



# 白菜*AOP2*基因生物学 功能分析

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第六组

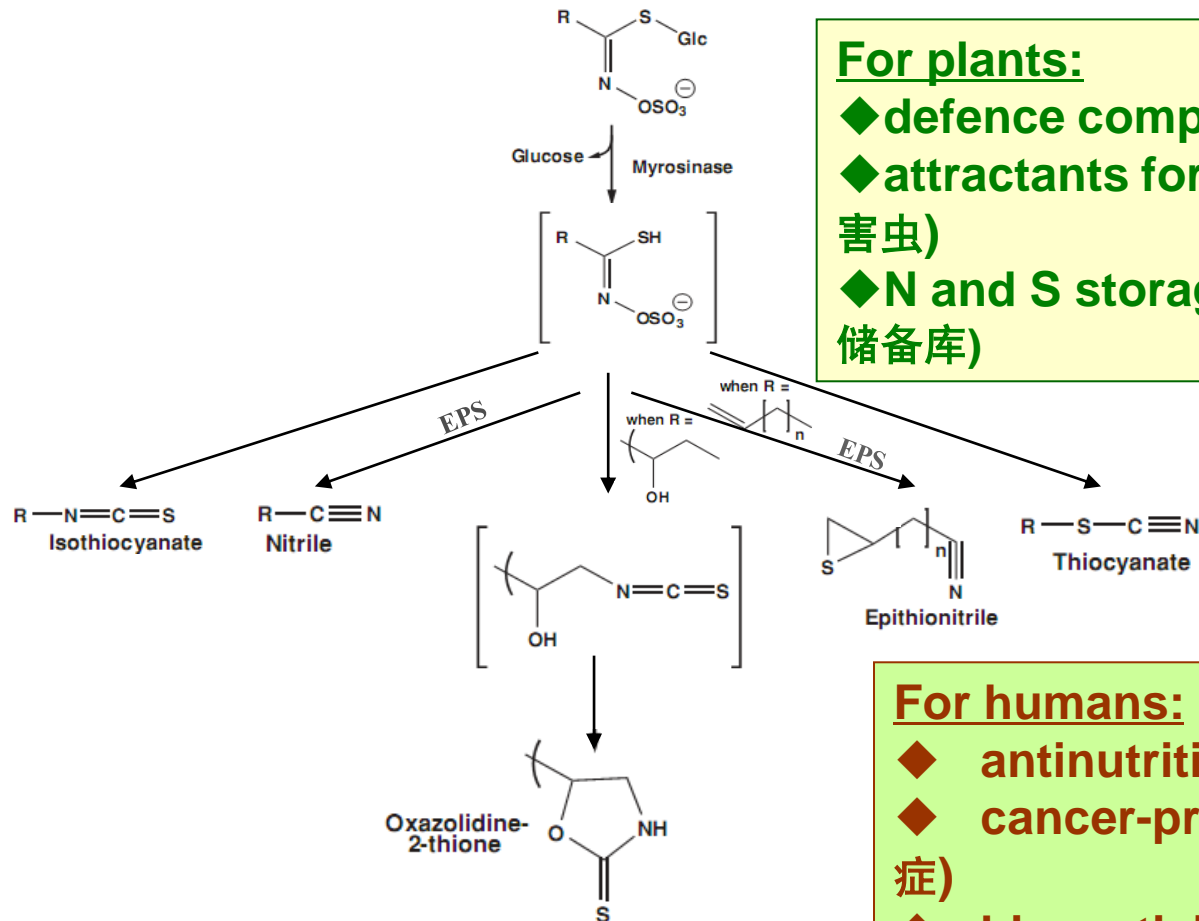


# 引言

- 白菜类作物(*Brassica rapa*, syn. A基因组,  $2n=2x=20$ )十字花科(Cruciferae)芸薹属(*Brassica*), 包含许多重要的蔬菜和油用作物。目前其栽培面积约400万公顷; 产量约12,000万吨, 在农业生产中占有举足轻重的地位。
- 硫代葡萄糖甙(简称硫甙, Glucosinolate)是一类含硫的阴离子亲水性植物次生代谢物质, 在十字花科植物中已明确结构的硫甙至少有120种。



# 硫脒降解产物的生物活性



## For plants:

- ◆ defence compounds(防御)
- ◆ attractants for specialist feeders(诱捕害虫)
- ◆ N and S storage compounds(氮硫成分储备库)

