

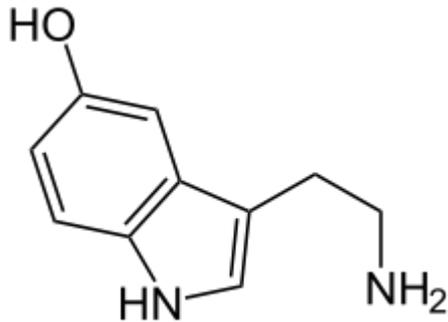
A trial of Bioinformatic analysis in Serotonin Receptor gene family

杨威

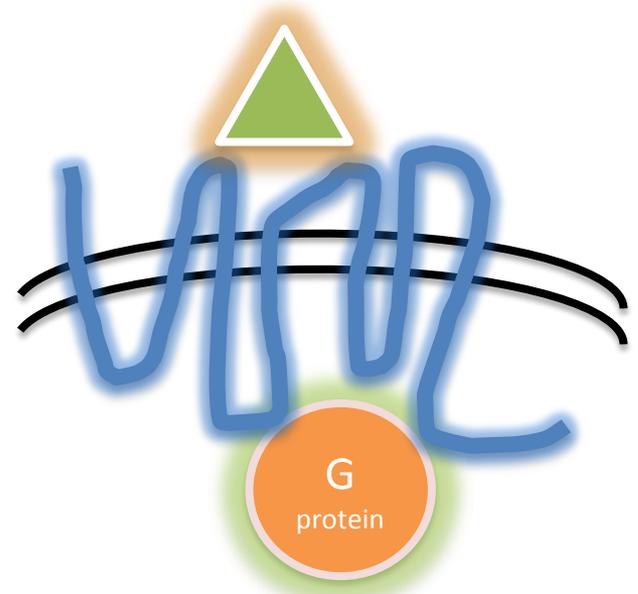
王魏然

刘绍峰

1. Background: Serotonin Receptors



neurotransmitter serotonin



GPCR structured serotonin

I. Importance:

- Serotonin receptors regulate neuronal signaling by exciting or inhibiting its neurotransmitter release.
- There are several animal neuronal activity coupled with serotonin receptors, including pain perception, angry expression etc.

1. Background: Serotonin Receptors

Family	Type	Mechanism	Potential
5-HT₁	G_i/G_o -protein coupled.	Decreasing cellular levels of cAMP .	Inhibitory
5-HT₂	G_q/G₁₁ -protein coupled.	Increasing cellular levels of IP₃ and DAG .	Excitatory
5-HT₃	Ligand-gated Na⁺ and K⁺ cation channel.	Depolarizing plasma membrane .	Excitatory
5-HT₄	G_s -protein coupled.	Increasing cellular levels of cAMP .	Excitatory
5-HT₅	G_i/G_o -protein coupled. ^[6]	Decreasing cellular levels of cAMP .	Inhibitory
5-HT₆	G_s -protein coupled.	Increasing cellular levels of cAMP .	Excitatory
5-HT₇	G_s -protein coupled.	Increasing cellular levels of cAMP .	Excitatory

Eur J Pharmacol. **361** (2–3): 299–309.

II. Diversity:

- There are 15 types of serotonin receptors, 14 of which are GPCRs. It is complicated that some serotonin receptor excite neuronal activity while others inhibit, which can be reflected by their protein diversity in sequence and protein structure.
- Our interests lie in the relationship between the two.

2. Procedures

1. List all members of serotonin receptor family;
2. Evolutionary distribution of serotonin family members;
3. Analysis of PTM source of serotonin receptor functional diversity;
4. GPCR TM analysis of serotonin receptor to reveal its bifurcation on G protein subtype selection and the output distinction in nervous system

Background:

Structural Overview of GPCR-members of Serotonin Receptors

2RH1

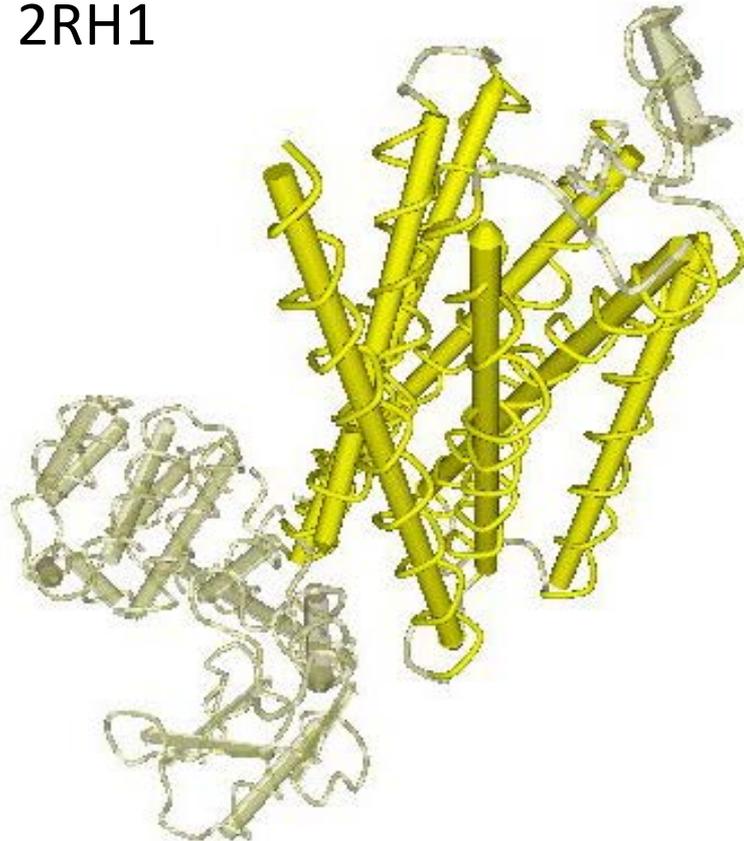


Fig. beta-2 adrenergic receptor
(2nd crystalized GPCR)

Most Serotonin Receptors are GPCRs, which are integral membrane protein that transduce signals inward.

1. N-terminal:

- 7 helical, hydrophobic TM;
- 3 extra- and 3 intra-cellular loops;
- barrel-like ligand binding domain;
- second extra-cellular loop serves as 'lid' for the ligand binding cavity;
- 2nd and 3rd intracellular loops are within the GEF domain, which are key to G-protein association
- At rest, inactive GDP-Galpa associates with GEF domain
- Upon ligand bound, a conformational change leads to GDP-GTP exchange of G protein.

