**Candidate vision genes in mammals and their actual/possible role in vision**

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| **Gene name** | **Gene function** | **Vision Phenotypes** | **Sample References** |
| GNGT1 | The transducin gamma subunit of G-protein is required for the GTPase activity, mediating rhodopsin-effector interaction in phototransduction signaling system.  | Null mice for the protein exhibit reduced signal amplification leading to rod visual sensitivity; | Lobanova et al. 2008; Kolesnikov et al. 2011; |
| RS1 | Secreted from photoreceptor cells of the outer retina and bipolar cellsof the inner retina. The protein plays a crucial role in the cellular stabilization and organization of the retina | Responsible for X-linked retinoschisis (XLRS), a retinal dystrophy that leads to schisis (splitting) of the neural retina. Leads to reduced visual acuity in affected men. | Skorczyk & Krawczyński 2012; |
| OPN1SW | Short wavelength sensitive cone pigment, a protein that changes its conformation following isomerization of 11-*cis*-retinal into all-*trans*-retinal by light in the blue region of spectrum which activates its binding to G-protein transducin triggering phototransduction cascade.  | Mutations in the protein leads to color blindness and color blindness, tritan | Nathans et al. 1986; Weitz et al. 1992; Chang et al.1995 |
| CNGA2 | Membrane ion channel which mediate phototransduction in photoreceptors and chemotransduction in olfactory neurons | Highly expressed in photoreceptors | Pifferi et al. 2006;Nache et al. 2013; |
| CNGA4 | Membrane ion channel which mediate phototransduction in photoreceptors and chemotransduction in olfactory neurons | Highly expressed in photoreceptors | Pifferi et al. 2006; Nache et al. 2013 |
| SLC4A7 | Sodium- and bicarbonate-dependent cotransporter maintain normal pH homeostasis in photoreceptor and auditory cells | Mice null for the gene show progressive retinal degeneration characterized by selective loss of photoreceptor cells | Pushkin et al. 1999; Bok et al. 2003; |
| GUCA1A | Stimulates guanylyl cyclase 1 (GC1) when free calcium ions concentration is low and inhibits GC1 when free calcium ions concentration is elevated.  | Ca2+-sensitive regulation of GC1 is a key event in recovery of the dark state of rod photoreceptors following light exposure; mutations in the gene are linked to autosomal dominant cone dystrophy, a disease characterized by reduced visual acuity. | Payne et al. 1998; Li et al. 2001; |
| CRYAA | Structural proteins in the lens fiber cells which contributes to the transparency and refractive index of the lens; its chaperone-like activity binds and prevent aggregation of unfolded or denatured proteins. | Defects in the gene cause autosomal dominant congenital cataract | Litt et al. 1998; Horwitz 2003; Nagaraj et al. 2012; |
| GNAT1 | The transducin alpha subunit of G-protein in rod cells is required for the GTPase activity, mediating rhodopsin-effector interaction during phototransduction cascade.  | Mutations in the gene are associated with congenital stationary night blindness. | Dryja et al. 1996; Goc et al. 2009; Naeem et al. 2012; |
| PLCB4 | Catalyze the reaction that produces second messengers diacylglycerol (DAG) and inositol trisphosphate (IP3) | Mutant mice null for the gene show diminished visual response suggesting the gene's role visual signal processing.  | Lee et al. 1994; Jiang et al. 1996; Lee et al. 1994; Jiang et al. 1996; |
| PDE6D | Following activation by transducin, the enzyme hydrolyze cGMP, a key messenger molecule in phototransduction | Mutations in a gene causes reduced enzyme activity leading to retinal degeneration in mice | Deterre et al. 1988; Bowes et al. 1990; |
| SAG | Photoreceptor regulation; binds to photoactivated-phosphorylated rhodopsin, apparently to desensitize rhodopsin which prevent transducin-mediated activation of phosphodiesterase | Mutation in the gene causes Oguchi disease characterized by discoloration of the fundus and retininis pigmentosa | Kuhn et al. 1984; Fuchs et al. 1995; Nakazawa et al. 1998; |
| GNB1 | The transducin beta subunit of a G-protein required for the GTPase activity, mediating rhodopsin-effector interaction in phototransduction signaling system.  | Disruptions of the gene leads to retinal degeneration | Kitamura et al. 2006; Chang 2013; |
| PRPH2 | An integral membrane glycoprotein that is present in the rims of photoreceptorouter segment disks; stabilize the disk rim through heterophilic interactionswith the related nonglycosylated protein rom1 | Mutations in the gene leads to various retinal degenarations including retininis pigmentosa, pattern dystrophy and macular degerations | Connell et al. 1991; Kajiwara et al. 1991; Jacobson et al. 1996; |
| PDC | May regulate visual phototransduction or integrity of photoreceptor metabolism | Abundantly expressed in the retina | Zhu & Craft 2000; Nishiguchi et al. 2004; |
| RPGRIP1 | a key component of cone and rod photoreceptor cells that interacts with retinitis pigmentosa GTPase regulator protein | Retininis pigmentosa and cone-rod dystrophy | Roepman et al. 2000; Kuznetsova et al. 2012; |
| ARR3 | May play a role in regulating opsin functions through interacting with photoactivated-phosphorylated red/green opsins. | Abundantly expressed in the retina | Craft et al. 1994; Gurevich et al. 1995; |
| ACCN1 | Proton-gated ion channels thought to modulate neuronal excitability through pH sensing | Abundantly expressed in photoreceptors and may confer retinal protection against light | Ettaiche et al. 2004; Lingueglia 2007; |