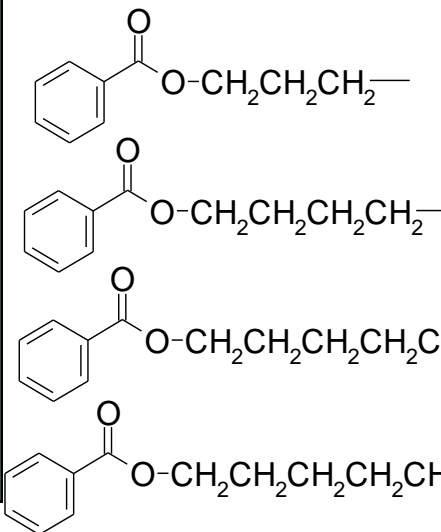
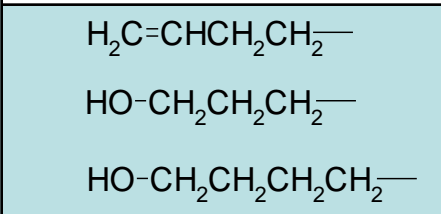
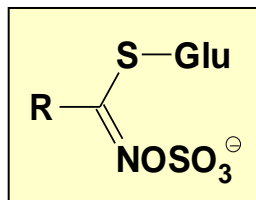
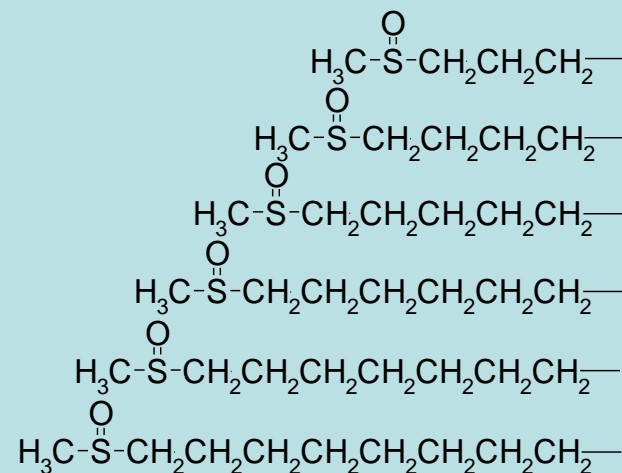
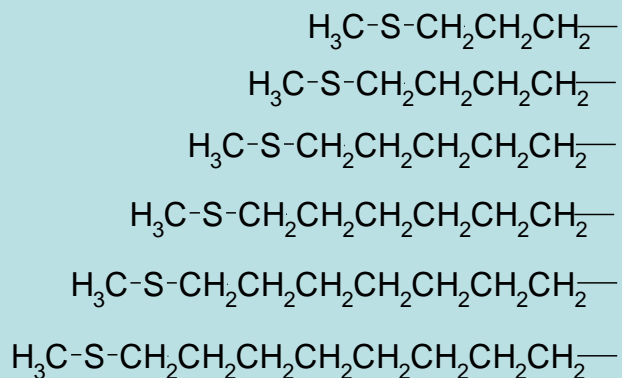
## For humans:

- ◆ antinutritional effects(负营养作用)
- ◆ cancer-preventive activity(预防癌症)
- ◆ biopesticides(生物杀虫剂)
- ◆ flavour compounds(芳香物质)

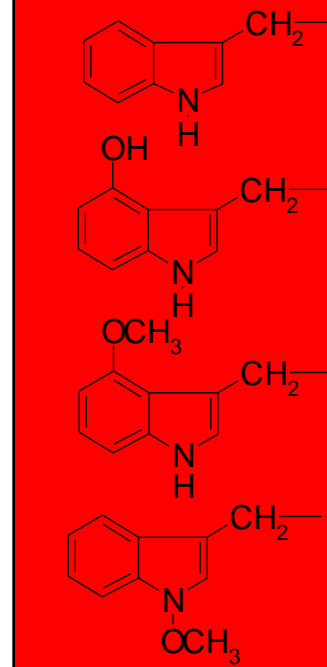


# GS(Glucosinolate)

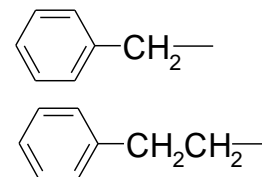
## Aliphatic(Met-derived)