Background:

Structural Overview of GPCR-members of Serotonin Receptors

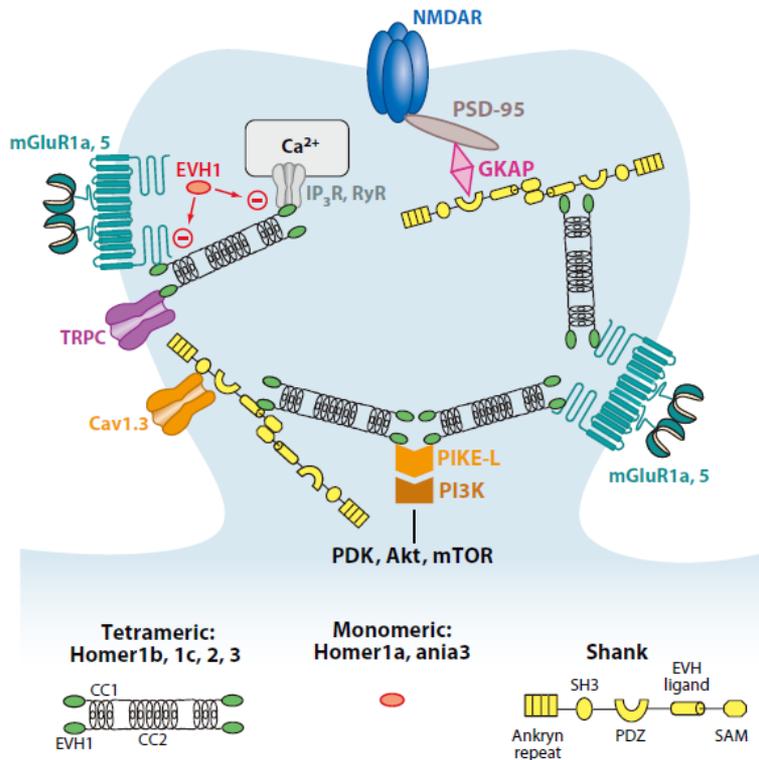


Fig. highly diverse C-termini
function of GPCR(2nd crystalized
GPCR)

N-termini are highly variable in seq,
but diverse in its interaction with
intracellular protein network, by virtue
of its rich PTMs.

2. C-terminal:

Highly variable in sequence and PTM;

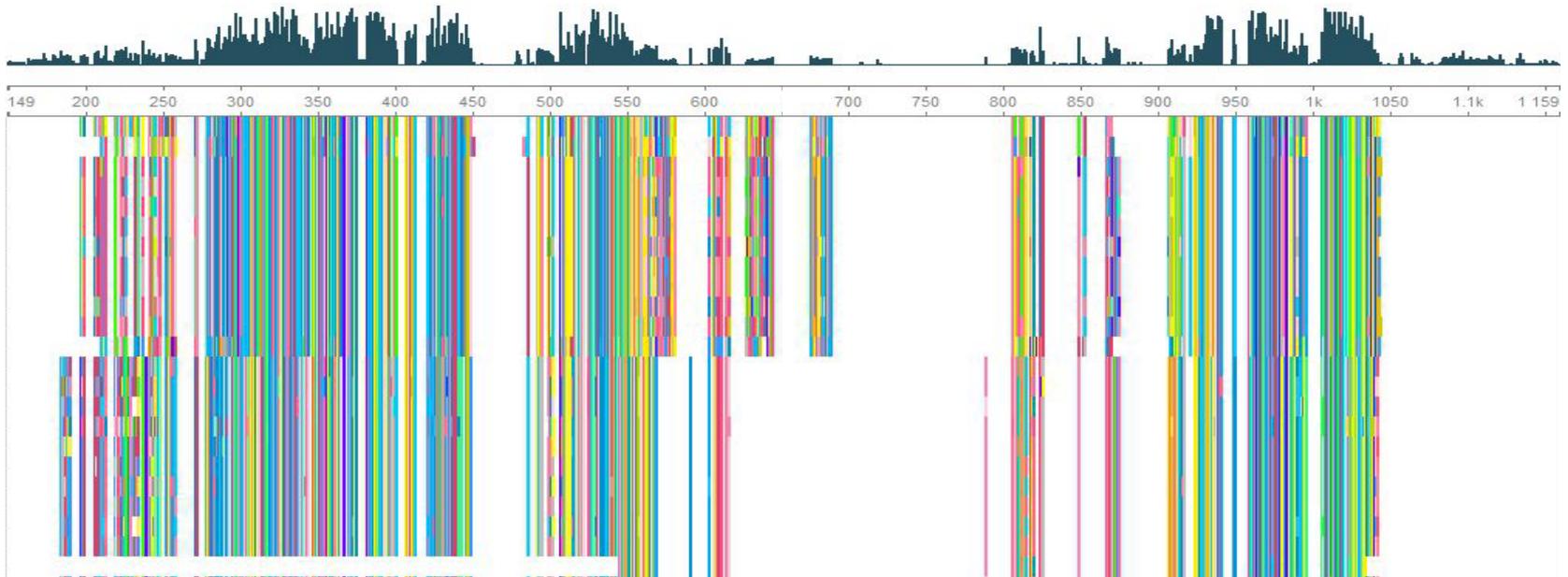
- Glycosylation
Important for trafficking etc.
- Phosphorylation
alternative pathway switch from G-
protein type to beta-arrestin pathways
- Palmytoylation or lipidation
hydrophobic acryl group addition
onto cystein, critical for signal complex
stabilization.

First question of interest:

The sequence source of Serotonin receptor functional diversity

Our first question of interest is:

What is the source of functional diversity of serotonin receptor family?



Candidate answers:

1. PTMs;
2. Conformational distinctiveness;
3. special sequence features.

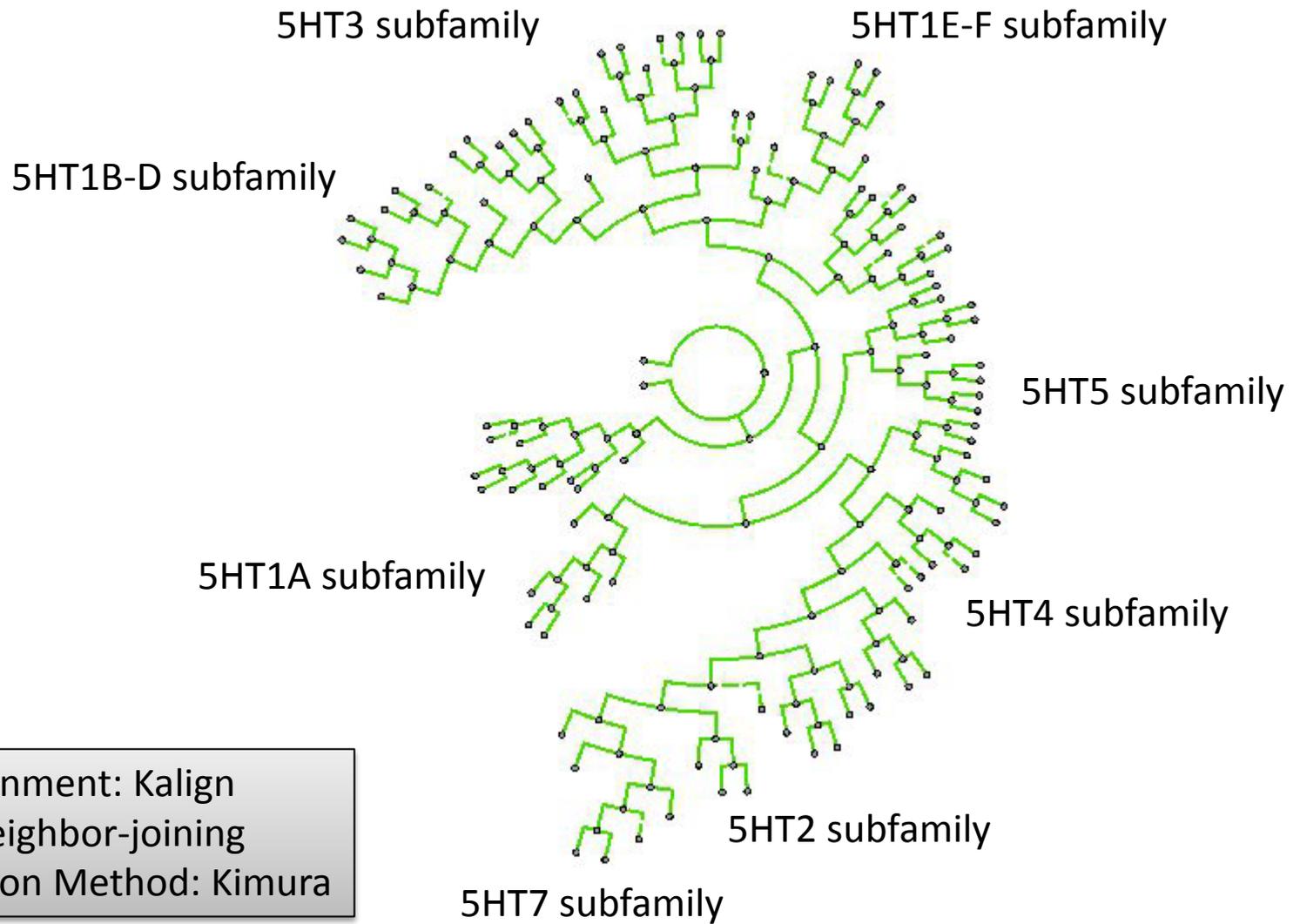
K-align (local mode)

