

Supplementary Information

Fluorescent Proteins and Genetically Encoded Biosensors

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Table S1. List of some genetically encoded fluorescent sensors of which analytes are metal ions, neuron transmitters, amino acids and nucleotides.

Name	Type	Ex/Em	FP1	FP2	$\Delta F/F$ or $\Delta FRET$	Sensor	analyte	Kd	Ref
GCaMP2	single	487/508	EGFP	-	1.5	CaM M13	Ca ²⁺	146nM	Ref ¹
GCaMP6f	single	496/513	EGFP	-	19.0	CaM M13	Ca ²⁺	375nM	Ref ²
RCaMP1h	single	575/602	mRuby	-	10.0	CaM M13	Ca ²⁺	1.9 μ M	Ref ³
Camgarrow-1	single	487/512	EYFP	-	7.0	CaM	Ca ²⁺	7 μ M	Ref ⁴
cameleon-2 yellow	FRET	433/535	ECFP	EYFP	1.5	CaM M13	Ca ²⁺	5.4 μ M	Ref ⁵
GAF-CAM3-sfGFP	single /GAF	648/676	GAF-FP 1-172	sfGFP	2.0	CaM M13	Ca ²⁺	433nM	Ref ⁶
GINKO1	single	502/514	GFP	-	2.5	Kbp	K ⁺	420 μ M	Ref ⁷
GEPII 1.0	FRET	456/525	CFP	Venus	-3.2	BON LysM	K ⁺	2.6mM	Ref ⁸
ZifCY	FRET	434/535	ECFP	EYFP	2.2	Zif268	Zn ²⁺	1.7 μ M	Ref ⁹
ZinCh-9	FRET	(475/527)	ECFP	EYFP	~4	ECFP- Y39H S208C	Zn ²⁺	500nM 88 μ M	Ref ¹⁰
BLZinCh-3	BRET FRET	Auto/ (530)	Nanoluc	Cerulean Citrine	0.5	H206/ C208	Zn ²⁺	15.6pM	Eef ¹¹
ZapCY1	FRET	434/535	ECFP	EYFP	4.2	Zap1	Zn ²⁺	2.5pM	Ref ¹²
ZapCY2	FRET	434/535	ECFP	EYFP	1.4	Zap1	Zn ²⁺	811pM	Ref ¹²
CALWY	FRET		CFP	YFP	0.15	AtoX1 WD4	Zn ²⁺	0.2pM	Ref ¹³
eCALWY-C2M	FRET	420/527	Cerulean	Citrine		AtoX1 WD4	Cu ⁺ Zn ²⁺	96pM	Ref ¹⁴