## indole (Trp-derived)



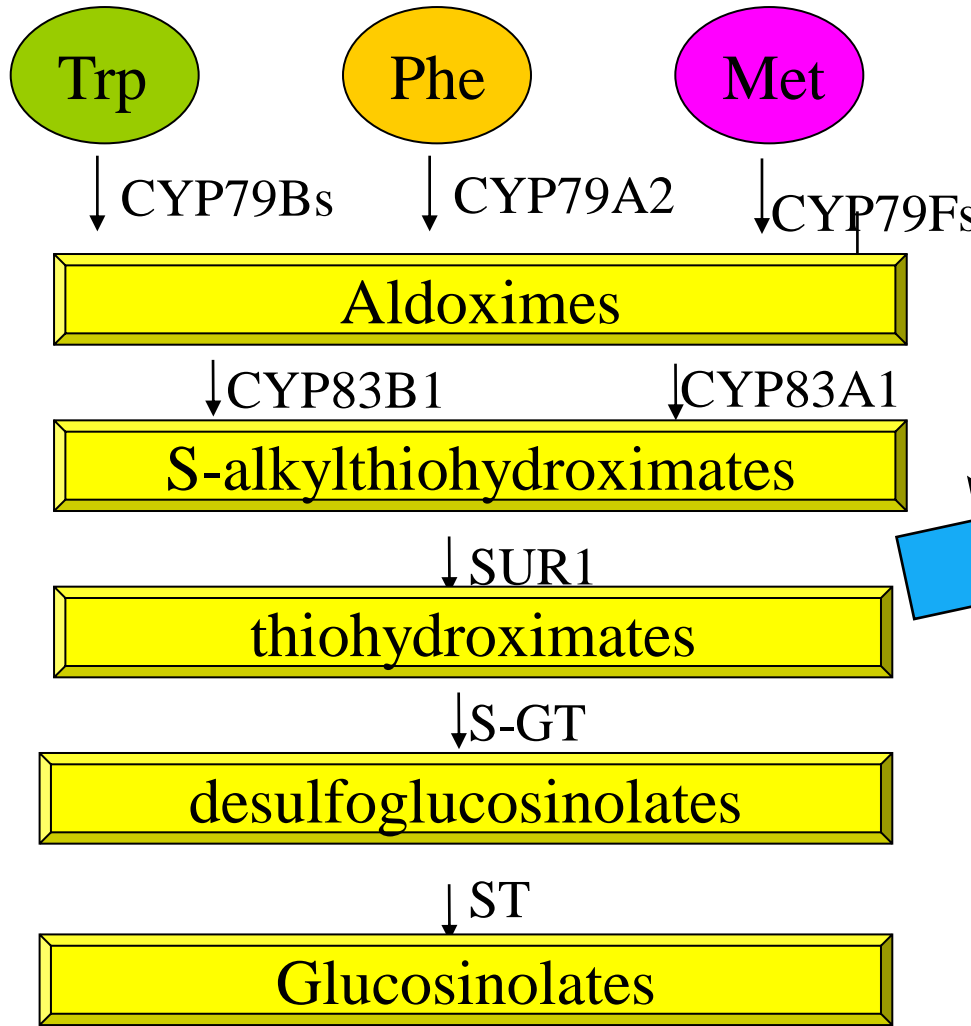
## aromatic (Phe-derived)