Gap Open: 53.90

Gap Extension: 8.52

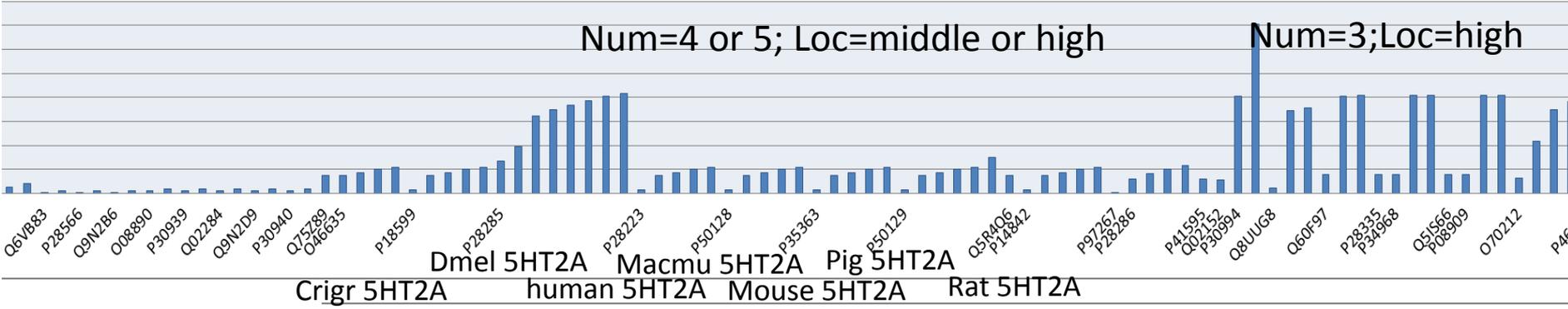
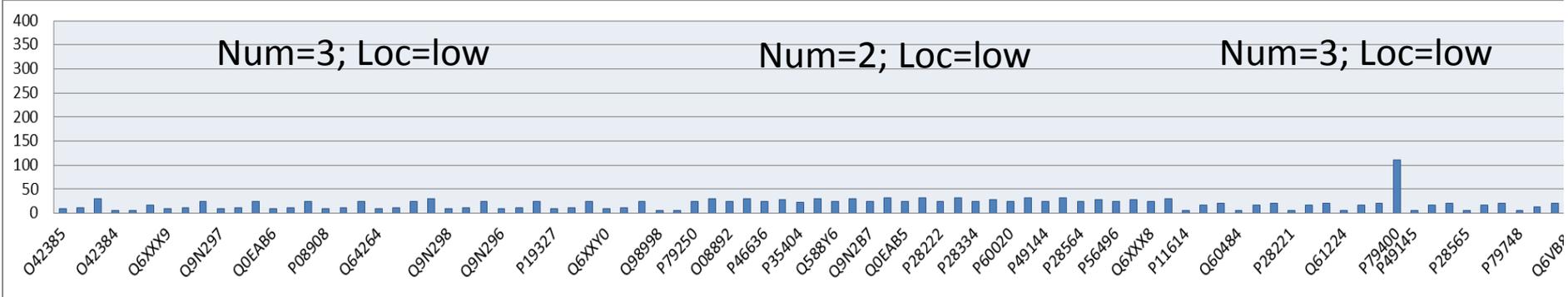
Terminal Gap: 4.42

Bonus Score: 0.02

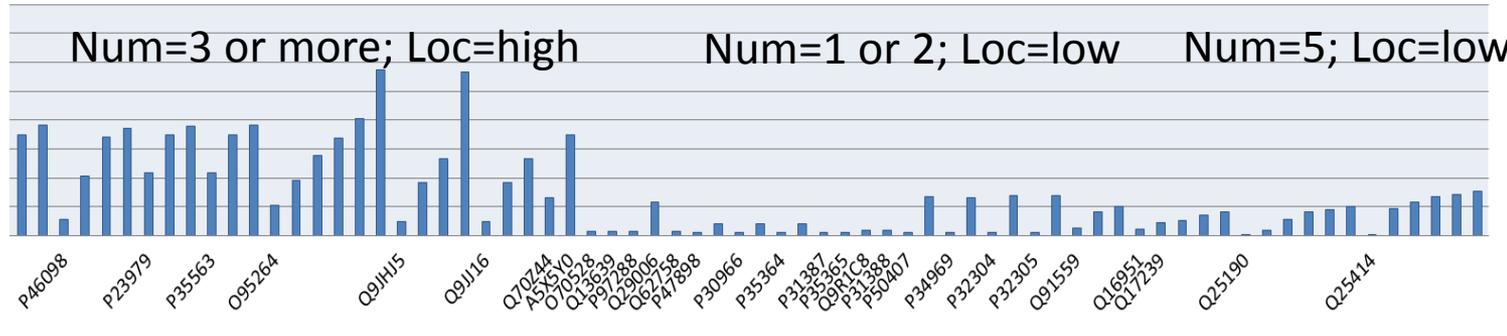


Multi-alignment: Kalign
PHYMLIP neighbor-joining
Substitution Method: Kimura

Serotonin Receptor Feature: Glycosylation diversity



Two parameters:
 1. number;
 2. locations



Serotonin Receptor Feature: phosphorylation

phosphoTyrosine:

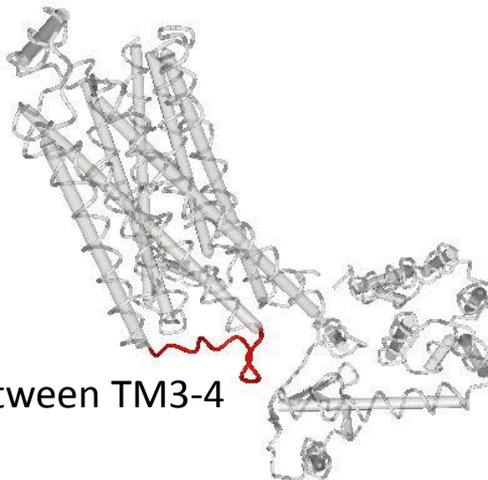
Nm/len	featr	loc
P50406/440	pY	125
Q9R1C8/440	pY	125
Q5IS65/440	pY	125
P31388/436	pY	125