Name	Type	Ex/Em	FP1	FP2	$\Delta F/F$ or $\Delta FRET$	Sensor	analyte	Kd	Ref
Amt1-FRET	FRET	433/527	CFP	YFP	0.16	Amt1 (Tran)	Cu ⁺	2.5aM	Ref ¹⁵
Ace1-FRET	FRET	433/527	CFP	YFP	<0.2	Ace1 (Tran)	Cu ⁺	4.7aM	Ref ¹⁶
GZnP1	single	488/513	GFP	-	2.6	Zap1	Zn ²⁺	58pM	Ref ¹⁷
ZnGreen1	single	(460/ 500)	mTFP1	-	-26.3	Zap1	Zn ²⁺	633nM	Ref ¹⁸
ZnGreen2	single	(460/ 500)	mTFP1	-	-8.7	Zn hook	Zn ²⁺	2.7 μ M	Ref ¹⁸
ZnRed1	single	(575/ 600)	mApple	-	3.8	M13 CaM	Zn ²⁺	166nM/ 20 μ M	Ref ¹⁸
(no name)	BiFC	(488)/510	EGFP	-	(-0.5)	Amt1	Cu ⁺	0.46aM	Ref ¹⁹
AR-18	single	(550/590)	RFP	-	-0.3	Amt1	Cu ⁺		Ref ²⁰
AR-41	single	(550/590)	RFP	-	-0.4	Amt1	Cu ⁺		Ref ²⁰
AR-59	single	(550/590)	RFP	-	-0.4	Amt1	Cu ⁺		Ref ²⁰
SenSil	FRET	(420/530)	ECFP	Venus	(0.5)	CusF	Ag ⁺	5.1 μ M	Ref ²¹
(HcRed)	single	592/645	HcRed	-	\sim -0.8	(HcRed)	Cu ⁺	3.6 μ M	Ref ²²
PbGFP	single		GFP	-	-1.0	Cys145/ Cys205	Pb ²⁺	700nM	Ref ²³
Met-Cad 1.57	FRET	458/535	ECFP	Venus	0.8	CadR	Cd ²⁺	271nM	Ref ²⁴
H ₃₉ GFP	single	(488)/513	EGFP	-	-1.0	39 Histi- dines	Cu ²⁺	16.2nM	Ref ²⁵
LaMP1	FRET	(433/529)	ECFP	Citrine	\sim 3.0	LanM	La ³⁺ Ce ³⁺ Pr ³⁺ Nd ³⁺ Sm ³⁺ Eu ³⁺ Gd ³⁺ Tb ³⁺ Dy ³⁺ Ho ³⁺ Er ³⁺ Yb ³⁺	9.4pM 16pM 13pM 12pM 12pM 16pM 10pM 18pM 26pM 29pM 36pM 44pM	Ref ²⁶
SenALiB	FRET	(420/530)	ECFP	Venus	(0.15)	ArsR	As ^{III}	676nM	Ref ²⁷
dLight1.1	single	(488)/513	EGFP	-	2.3	DRD1	Dopamine	330nM	Ref ²⁸
GRAB _{NE1m}	single		EGFP	-	2.3	α 2AR _{NE}	Norepine- phrine	930nM (EC50)	Ref ²⁹
GRAB _{DA1m}	single		EGFP	-	0.9	D2R _{DA}	Dopamine	97nM (EC50)	Ref ³⁰
GRAB _{SHT}	single		EGFP	-	2.5	5-HT2C	5-HT	22nM	Ref ³¹

Name	Type	Ex/Em	FP1	FP2	$\Delta F/F$ or $\Delta FRET$	Sensor	analyte	Kd	Ref
GACH2.0	single		EGFP	-	0.94	M3R _{ACh}	Acetyl- choline	(EC50) 1.9 μ M	Ref ³²
OxLight1	single		EGFP	-	1.3	OX2R	Orexin-A	(EC50) 47nM	Ref ³³
MBP165- cpGFP	single	(485/515)	EGFP	-	2.5	MBP	maltose	(EC50) 3 μ M	Ref ³⁴
FLIPglu- 600 μ Δ 13	FRET	433/(525)	ECFP	EYFP	-0.28	MglB	glucose	(0.6 μ M)	Ref ³⁵
Super GluSnFR	FRET	(420/526)	CFP	Citrine	-0.44	GltI	Glutamate	2.5 μ M	Ref ³⁶
SF- iGluSnFR	single		sfGFP	-	0.3	GltI	Glutamate		Ref ³⁷
iGAGA- SnFR	single		sfGFP	-	2.5	Pf622	γ -amino- butyric acid	9 μ M	Ref ³⁸
FLIP- Leu50	FRET	430/535	CFP	YFP	0.3	LivK	leucine	50 μ M	Ref ³⁹
FLIP-M	FRET	430/535	CFP	YFP	0.2	MetN	methionine	203 μ M	Ref ⁴⁰
FLIPK	FRET	430/535	CFP	YFP	0.2	LAO	lysine	97 μ M	Ref ⁴¹
GBOS	FRET	(435/535)	CFP	YFP	0.3	ProX	Glycine- betaine	400 μ M	Ref ⁴²
GRAB _{ATP} 1.0	single		EGFP	-	5.0 – 10.0	hp2Y1	ATP	6.7 μ M	Ref ⁴³
iATPSnFR	single	(435/530)	sfGFP	-	2.4	PS3 F ₀ F ₁ ATP Synthase	ATP	120 μ M	Ref ⁴⁴
NS2 C3L194E	single	421, 500/518	YFP	-	9.0	T-Rex	NADH	3.7 μ M	Ref ⁴⁵
NS2 C8N120E	single	421, 500/519	YFP	-	-0.66	T-Rex	NADH	40nM	Ref ⁴⁵
Peredox	single	400/510	T- Sapphire	-	1.5	T-Rex	NADH	<5nM	Ref ⁴⁶
(no name)	single	(500/520)	Venus	-	~-0.5	(Bacterial DNA ligase)	NAD ⁺	65 μ M	Ref ⁴⁷