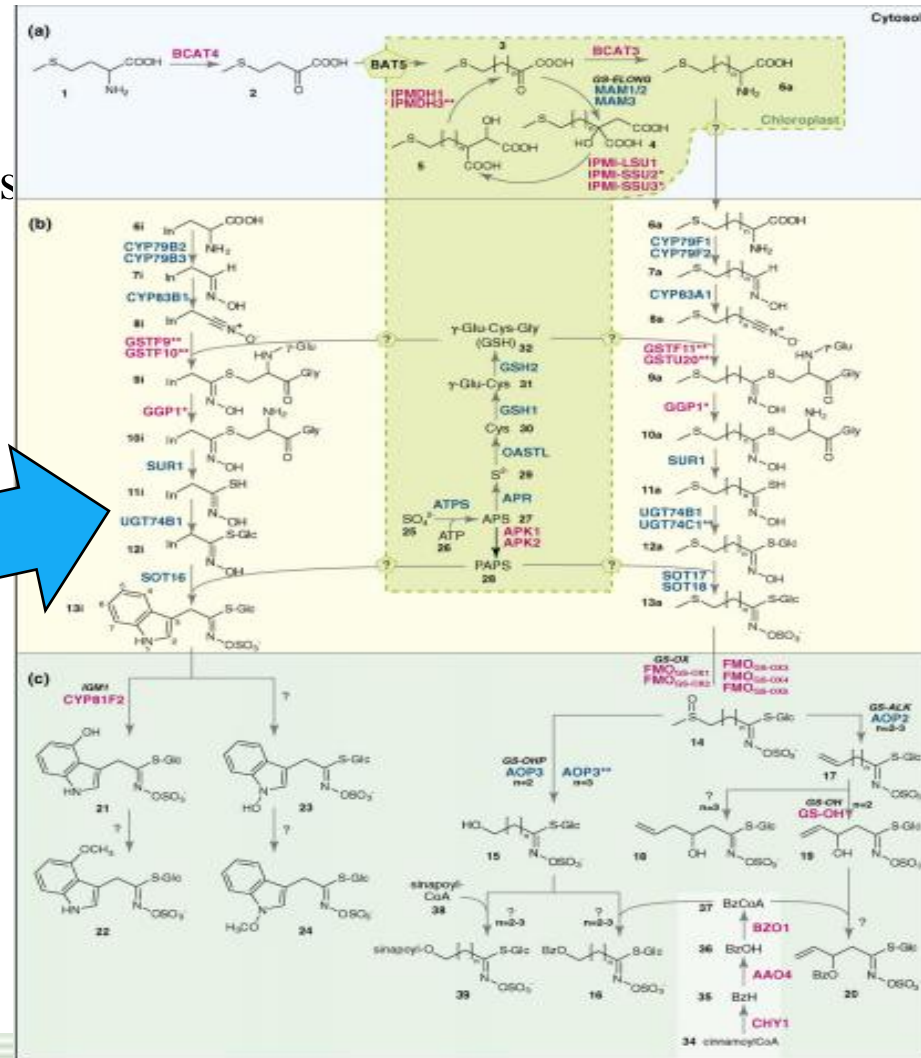
在十字花科植物中已发现120多种硫甙



# 拟南芥中硫甙生物合成途径



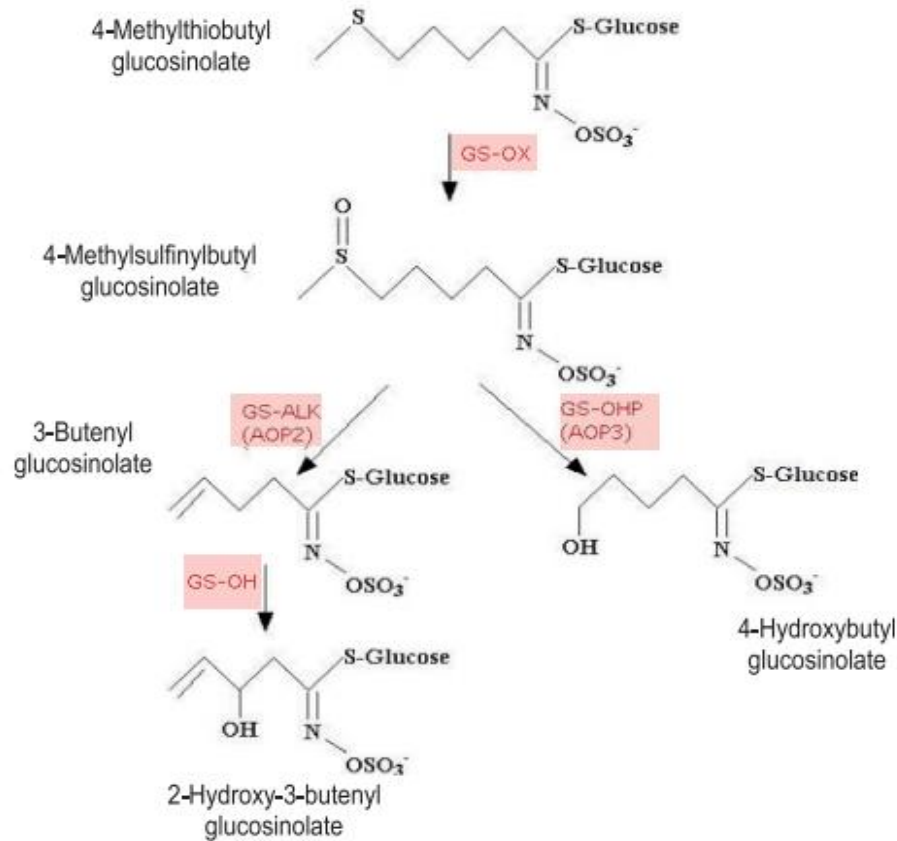
(Paweł Bednarek, 2008)



(Sønderby, et al., 2010)