MUSCLE Multi-align

Annotation

- Topological domain
- Chain
- Modified residue
- Sequence conflict
- Transmembrane
- Glycosylation
- Disulfide bond

N-terminus



Loop between TM3-4

```

1  MVPEFGPTANSTPAWGAPPSAPGGSGWVAALC VVI125ALTA125AA125NS125LL125I125AL125ICT125Q125P125AL125R125NT 60 P50406 5HT6R_HUMAN
1  MVPEFGPV125NS125TP125AW125GP125PP125AP125GG125SG125W125V125AA125LC VVI125VL125TA125AA125NS125LL125I125AL125ICT125Q125P125AL125R125NT 60 Q9R1C8 5HT6R_MOUSE
1  MVPEFGPSANSTPAWGAPPSAPGGSGWVAALC VVI125ALTA125AA125NS125LL125I125AL125ICT125Q125P125AL125R125NT 60 Q5IS85 5HT6R_PANTR
1  MVPEFGPV125NS125TP125AW125GP125PP125AP125GG125SG125W125V125AA125LC VVI125VL125TA125AA125NS125LL125I125AL125ICT125Q125P125AL125R125NT 60 P31388 5HT6R_RAT
***** .***** ** *****

61  SNFF125LV125SL125FT125SD125LM125V125GL125V125MP125P125AM125L125NA125LY125GR125WL125ARG125L125CL125L125WT125AF125DM125CC125S125AS125IL125N125LC125LI 120 P50406 5HT6R_HUMAN
61  SNFF125LV125SL125FT125SD125LM125V125GL125V125MP125P125AM125L125NA125LY125GR125WL125ARG125L125CL125L125WT125AF125DM125CC125S125AS125IL125N125LC125LI 120 Q9R1C8 5HT6R_MOUSE
61  SNFF125LV125SL125FT125SD125LM125V125GL125V125MP125P125AM125L125NA125LY125GR125WL125ARG125L125CL125L125WT125AF125DM125CC125S125AS125IL125N125LC125LI 120 Q5IS85 5HT6R_PANTR
61  SNFF125LV125SL125FT125SD125LM125V125GL125V125MP125P125AM125L125NA125LY125GR125WL125ARG125L125CL125L125WT125AF125DM125CC125S125AS125IL125N125LC125LI 120 P31388 5HT6R_RAT
*****

121  S125LD125R125V125LL125IS125PL125RY125KL125EM125T125PR125AL125AL125VL125GA125WS125LA125AL125AS125FL125PL125LL125GW125HEL125G125HAR125PP125VP125GC 180 P50406 5HT6R_HUMAN
121  S125LD125R125V125LL125IS125PL125RY125KL125EM125T125AP125R125AL125AL125VL125GA125WS125LA125AL125AS125FL125PL125LL125GW125HEL125G125KART125S125AP125GC 180 Q9R1C8 5HT6R_MOUSE
121  S125LD125R125V125LL125IS125PL125RY125KL125EM125T125PP125R125AL125AL125VL125GA125WS125LA125AL125AS125FL125PL125LL125GW125HEL125G125HAR125PP125VP125GC 180 Q5IS85 5HT6R_PANTR
121  S125LD125R125V125LL125IS125PL125RY125KL125EM125T125AP125R125AL125AL125VL125GA125WS125LA125AL125AS125FL125PL125LL125GW125HEL125G125KART125PA125GC 180 P31388 5HT6R_RAT
*****

181  RLLA125SL125PF125VL125VAS125GL125TF125FL125PS125GA125IC125FT125Y125CR125ILLA125AAR125KQ125AV125Q125VAS125LT125TGMA125--SQ125AS125ET125LQ 238 P50406 5HT6R_HUMAN
181  RLLA125SL125PY125VL125VAS125GV125TF125FL125PS125GA125IC125FT125Y125CR125ILLA125AAR125KQ125AV125Q125VAS125LT125TG125AT125AG125ALET125LQ 240 Q9R1C8 5HT6R_MOUSE
181  RLLA125SL125PF125VL125VAS125GL125TF125FL125PS125GA125IC125FT125Y125CR125ILLA125AAR125KQ125AV125Q125VAS125LT125TGMA125--SQ125AS125ET125LQ 238 Q5IS85 5HT6R_PANTR
181  RLLA125SL125PF125VL125VAS125GV125TF125FL125PS125GA125IC125FT125Y125CR125ILLA125AAR125KQ125AV125Q125VAS125LT125TG125A--GQ125ALET125LQ 238 P31388 5HT6R_RAT
*****

239  VPR125TR125PR125GP125VES125AD125SR125RL125TK125HS125RK125ALK125AS125LT125LG125ILL125GM125FF125VT125W125LP125FF125VAN125IV125Q125AV125CD125CIS 298 P50406 5HT6R_HUMAN
241  VPR125TR125PR125GP125MES125AD125SR125RL125TK125HS125RK125ALK125AS125LT125LG125ILL125SM125FF125VT125W125LP125FF125VAS125IA125Q125AV125CD125CIS 300 Q9R1C8 5HT6R_MOUSE
239  VPR125TR125PR125GP125VES125AD125SR125RL125TK125HS125RK125ALK125AS125LT125LG125ILL125GM125FF125VT125W125LP125FF125VAN125IV125Q125AV125CD125CIS 298 Q5IS85 5HT6R_PANTR