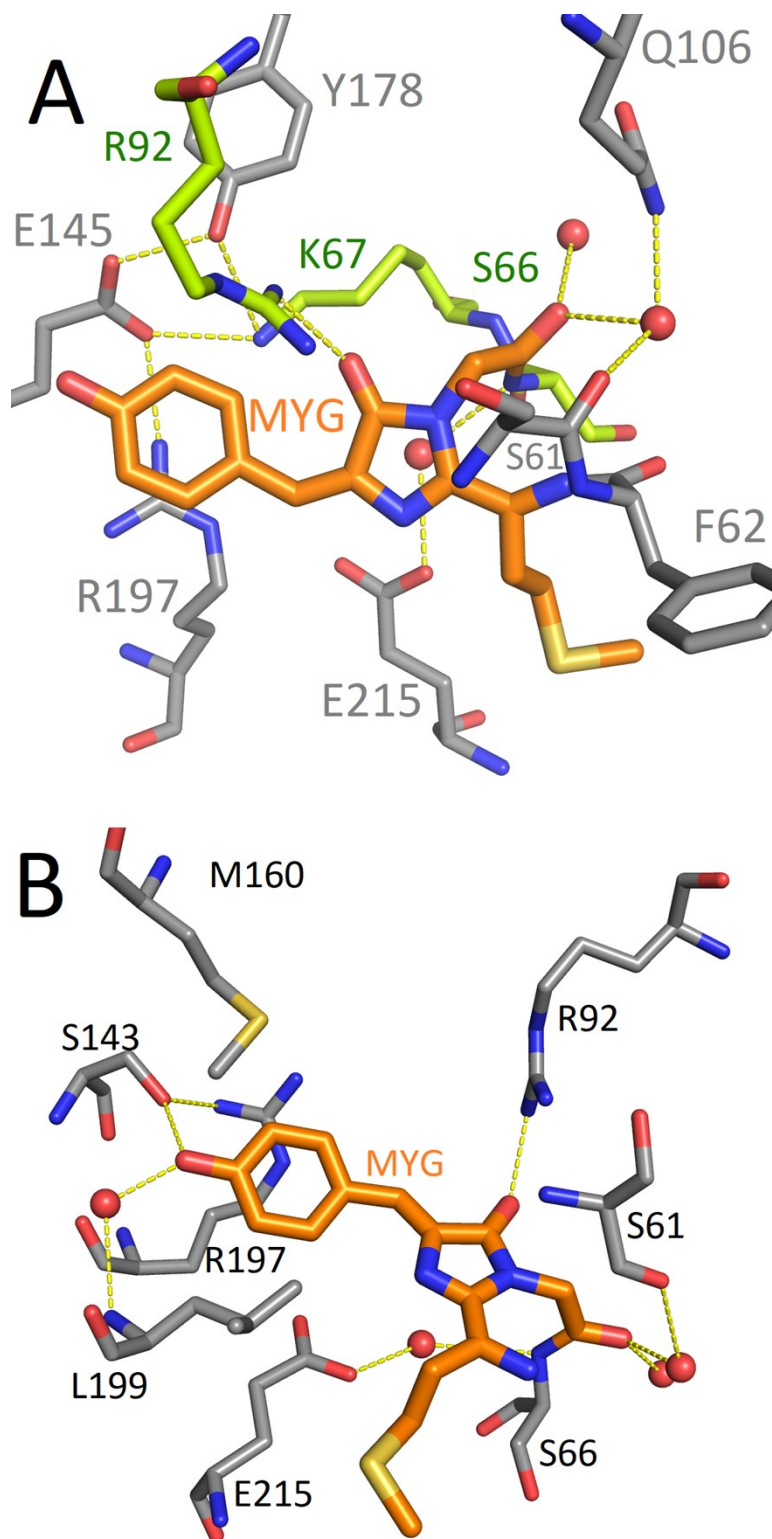


Fig. S1. Sticks representation showing the micro-environment of the fluorophore of (A) mKate under pH 2.0 (the trans- form, PDB: 3BX9) and (B) mKate under pH 7.0 (the cis- form, PDB: 3BXB). The fluorophore and the surrounding residues are shown as sticks whilst the water molecules are shown as red spheres. Important hydrogen bonds are shown as dash lines.