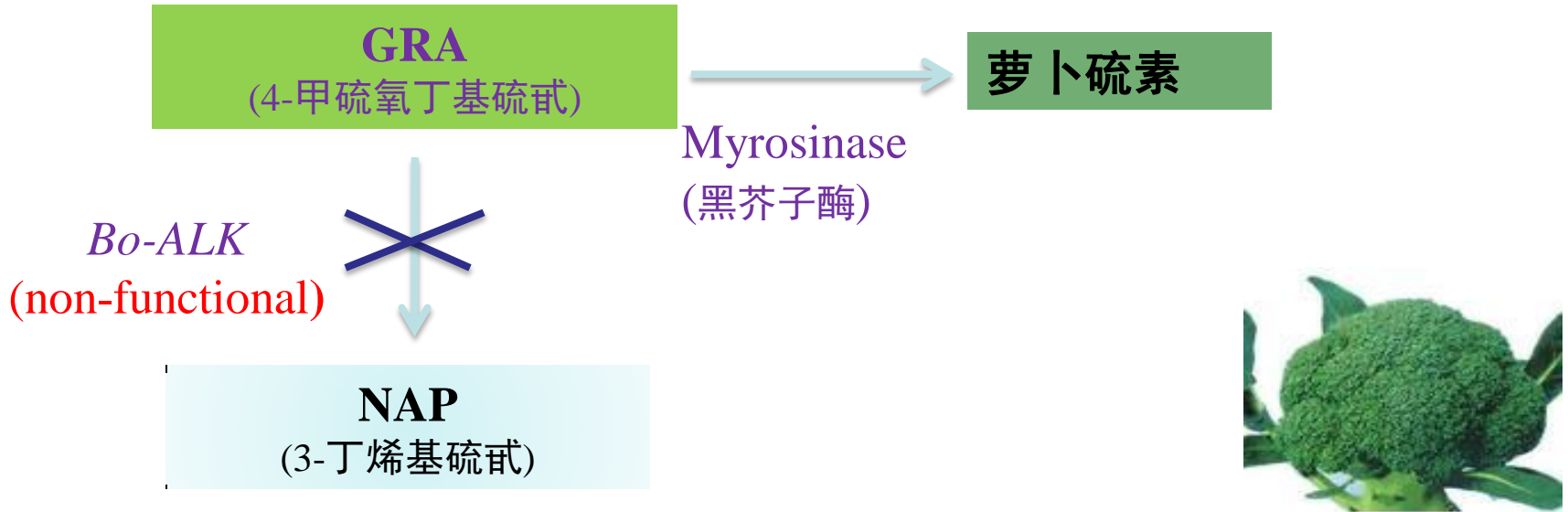


# 拟南芥硫甙合成过程中AOP基因的作用



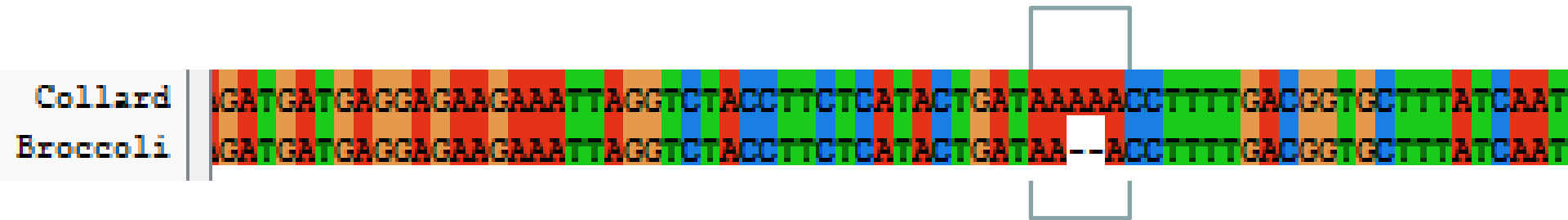
# 硫甙在甘蓝中的作用

- 甘蓝中包括具有抗癌作用的西兰花，也包括无抗癌作用的羽衣甘蓝；其中西兰花的抗癌机理如下：



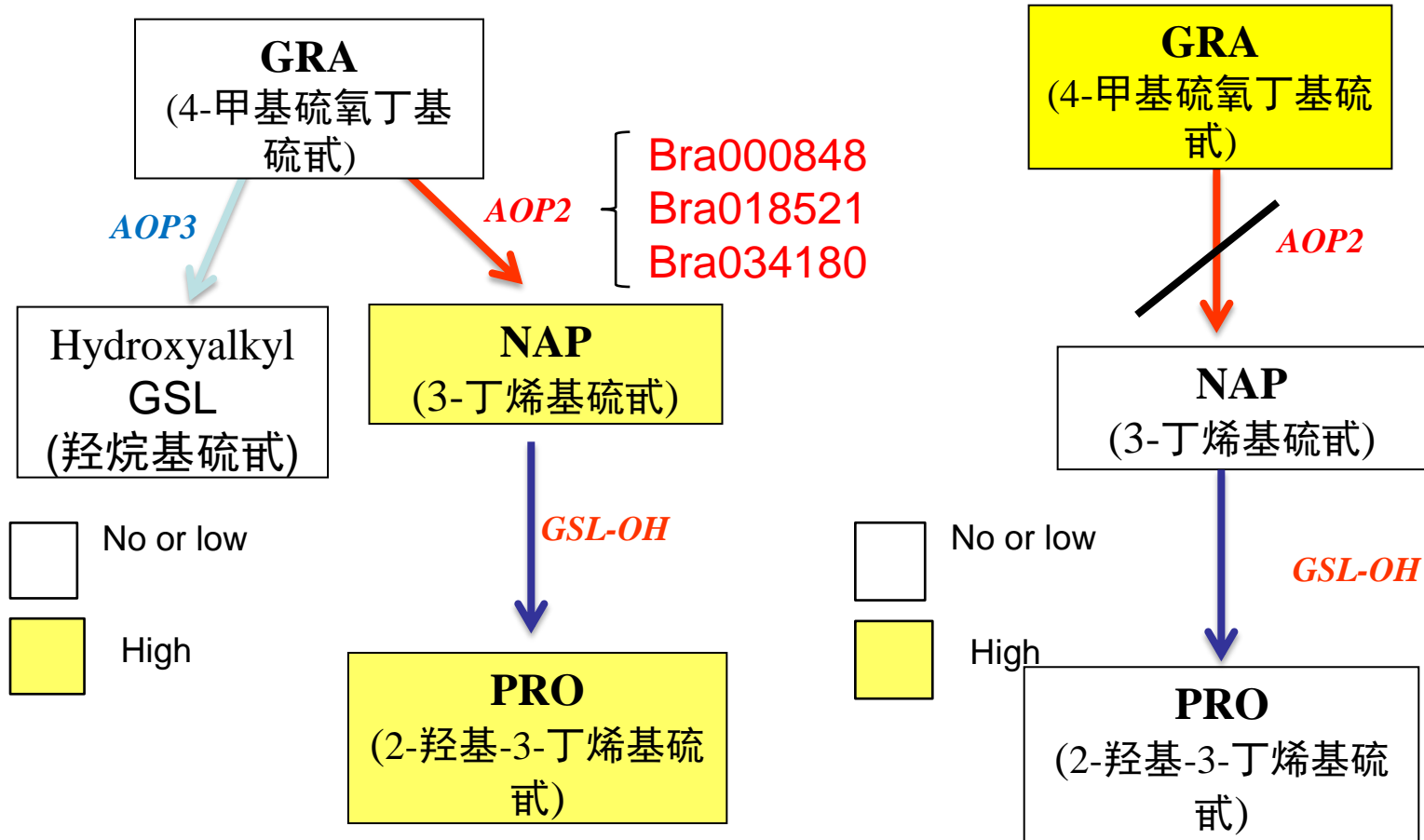