239  VPR125TR125PR125GP125MES125AD125SR125RL125TK125HS125RK125ALK125AS125LT125LG125ILL125GM125FF125VT125W125LP125FF125VAN125IA125Q125AV125CD125CIS 298 P31388 5HT6R_RAT
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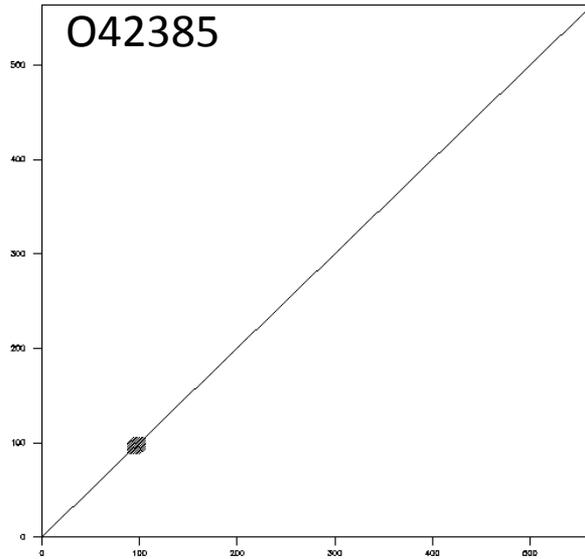
299  PGL125FD125VLT125W125LG125YCN125STM125N125PI125IY125PL125FMR125DF125KRAL125GR125FL125PC125PC125PR125ER125QAS125LAS125PS125LR125TS125HS 358 P50406 5HT6R_HUMAN
301  PGL125FD125VLT125W125LG125YCN125STM125N125PI125IY125PL125FMR125DF125KRAL125GR125V125PC125V125HC125PP125EH125RASP125SP125SM125W125TS125HS 360 Q9R1C8 5HT6R_MOUSE
299  PGL125FD125VLT125W125LG125YCN125STM125N125PI125IY125PL125FMR125DF125KRAL125GR125FL125PC125PC125PR125ER125QAS125LAS125PS125LR125TS125HS 358 Q5IS85 5HT6R_PANTR
299  PGL125FD125VLT125W125LG125YCN125STM125N125PI125IY125PL125FMR125DF125KRAL125GR125FL125PC125V125HC125PP125EH125RP125AL125FP125PC125GL125TA 358 P31388 5HT6R_RAT
*****

359  GPR125FG125LS125LQ125VL125PL125FP125DS125SD125S125DAG125SG125SS125GL125R125LT125AQ125LL125LP125GEAT125Q125DP125PL125TRAA125AAV 418 P50406 5HT6R_HUMAN
361  GAR125FG125LS125LQ125VL125PL125FP125NS125DS125--SAS125GG125TS125GL125QL125TAQ125LL125LP125GEAT125RD125PP125TRAP125TV 418 Q9R1C8 5HT6R_MOUSE
359  GPR125FG125LS125LQ125VL125PL125FP125DS125SD125S125DAG125SG125SS125GL125R125LT125AQ125LL125LP125GEAT125RD125PL125TRAA125AAV 418 Q5IS85 5HT6R_PANTR
359  VP125-----DQ125ASAC-----SR125CC125LC125R125QT125IQ125TP125LQ125--GAP-----RAC125SSQ 393 P31388 5HT6R_RAT
*****

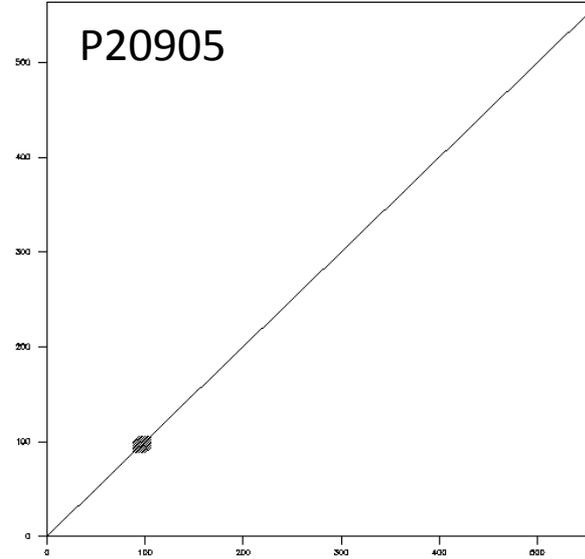
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419  NFF125VT125DS125VE125PE125TR125QH125LG125SP125MN----- 440 Q9R1C8 5HT6R_MOUSE
419  NFF125NID125PAE125PE125LR125PH125PL125GI125PTN----- 440 Q5IS85 5HT6R_PANTR
394  PS125FC125CL125LR125PP125GT125PR125HP125GP125PL125W125ST125SL125S125Q125TL125W125SL125RY125GR125HS125V125PP 436 P31388 5HT6R_RAT
* * * * *
    
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It is shown that this consensus pY is located between 3rd and 4th TM domains, the sites where they interact with Gs proteins.

Serotonin Receptor Feature: sequence repeats



GS repeats on N-terminus

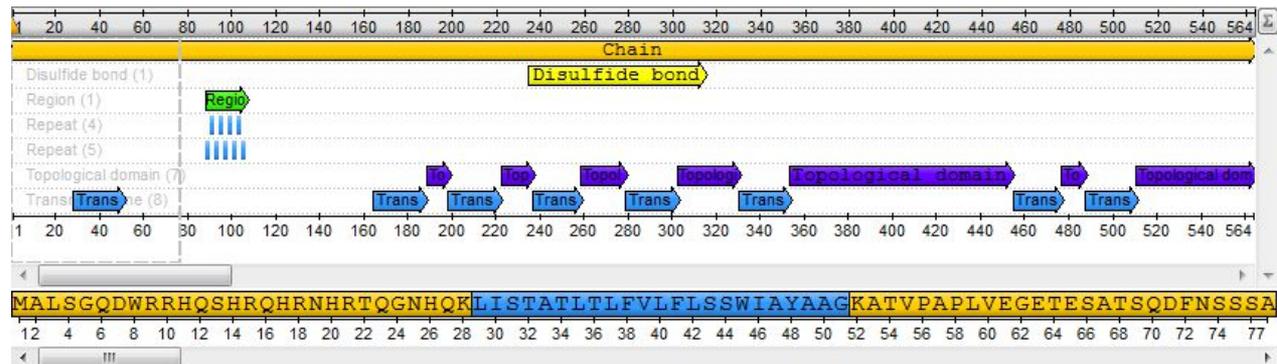


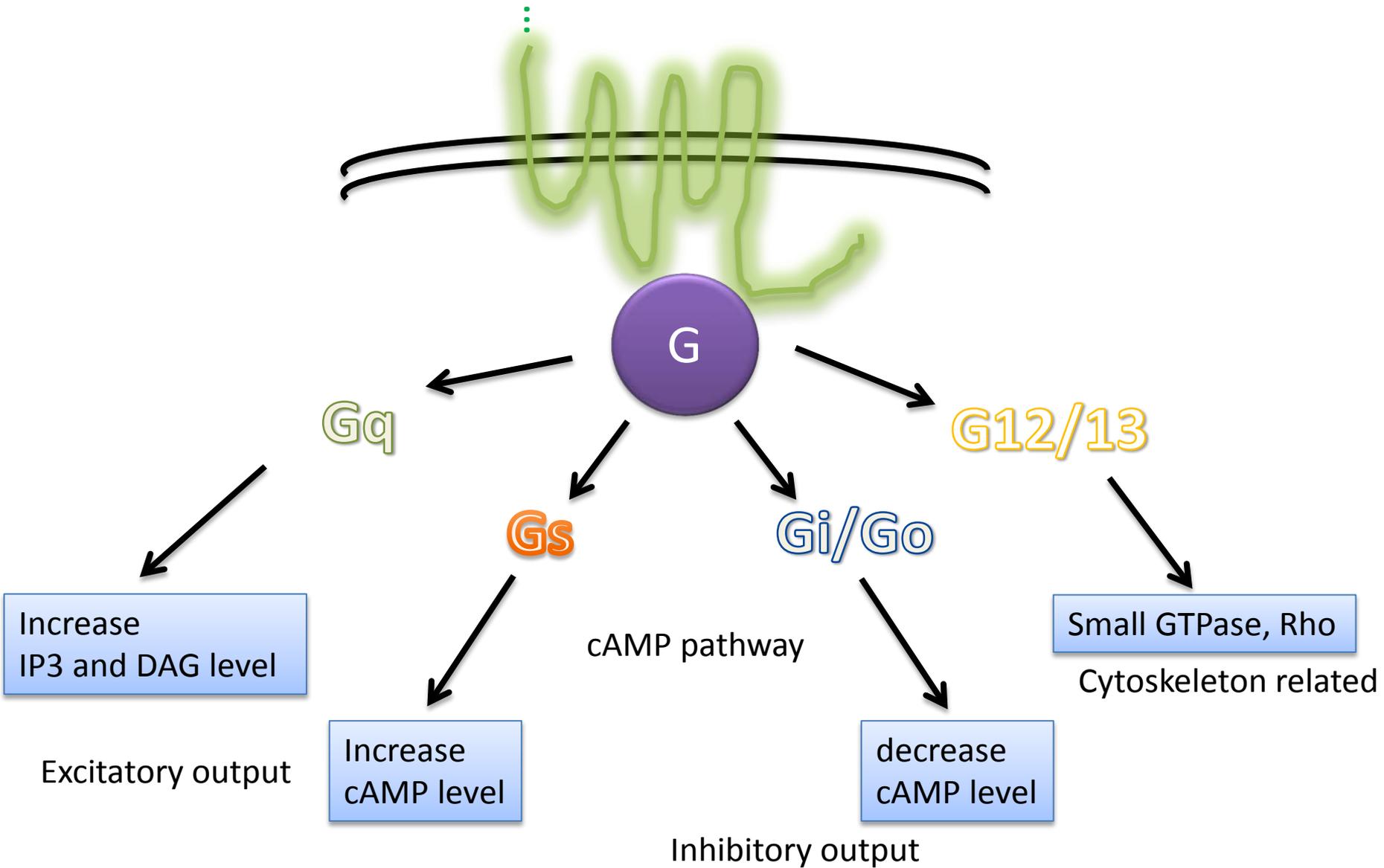
Same on the 2nd sequence of 5HT1A

...

Polydot command from Weblab of cbi: align on the whole sequence of self

GS repeats:
same loci
same numbers





The second question of interest: Why Galpha are different among Serotonin receptors

- Functional Selectivity theory: It is the ligand diversity that determines the distinctiveness in output types.
- However, it is difficult to apply this on case of serotonin receptors, since their ligands are the same while their outputs are not.
- In this case, some SRs are excitatory in neuronal signaling regulation while others are inhibitory.
- Therefore, our second question of interest is whether this difference could be related to the sequence bifurcation in the interface that interacts with the G proteins.
- Notice: it is only in theory prediction, and further evidence from experiments are required to demonstrate them.

Serotonin Receptor Feature: G protein interacting sequence and G subtype

结合Gs/Gq

着色：根据identity比例

	1	2	4	6	8	10	12	14	16	18	20												