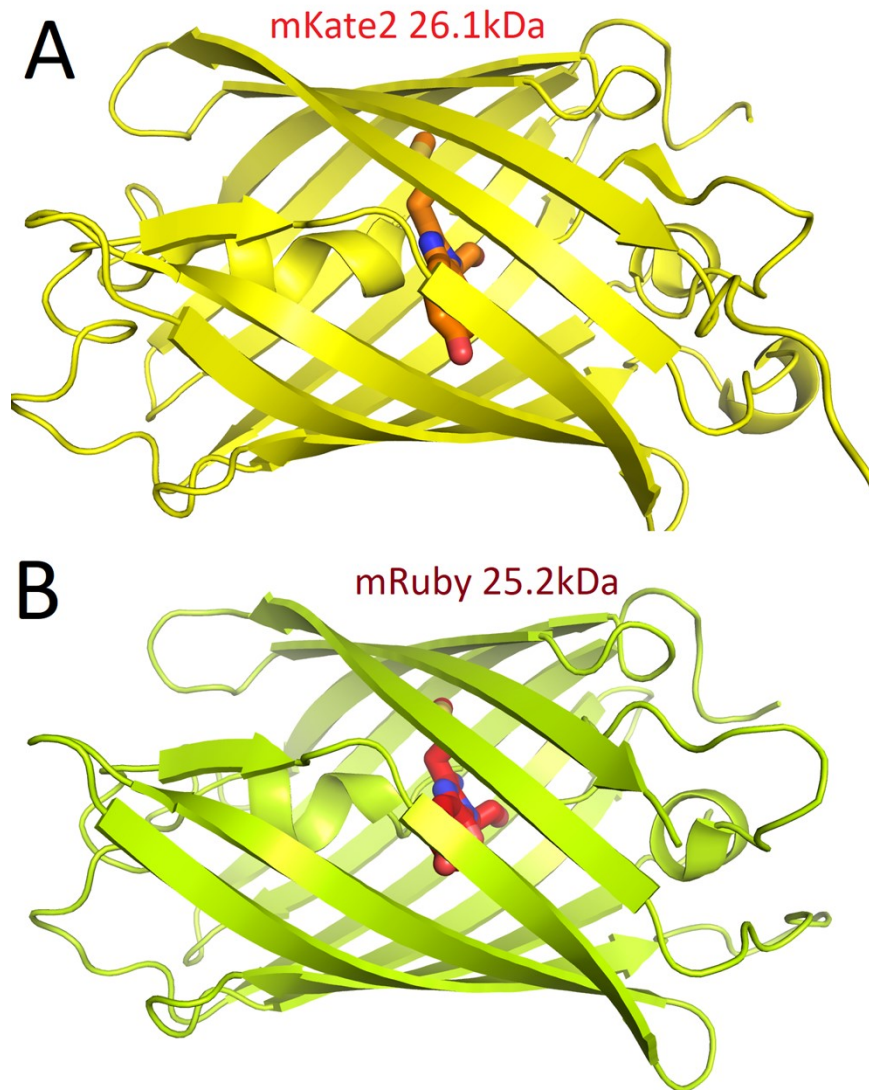


Fig. S2. The overall structure of mKate2 (A, an eqFP578 derivative, PDB: 3BX9) and mRuby (B, an eqFP611 derivative, PDB: 3U0L) in cartoon representation. The α -helices are shown as helices whilst β -sheets are shown as arrows.

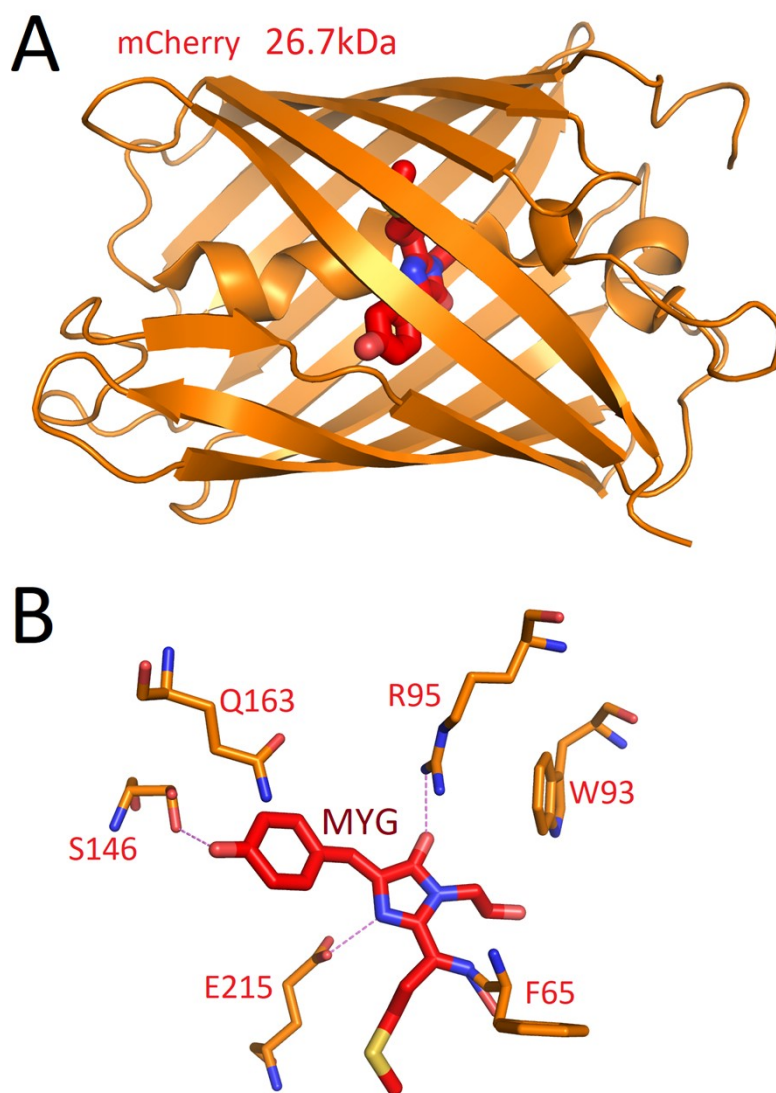


Fig. S3. The overall structure in cartoon representation (A) and the micro-environment of the fluorophore (B) in the DsRed-derivative fluorescent protein, mCherry. (PDB: 2H5Q) In (A), α -helices are shown as helices whilst β -sheets are shown as arrows. In (B), the fluorophore and surrounding residues are shown as sticks. Important hydrogen bonds are shown as dash lines.

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