# 西兰花和羽衣甘蓝AOP2比较

通过对上述二者的*Bo-ALK*比较，发现在西兰花*Bo-ALK*外显子2上缺少两个碱基A，使其基因阅读框发生错位，导致*Bo-ALK*基因功能丧失。

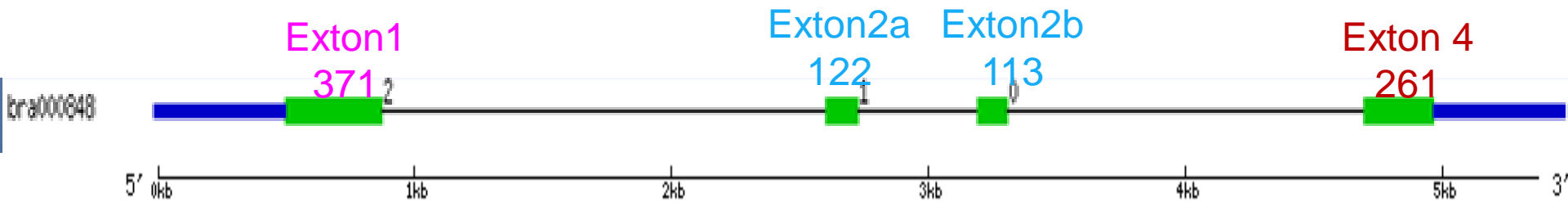
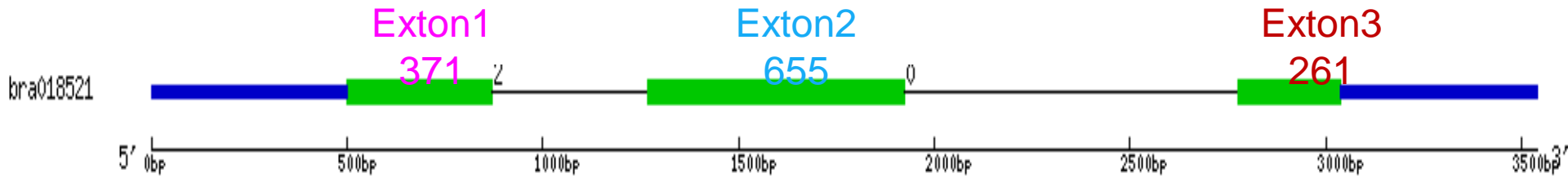
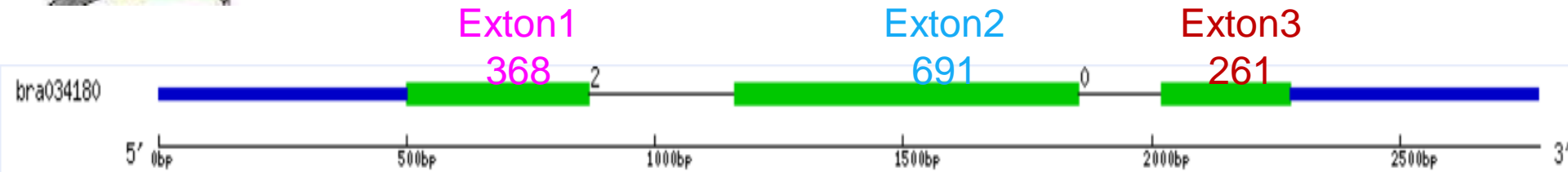
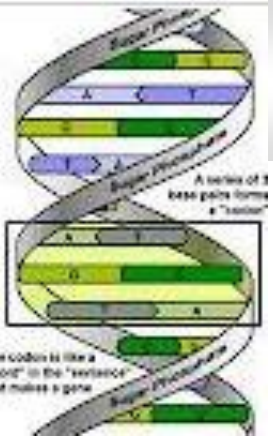




