Supplementary Table 1. Composition of pipette and bath solutions and liquid junction potentials in experiments with HEK293/HEK293A cells.

	NaCl	KCl	LiCl	RbCl	CsCl	NMDG	$MgCl_2$	$CaCl_2$	HEPES	Glucose	LJP pip. stand
Pipette standard	—	130	—	—	—	—	2	—	10	—	—
Pipette $NMDG^+$	—	—	—	—	—	130	2	—	10	—	—
Bath Na^+	130	—	—	—	—	—	2	2	10	10	4.4
Bath K^+	—	130	—	—	—	—	2	2	10	10	0.2
Bath Li^+	—	—	130	—	—	—	2	2	10	10	6.7
Bath Rb^+	—	—	—	130	—	—	2	2	10	10	-0.5
Bath Cs^+	—	—	—	—	130	—	2	2	10	10	-0.4
Bath $NMDG^+$	—	—	—	—	—	130	2	2	10	10	9.9
Bath Mg^{2+}	—	—	—	—	—	—	65	2	10	10	-3.8
Bath Ca^{2+}	—	—	—	—	—	—	2	65	10	10	-4.2

Abbreviations: HEPES, 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid; LJP, liquid junction potential; NMDG, N-Methyl-D-glucamine. All concentrations are in mM.

Supplementary Table 2. Comparison of amino acid residues forming the retinal-binding pockets of *Hc*KCR1 and red-shifted ChRs.

	49	53	57	85	89	90	93	115	138	141	142	145	182	185	186	189
***Hc*KCR1**	**L**	**I**	**C**	**D**	**T**	**C**	**L**	**L**	**Y**	**G**	**C**	**F**	**W**	**F**	**P**	**F**
Chrimson	V	E	V	E	S	C	I	C	Y	S	C	G	W	Y	P	W
RubyACRs	V	T	Y	F	T	C	I	D	N	S	Y	C	Q	F	I	Y
*Cs*CCR	I	E	Y	G	T	T	I	N	F	G	C	M	W	F	P	W
BR	V	A	Y	D	T	T	L	D	W	S	T	M	W	F	P	W

Abbreviations: *Cs*CCR, *Crustomastix stigmatica* cation channelrhodopsin; BR, bacteriorhodopsin. The numbers are the residue positions in bacteriorhodopsin.

Supplementary Table 3. Comparison of *Hc*KCR1 with previously available tools for optogenetic manipulation of K^+ gradients.

Name	Modality	Activation	P_K/P_{Na}	Half-saturation light intensity ($mW\ mm^{-2}$)	Rise τ (ms)	Decay τ (ms)	Reference
***Hc*KCR1_mCherry**	natural channelrhodopsin	Direct	23	0.2*	3.6	36	This study
BLINK2	viral K^+ channel K_{CV} fused with LOV2 domain	Direct	9.3#	n.d.	162,000	444,000	[13,38]
SthK-T-YFP-bPAC-Ex	*Spirochaeta* K^+ channel fused with *Beggiatoa* photoactivated adenylyl cyclase	Indirect	n.d.	0.5	4,000	254,000	[14]
SthK-P2A-bPAC_mCherry	*Spirochaeta* K^+ channel coexpressed with *Beggiatoa* photoactivated adenylyl cyclase	Indirect	n.d.	0.85	12,000	33,000	[15]

*For current at the end of a 200-ms light pulse; #determined in natural K_{CV}; n.d., not determined.