sp|Q75Z89|5HT2A_BO	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|O46635|5HT2A_CAI	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|P35382|5HT2A_CAV	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|P18599|5HT2A_CRI	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|P28223|5HT2A_HUM	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|P50128|5HT2A_MAC	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|P35363|5HT2A_MOL	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|Q5R4Q6|5HT2A_PO	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|P14842|5HT2A_RAT	[1	D	R	Y	V	A	I	-	Q	N	P	I	H	H	S	-	R	F	N	S	R	-	18]
sp|P41595|5HT2B_HUM	[1	D	R	Y	I	A	I	-	K	K	P	I	Q	A	N	-	Q	Y	N	S	R	-	18]
sp|Q02152|5HT2B_MO	[1	D	R	Y	I	A	I	-	K	K	P	I	Q	A	N	-	Q	C	N	S	R	-	18]
sp|P30994|5HT2B_RAT	[1	D	R	Y	I	A	I	-	K	K	P	I	Q	A	N	-	Q	C	N	S	R	-	18]
sp|Q8UU8|5HT2B_TE	[1	D	R	Y	I	A	I	-	K	K	P	I	Q	H	S	-	Q	Y	K	S	R	-	18]
sp|P28335|5HT2C_HUM	[1	D	R	Y	V	A	I	-	R	N	P	I	E	H	S	-	R	F	N	S	R	-	18]
sp|P34968|5HT2C_MOL	[1	D	R	Y	V	A	I	-	R	N	P	I	E	H	S	-	R	F	N	S	R	-	18]
sp|Q51S66|5HT2C_PAN	[1	D	R	Y	V	A	I	-	R	N	P	I	E	H	S	-	R	F	N	S	R	-	18]
sp|P08909|5HT2C_RAT	[1	D	R	Y	V	A	I	-	R	N	P	I	E	H	S	-	R	F	N	S	R	-	18]
sp|O70528|5HT4R_CAI	[1	D	R	Y	Y	A	I	C	C	Q	P	L	V	Y	R	-	N	K	M	T	P	-	19]
sp|Q13639|5HT4R_HUI	[1	D	R	Y	Y	A	I	C	C	Q	P	L	V	Y	R	-	N	K	M	T	P	-	19]
sp|P97288|5HT4R_MOL	[1	D	R	Y	Y	A	I	C	C	Q	P	L	V	Y	R	-	N	K	M	T	P	-	19]
sp|Q62758|5HT4R_RA	[1	D	R	Y	Y	A	I	C	C	Q	P	L	V	Y	R	-	N	K	M	T	P	-	19]
sp|P50406|5HT6R_HUM	[1	D	R	Y	L	L	I	-	L	S	P	L	R	Y	K	L	R	M	T	P	L	-	19]
sp|Q9R1C8|5HT6R_MO	[1	D	R	Y	L	L	I	-	L	S	P	L	R	Y	K	L	R	M	T	A	P	-	19]
sp|Q51S65|5HT6R_PAN	[1	D	R	Y	L	L	I	-	L	S	P	L	R	Y	K	L	R	M	T	P	P	-	19]
sp|P31388|5HT6R_RAT	[1	D	R	Y	L	L	I	-	L	S	P	L	R	Y	K	L	R	M	T	A	P	-	19]
sp|P50407|5HT7R_CAV	[1	D	R	Y	L	G	I	-	T	R	P	L	T	Y	P	V	R	Q	N	G	K	-	19]
sp|P34969|5HT7R_HUM	[1	D	R	Y	L	G	I	-	T	R	P	L	T	Y	P	V	R	Q	N	G	K	C	20]
sp|P32304|5HT7R_MOL	[1	D	R	Y	L	G	I	-	T	R	P	L	T	Y	P	V	R	Q	N	G	K	C	20]
sp|P32305|5HT7R_RAT	[1	D	R	Y	L	G	I	-	T	R	P	L	T	Y	P	V	R	Q	N	G	K	C	20]
sp|O91559|5HT7R_XEN	[1	D	R	Y	L	G	I	-	T	R	P	L	T	Y	P	A	R	O	N	G	K	L	20]

IL-3

CHARGE
POLAR

0
N

+ or 0

0 0 +
NPN

Serotonin Receptor Feature: G protein interacting sequence and G subtype

结合Gi/Go

着色：根据identity比例

	1	2	4	6	8	10	12	14	16	18	21												
sp|P30966|5HT5A_MOL	[1	D	R	Y	W	S	I	-	T	R	H	L	E	Y	T	L	R	T	R	K	R	-	[19]
sp|P35364|5HT5A_RAT	[1	D	R	Y	W	S	I	-	T	R	H	L	E	Y	T	L	R	A	R	K	R	-	[19]
sp|P31387|5HT5B_MOL	[1	D	R	Y	W	T	I	-	T	R	H	L	Q	Y	T	L	R	T	R	S	R	-	[19]
sp|P35365|5HT5B_RAT	[1	D	R	Y	W	T	I	-	T	R	H	L	Q	Y	T	L	R	T	R	R	R	-	[19]
sp|Q42385|5H1AA_TAI	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|Q6XXX9|5HT1A_CAI	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|Q9N297|5HT1A_GOI	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|Q0EAB6|5HT1A_HOI	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|P08908|5HT1A_HUM	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|Q64264|5HT1A_MOI	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|Q9N298|5HT1A_PAI	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|Q9N296|5HT1A_POI	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|P19327|5HT1A_RAT	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|Q6XXY0|5HT1A_VUI	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|Q98998|5HT1A_XEM	[1	D	R	Y	W	A	I	-	T	D	P	I	D	Y	V	-	N	K	R	T	P	-	[18]