| OPN1LW | Long-wavelength sensitive opsin, a protein that changes its conformation following isomerization of 11-*cis*-retinal into all-*trans*-retinal by light in the red region of spectrum which activates its binding to G-protein transducin triggering phototransduction cascade | Mutations in the protein leads to blue-cone monochromacy | Nathans et al, 1986; Nathans et al. 1993; |
| CDS2 | Regulates availability of second messengers in GPCR pathways. | Highly expressed in the retina | Volta et al. 1999; |
| TTR | A carrier protein that transports thyroid hormones in the plasma and cerebrospinal fluid, and also transports retinol (vitamin A) in the plasma. | Highly expressed in the retina; mutations in the gene may disrupt the availability of retinal in the eye | Bernis et al. 1994; Bui et al. 2001; |
| OPN4 | Similar to other opsins but its photosensitivity is limited to pupillar reflex, circardian rythms, and other non-image forming responses to light. | Expressed in the retina ganglion cells; mice exhibit a shorter than normal period when exposed to constant light | Provencio et al. 2002; Tu et al. 2005; Panda et al. 2002; Tu et al. 2005; |
| PCP2 | Functions as a cell-type specific modulator for G protein-mediated cell signaling inhibiting the dissiciation of GDP from alpha subunit of G-protein. | Expressed in the retinal ON bipolar cells; maintain the hyperpolarization of cell and speeds up visual response | Guan et al. 2005; Xu et al. 2008; |
| LUM | Structural function forming the bulk of corneal connective tissue | Null mice for the gene leads to opaque cornea suggesting the role of the protein in cornea light transparency | Chakravarti et al. 2000; Chakravarti et al. 2003; |
| AIPL1 | Interacts (chaperone activity) with the visual effector enzyme phosphodiesterase-6 | Mutations cause Leber congenital amaurosis, a severe, early onset, inherited retinopathy | Sohocki et al. 2003; Majumder et al. 2013; |
| RDH12 | Catalytical role in the metabolism of retinoids, chromophores involved in vision; may be involved in the formation of 11-cis-retinal from 11-cis-retinol during regeneration of the cone visual pigments | Mutations cause Leber congenital amaurosis, a severe form inherted retinal dystrophy | Haeseleer et al. 2002; Perrault et al. 2004; |
| RPE65 | Critical in the visual retinoid cycle; the production of 11-cis retinal and in visual pigment regeneration | Mutations causes severe retinal dystrophy | Gu et al. 1997; Moiseyev et al. 2005; |
| RDH11 | NADPH-dependent retinal reductase converting all-trans-retinol to all-trans-retinal | Expressed in the retina; gene disruption in mice exhibit delayed dark adaptation | Haeseleer et al. 2002; Kasus-Jacobi et al. 2005; |
| GNAT2 | Transducin alpha subunit of G-protein coupled to cone visual pigment required for GTPase activity, mediating photopsin-effector interaction in phototransduction signaling system | Mutations in the gene result in achromatopsia, failure to discriminate colors in human | Aligianis et al. 2002; Kohl et al. 2002; |
| RHO | Primary visual pigment in retinal rod cells; initiates the visual transduction cascade following photo-excitation; very sensitive to light enabling dark vision | Mutations in the gene causes autosomal dominant retinitis pigmentosa and night blindness | McIness & Bascom 1992; Sieving et al. 1995; |
| CYP27B1 | Catalyzes the conversion of 25-hydroxyvitamin D3 (25(OH)D) to 1-alpha,25-dihydroxyvitamin D3 (1,25(OH)2D) plays an important role in normal bone growth, calcium metabolism, and tissue differentiation | Ocular barrier epithelial cells express the machinery for vitamin D3 production;an inverse association between plasma 25-hydroxyvitamin D and the presence of subretinal fibrosis was found in patients with age-related macular degeneration | Singh et al. 2013; Alsalem et al. 2014; |
| RGR | Required in the production of 11-cis-retinal by the retinal pigment epithelium (RPE) under light condition and normal regeneration of rhodopsin | Exclusively expressed in tissue adjacent to retinal photoreceptor cells, the retinal pigment epithelium and Mueller cells; mutations cause retininis pigmentosa | Morimura et al. 1999; Yang & Fong 2002; |
| RRH | RPE rhodopsin homolog; may play a role in RPE physiology either by detecting light directly or by modulating the retinoid cycle | Exclusively expressed in the RPE; mutations in the gene are implicated in various forms of retinal degenerations | Sun et al. 1997; Rivolta et al. 2006; |
| GUCA1B | Stimulates both guanylyl cyclase 1 (GC1) and guanylyl cyclase 2 (GC1) when free calcium ions concentration is low  | Ca2+-sensitive regulation of GC1 is a key event in recovery of the dark state of rod photoreceptors following light exposure; mutations in the gene are linked to autosomal dominant cone dystrophy, a disease characterized by reduced visual acuity | Payne et al. 1999; Sato & Nakazawa 2004; |
| PPEF2 | May play a role in phototransduction. May dephosphorylate photoactivated rhodopsin. May function as a calcium sensing regulator of ionic currents, energy production or synaptic transmission | Expressed specifically in photoreceptors and the pineal | Sherman et al. 1997; Ramulu et al. 2001; |
| ADAMTSL4 | A member of ADAMTS (a disintegrin and metalloproteinase with thrombospondin motifs)-like gene family and encodes a protein with seven thrombospondin type 1 repeats. The thrombospondin type 1 repeat domain is found in many proteins with diverse biological functions including cellular adhesion, angiogenesis, and patterning of the developing nervous system | Wide distribution in the eye; mutation in the gene have been associated with ectopia lentis – dislocation of the lens from its optimal position  | Ahram et al. 2009; Gabriel et al. 2014; |

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