# 白菜硫甙组成特征与AOP基因的关系



# Bra-AOP2基因结构



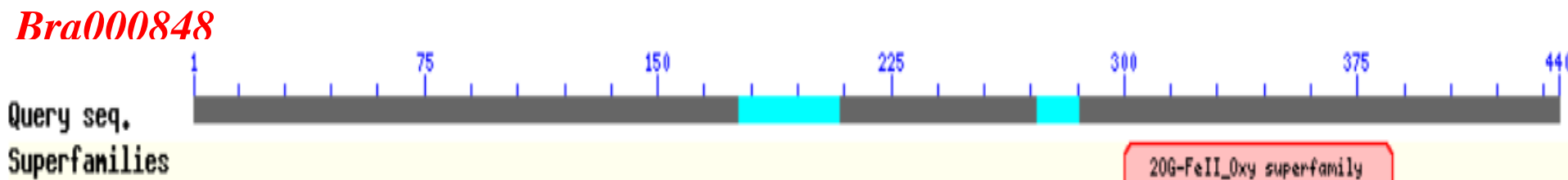
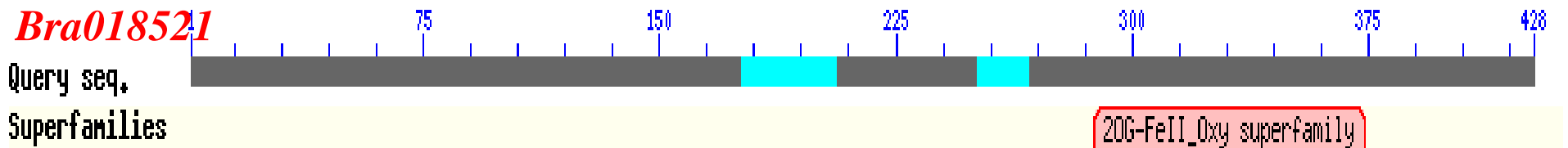
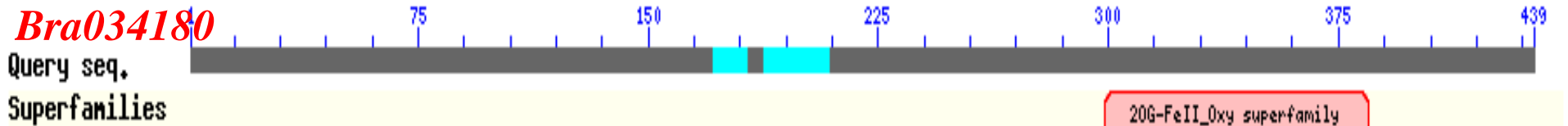


# 白菜、拟南芥和甘蓝AOP2基因的比较

	Bra00084 8	Bra01852 1	Bra0341 80	AT (CVI) AOP2	Collard- AOP2
CDS	867 (1323)	1287	1320	1299	1320
氨基酸	288 (441)	428	439	432	439
外显子	4 (3)	3	3	3	3