sp|P79250|5HT1B_CAI	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|P35404|5HT1B_DID	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|Q588Y6|5HT1B_FEL	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|Q9N2B7|5HT1B_GOI	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|Q0EAB5|5HT1B_HOI	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|P28222|5HT1B_HUM	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|P60020|5HT1B_PAN	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|P56496|5HT1B_SPA	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|Q6XXX8|5HT1B_VUI	[1	D	R	Y	W	A	I	-	T	D	A	V	E	Y	S	-	A	K	R	T	P	-	[18]
sp|P11614|5HT1D_CAI	[1	D	R	Y	W	A	I	-	T	D	A	L	E	Y	S	-	K	R	R	T	A	-	[18]
sp|Q60484|5HT1D_CAI	[1	D	R	Y	W	A	I	-	T	D	A	L	E	Y	S	-	K	R	R	T	A	-	[18]
sp|P79400|5HT1D_PIG	[1	D	R	Y	W	A	I	-	T	D	A	L	E	Y	S	-	K	R	R	T	A	-	[18]
sp|P49145|5HT1D_RAE	[1	D	R	Y	W	A	I	-	T	D	A	L	E	Y	S	-	K	R	R	T	A	-	[18]
sp P28565 5HT1D_RAT	[1	D	R	Y	W	A	I	-	T	D	A	L	E	Y	S	-	K	R	R	T	A	-	[18]
sp P79748 5HT1D_TAK	[1	D	R	Y	W	A	I	-	T	D	A	L	E	Y	S	-	K	R	R	T	M	-	[18]

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	1	2	4	6	8	10	12	14	16	18	20	22	24	26															
sp Q75Z89 5HT2A_BOVIN 5-hy	[1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	I	P	V	F	-	-	-	-	-	21]	
sp|O46635|5HT2A_CANFA 5-hy	[	1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	I	P	V	F	-	-	-	-	-	21]
sp|P28223|5HT2A_HUMAN 5-hy	[	1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	I	P	V	F	-	-	-	-	-	21]
sp|P50128|5HT2A_MACMU 5-hy	[	1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	I	P	V	F	-	-	-	-	-	21]
sp|P35363|5HT2A_MOUSE 5-hy	[	1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	I	P	V	F	-	-	-	-	-	21]
sp|P50129|5HT2A_PIG 5-hydro	[	1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	I	P	V	F	-	-	-	-	-	21]
sp|Q5R4Q6|5HT2A_PONPY 5-hy	[	1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	I	P	V	F	-	-	-	-	-	21]
sp|P14842|5HT2A_RAT 5-hydro	[	1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	I	P	V	F	-	-	-	-	-	21]
sp|P35382|5HT2A_CAVPO 5-hy	[	1	F	L	K	I	A	V	W	T	I	S	V	G	I	S	M	P	V	P	V	F	-	-	-	-	-	21]
sp|P18599|5HT2A_CRIGR 5-hy	[	1	F	L	K	I	A	V	W	T	I	S	V	G	V	S	M	P	I	P	V	F	-	-	-	-	-	21]
sp|P41595|5HT2B_HUMAN 5-hy	[	1	F	I	K	I	T	V	W	L	I	S	I	G	I	A	I	P	V	P	I	K	-	-	-	-	-	21]
sp|Q02152|5HT2B_MOUSE 5-hy	[	1	F	I	K	I	T	V	W	L	I	S	I	G	I	A	I	P	V	P	I	K	-	-	-	-	-	21]
sp|Q29005|5HT2B_PIG 5-hydro	[	1	F	I	K	I	T	V	W	L	I	S	I	G	-	-	-	-	-	-	-	-	-	-	-	-	13]	
sp|P30994|5HT2B_RAT 5-hydro	[	1	F	V	K	I	T	V	W	L	I	S	I	G	I	A	I	P	V	P	I	K	-	-	-	-	-	21]
sp|Q8UUG8|5HT2B_TETFL 5-hy	[	1	M	L	K	I	A	L	V	L	I	S	I	C	I	A	I	P	I	P	I	K	-	-	-	-	-	21]
sp|Q60F97|5HT2C_CANFA 5-hy	[	1	I	M	K	I	A	I	V	W	A	I	S	I	G	V	S	V	P	I	P	V	I	-	-	-	-	21]
sp|P28335|5HT2C_HUMAN 5-hy	[	1	I	M	K	I	A	I	V	W	A	I	S	I	G	V	S	V	P	I	P	V	I	-	-	-	-	21]
sp|P34968|5HT2C_MOUSE 5-hy	[	1	I	M	K	I	A	I	V	W	A	I	S	I	G	V	S	V	P	I	P	V	I	-	-	-	-	21]
sp|Q5IS66|5HT2C_PANTR 5-hy	[	1	I	M	K	I	A	I	V	W	A	I	S	I	G	V	S	V	P	I	P	V	I	-	-	-	-	21]
sp|P08909|5HT2C_RAT 5-hydro	[	1	I	M	K	I	A	I	V	W	A	I	S	I	G	V	S	V	P	I	P	V	I	-	-	-	-	21]
sp|O70528|5HT4R_CAVPO 5-hy	[	1	A	L	M	L	G	G	C	W	V	I	P	M	F	I	S	F	L	P	I	M	Q	G	W	N	-	24]
sp|Q62758|5HT4R_RAT 5-hydr	[	1	A	L	M	L	G	G	C	W	V	I	P	M	F	I	S	F	L	P	I	M	Q	G	W	N	-	24]
sp|Q13639|5HT4R_HUMAN 5-hy	[	1	A	L	M	L	G	G	C	W	V	I	P	T	F	I	S	F	L	P	I	M	Q	G	W	N	-	24]
sp|P97288|5HT4R_MOUSE 5-hy	[	1	A	L	M	L	G	G	C	W	V	L	P	M	F	I	S	F	L	P	I	M	Q	G	W	N	-	24]
sp|Q29006|5HT4R_PIG 5-hydro	[	1	A	V	L	L	A	G	C	W	A	I	P	V	L	I	S	F	L	P	I	M	Q	G	W	N	-	24]
