19, and 22;
lvii) SEQ ID NOs: 1, 2, 13, 16, 18, and 22;
lviii) SEQ ID NOs: 1, 3, 13, 16, 18, and 22;
lix) SEQ ID NOs: 1, 4, 13, 16, 18, and 22;
lx) SEQ ID NOs: 1, 5, 13, 16, 18, and 22;
lxi) SEQ ID NOs: 1, 6, 13, 16, 18, and 22;
lxii) SEQ ID NOs: 1, 7, 13, 16, 18, and 22;
lxiii) SEQ ID NOs: 1, 8, 13, 16, 18, and 22;
lxiv) SEQ ID NOs: 1, 2, 14, 16, 18, and 22;
lxv) SEQ ID NOs: 1, 3, 14, 16, 18, and 22;
lxvi) SEQ ID NOs: 1, 4, 14, 16, 18, and 22;
lxvii) SEQ ID NOs: 1, 5, 14, 16, 18, and 22;
lxviii) SEQ ID NOs: 1, 6, 14, 16, 18, and 22;

lxix) SEQ ID NOs: 1, 7, 14, 16, 18, and 22;
lxx) SEQ ID NOs: 1, 8, 14, 16, 18, and 22;
lxxi) SEQ ID NOs: 1, 2, 13, 16, 19, and 22;
lxxii) SEQ ID NOs: 1, 3, 13, 16, 19, and 22;
lxxiii) SEQ ID NOs: 1, 4, 13, 16, 19, and 22;
lxxiv) SEQ ID NOs: 1, 5, 13, 16, 19, and 22;
lxxv) SEQ ID NOs: 1, 6, 13, 16, 19, and 22;
lxxvi) SEQ ID NOs: 1, 7, 13, 16, 19, and 22;
lxxvii) SEQ ID NOs: 1, 8, 13, 16, 19, and 22;
lxxviii) SEQ ID NOs: 1, 2, 14, 16, 19, and 22;
lxxix) SEQ ID NOs: 1, 3, 14, 16, 19, and 22;
lxxx) SEQ ID NOs: 1, 4, 14, 16, 19, and 22;
lxxxi) SEQ ID NOs: 1, 5, 14, 16, 19, and 22;
lxxxii) SEQ ID NOs: 1, 6, 14, 16, 19, and 22;
lxxxiii) SEQ ID NOs: 1, 7, 14, 16, 19, and 22;
lxxxiv) SEQ ID NOs: 1, 8, 14, 16, 19, and 22;
lxxxv) SEQ ID NOs: 1, 2, 9, 13, 16, 18, and 22;
lxxxvi) SEQ ID NOs: 1, 3, 9, 13, 16, 18, and 22;
lxxxvii) SEQ ID NOs: 1, 4, 9, 13, 16, 18, and 22;
lxxxviii) SEQ ID NOs: 1, 5, 9, 13, 16, 18, and 22;
lxxxix) SEQ ID NOs: 1, 6, 9, 13, 16, 18, and 22;
xc) SEQ ID NOs: 1, 7, 9, 13, 16, 18, and 22;
xci) SEQ ID NOs: 1, 8, 9, 13, 16, 18, and 22;
xcii) SEQ ID NOs: 1, 2, 9, 14, 16, 18, and 22;
xciii) SEQ ID NOs: 1, 3, 9, 14, 16, 18, and 22;
xciv) SEQ ID NOs: 1, 4, 9, 14, 16, 18, and 22;
xcv) SEQ ID NOs: 1, 5, 9, 14, 16, 18, and 22;
xcvi) SEQ ID NOs: 1, 6, 9, 14, 16, 18, and 22;
xcvii) SEQ ID NOs: 1, 7, 9, 14, 16, 18, and 22;
xcviii) SEQ ID NOs: 1, 8, 9, 14, 16, 18, and 22;
xcix) SEQ ID NOs: 1, 2, 9, 13, 16, 19, and 22;
c) SEQ ID NOs: 1, 3, 9, 13, 16, 19, and 22;
ci) SEQ ID NOs: 1, 4, 9, 13, 16, 19, and 22;
cii) SEQ ID NOs: 1, 5, 9, 13, 16, 19, and 22;
ciii) SEQ ID NOs: 1, 6, 9, 13, 16, 19, and 22;
civ) SEQ ID NOs: 1, 7, 9, 13, 16, 19, and 22;
cv) SEQ ID NOs: 1, 8, 9, 13, 16, 19, and 22;

cvi) SEQ ID NOs: 1, 2, 9, 14, 16, 19, and 22;

cvii) SEQ ID NOs: 1, 3, 9, 14, 16, 19, and 22;

cviii) SEQ ID NOs: 1, 4, 9, 14, 16, 19, and 22;

cix) SEQ ID NOs: 1, 5, 9, 14, 16, 19, and 22;

cx) SEQ ID NOs: 1, 6, 9, 14, 16, 19, and 22;

cxi) SEQ ID NOs: 1, 7, 9, 14, 16, 19, and 22; and

cxii) SEQ ID NOs: 1, 8, 9, 14, 16, 19, and 22.

18. The viral vector of claim 17, wherein the vector genome comprises, in the 5' to 3' direction, the nucleotide sequences of SEQ ID NOs: 1, 6, 14, 18, and 22.
19. The viral vector of claim 17, wherein the vector genome comprises, in the 5' to 3' direction, the nucleotide sequences of SEQ ID NOs: 1, 6, 9, 14, 18, and 22.
20. The viral vector of any one of claims 1 to 19, further comprising a stuffer nucleotide sequence positioned between the polyA signal sequence and the 3' ITR nucleotide sequence.
21. The viral vector of claim 20, wherein the stuffer nucleotide sequence is between about 1,00 and 1,500 nucleotides in length.
22. The viral vector of any one of claims 1 to 21, further comprising an adeno-associated virus (AAV) serotype 8, 9, 2, or 5 capsid.
23. The viral vector of claim 22, wherein the adeno-associated virus (AAV) serotype capsid is an AAV serotype 9 capsid.
24. The viral vector of claim 23, further comprising 1) an AAV9 capsid comprising VP1, VP2, and VP3 amino acid sequences with greater than or about 90% identity to SEQ ID NOs: 28, 29, and 30, respectively; or 2) an AAV9 capsid encoded by a nucleotide sequence with greater than or about 90% identity to SEQ ID NO: 27.
25. The viral vector of claim 22, further comprising 1) an AAV8 capsid comprising VP1, VP2, and VP3 amino acid sequences with greater than or about 90% identity to SEQ ID NOs: 24, 25, and 26, respectively; or 2) an AAV8 capsid encoded by a nucleotide sequence with greater than or about 90% identity to SEQ ID NO: 23.
26. A composition comprising the viral vector of any one of claims 1 to 25.
27. A method of expressing a heterologous CYP4V2 gene in a retinal cell, the method comprising contacting the retinal cell with the viral vector of any one of claims 1 to 25.
28. The composition of claim 26 for use in a method of treating a subject with Bietti crystalline dystrophy (BCD).
29. Use of the composition of claim 26 in the manufacture of a medicament for treating a subject with Bietti crystalline dystrophy (BCD).

30. The use of claim 29 wherein the medicament is to be used to improve visual acuity, improve visual function or functional vision, or inhibit decline of visual function or functional vision in the subject.

31. The use of claim 29 or claim 30, wherein the medicament is to be administered to the subject in an effective amount to enable said treating, improving, or inhibiting to take place.