sp|P50406|5HT6R_HUMAN 5-hy	[1	L	A	L	V	L	G	A	W	S	L	A	A	L	A	S	F	L	P	L	L	L	G	W	H	E	L	26]
sp|Q5IS65|5HT6R_PANTR 5-hy	[1	L	A	L	V	L	G	A	W	S	L	A	A	L	A	S	F	L	P	L	L	L	G	W	H	E	L	26]
sp|Q9R1C8|5HT6R_MOUSE 5-hy	[1	L	A	L	I	L	G	A	W	S	L	A	A	L	A	S	F	L	P	L	L	L	G	W	H	E	L	26]
sp|P31388|5HT6R_RAT 5-hydro	[1	L	A	L	I	L	G	A	W	S	L	A	A	L	A	S	F	L	P	L	L	L	G	W	H	E	L	26]
sp|P50407|5HT7R_CAVPO 5-hy	[1	P	K	M	I	L	S	V	W	L	L	S	A	S	I	T	L	P	-	P	L	F	G	W	A	Q	-	24]

	1	2	4	6	8	10	12	14	16	18	20	22	24	26														
sp|Q6XXX8|5HT1B_VULVU 5-hy	[1	A	V	M	I	A	L	V	W	V	F	S	I	S	I	S	L	P	-	P	F	F	-	W	R	Q	-	23]
sp|O08892|5HT1B_CAVPO 5-hy	[1	A	G	M	I	A	L	V	W	V	F	S	I	C	I	S	L	P	-	P	F	F	-	W	R	Q	-	23]
sp|P46636|5HT1B_CRIGR 5-hyt	[1	A	I	M	I	A	L	V	W	V	F	S	I	S	I	S	L	P	-	P	F	F	-	W	R	Q	-	23]
sp|P35404|5HT1B_DIDMA 5-hyt	[1	A	G	M	I	M	V	W	V	F	S	V	S	I	S	M	P	-	P	L	F	-	W	R	Q	-	23]	
sp|P28334|5HT1B_MOUSE 5-hy	[1	A	I	M	I	Y	L	V	W	V	F	S	I	S	I	S	L	P	-	P	F	F	-	W	R	Q	-	23]
sp|P28564|5HT1B_RAT 5-hydro	[1	A	I	M	I	Y	L	V	W	V	F	S	I	S	I	S	L	P	-	P	F	F	-	W	R	Q	-	23]
sp|P49144|5HT1B_RABIT 5-hyc	[1	A	I	M	I	R	L	V	W	V	F	S	I	C	I	S	L	P	-	P	F	F	-	W	R	Q	-	23]
sp|P56496|5HT1B_SPAEH 5-hyc	[1	A	V	M	I	A	L	V	W	V	F	S	I	S	I	S	L	P	-	R	F	F	-	W	R	Q	-	23]
sp|P11614|5HT1D_CANFA 5-hyt	[1	A	V	M	I	A	T	V	W	V	I	S	I	C	I	S	I	P	-	P	L	F	-	W	R	Q	-	23]
sp|Q60484|5HT1D_CAVPO 5-hy	[1	G	A	M	I	A	A	V	W	V	I	S	I	C	I	S	I	P	-	P	L	F	-	W	R	Q	-	23]
sp|P28221|5HT1D_HUMAN 5-hy	[1	A	T	M	I	A	I	V	W	A	I	S	I	C	I	S	I	P	-	P	L	F	-	W	R	Q	-	23]
sp|Q61224|5HT1D_MOUSE 5-hy	[1	A	A	M	I	A	A	V	W	I	S	I	C	I	S	I	P	-	P	L	F	-	W	R	Q	-	23]	
sp|P79400|5HT1D_PIG 5-hydro	[1	A	A	M	I	A	I	V	W	A	I	S	I	C	I	S	I	P	-	P	L	F	-	W	R	Q	-	23]
sp|P49145|5HT1D_RABIT 5-hyc	[1	A	A	M	I	A	V	W	A	I	S	I	C	I	S	I	P	-	P	L	F	-	W	R	Q	-	23]	
sp|P28565|5HT1D_RAT 5-hydro	[1	A	A	M	I	A	A	V	W	A	I	S	I	C	I	S	I	P	-	P	L	F	-	W	R	Q	-	23]
sp|P79748|5HT1D_TAKRU 5-hyt	[1	A	V	M	V	A	V	W	V	I	S	I	S	I	S	M	P	-	P	L	F	-	W	R	Q	-	23]	
sp|Q6VB83|5HT1E_CAVPO 5-hy	[1	G	L	M	I	L	T	V	W	T	I	S	I	F	I	S	M	P	-	P	L	F	-	W	R	S	H	24]
sp|P28566|5HT1E_HUMAN 5-hy	[1	A	L	M	I	L	T	V	W	T	I	S	I	F	I	S	M	P	-	P	L	F	-	W	R	S	H	24]
sp|Q9N2B6|5HT1E_PANTR 5-hy	[1	A	L	M	I	L	T	V	W	T	I	S	I	F	I	S	M	P	-	P	L	F	-	W	R	S	H	24]
sp|Q29003|5HT1E_PIG 5-hydro	[1	G	L	M	I	L	T	V	W	T	I	S	I	F	I	S	M	P	-	P	L	F	-	W	R	S	H	24]
sp|O08890|5HT1F_CAVPO 5-hy	[1	G	I	M	I	T	I	V	W	I	I	S	V	F	I	S	M	P	-	P	L	F	-	W	R	H	-	23]
sp|P30939|5HT1F_HUMAN 5-hyt	[1	G	I	M	I	T	I	V	W	I	I	S	V	F	I	S	M	P	-	P	L	F	-	W	R	H	-	23]
sp|Q9N2D9|5HT1F_PANTR 5-hy	[1	G	I	M	I	T	I	V	W	I	I	S	V	F	I	S	M	P	-	P	L	F	-	W	R	H	-	23]
sp|Q02284|5HT1F_MOUSE 5-hy	[1	G	I	M	I	T	I	V	W	V	I	S	V	F	I	S	M	P	-	P	L	F	-	W	R	H	-	23]
sp|P30940|5HT1F_RAT 5-hydro	[1	G	I	T	I	T	V	W	V	I	S	V	F	I	S	V	P	-	P	L	F	-	W	R	H	-	23]	
sp|P47898|5HT5A_HUMAN 5-hy	[1	N	V	M	I	A	L	T	W	A	L	S	A	V	I	S	L	A	P	L	L	F	G	W	G	E	-	25]
sp|P30966|5HT5A_MOUSE 5-hy	[1	N	V	M	I	L	L	T	W	A	L	S	T	V	I	S	L	A	P	L	L	F	G	W	G	E	-	25]
sp|P35364|5HT5A_RAT 5-hydro	[1	N	V	M	I	L	L	T	W	A	L	S	A	V	I	S	L	A	P	L	L	F	G	W	G	E	-	25]
sp|P31387|5HT5B_MOUSE 5-hy	[1	A	L	M	I	A	I	T	W	A	L	S	A	L	I	A	L	A	P	L	L	F	G	W	G	E	-	25]
sp|P35365|5HT5B_RAT 5-hydro	[1	A	L	M	I	A	I	T	W	A	L	S	A	L	I	A	L	A	P	L	L	F	G	W	G	E	-	25]

Thank You for your attention !

工作分配:

杨威, 五羟色胺受体和GPCR背景知识, 五羟色胺受体家族同源序列的进化树分析, 所有家族成员的局部比对;

王魏然, 五羟色胺受体同源序列翻译后修饰 (磷酸化, 糖基化, GS重复序列) 位点的多态性分析;

刘少锋, 五羟色胺受体桐原序列的跨膜区重要序列多态性分析, G蛋白识别差异分析;

在这里再次感谢以上组员的合作与支持, 预祝本次ppt展示圆满成功!