# Bra-AOP2基因蛋白一级结构

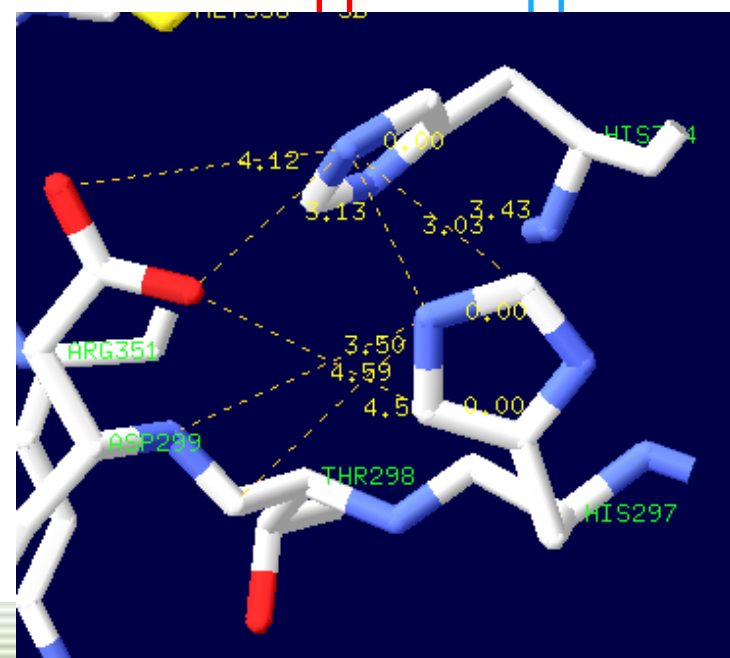


# *pfam03171*

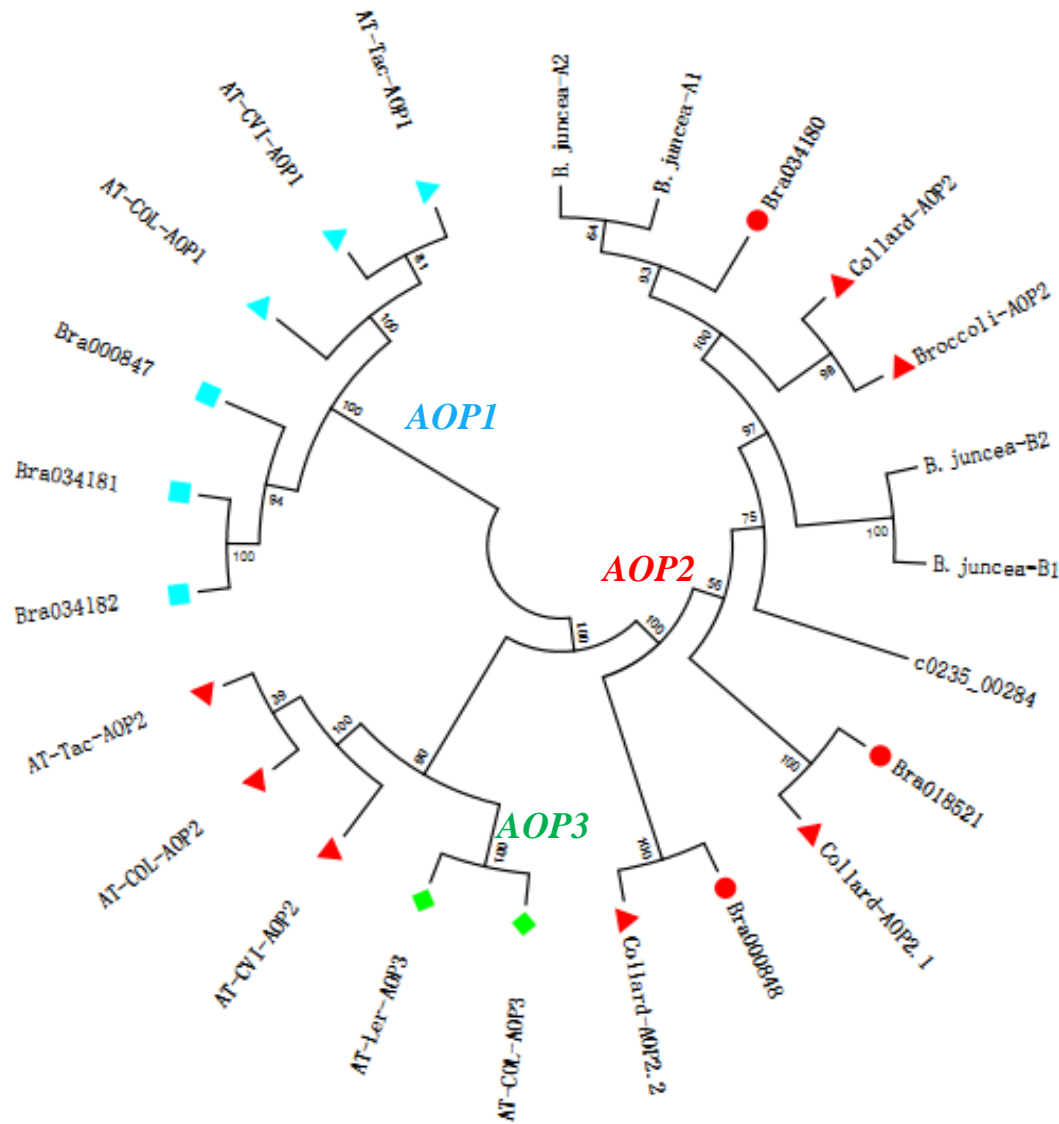
CVI-AOP2	NEEKKLGLPCHMDKNLFTVLPQHEIEGLEVKTKDEKWIQVKPSFNTFIVIAGDSLCAIMNGHIRAPYHWRVTEKKRIRYTAAIFTCE
Tac-AOP2	NEEKKLGLPCHMDKNLFTVLPQHEIEGLEVKTKDEKWIQVKPSFNTFIVIAGDSLCAIMNGHIRAPYHWRVTEKKRIRYTAAIFTCE
Ema-1	NEEKKLGLPCHMDKNLFTVLPQHEIEGLEVKTKDEKWIQVKPSFNTFIVIAGDSLCAIMNGHIRAPYHWRVTEKKRIRYTAAIFTCE
Bra034180	DEEKKLGLPSHMDKNLLTVLYQYEIEGLEVLTKDEKWIQLKPSHNSFVVMAGDSLYALMNGALSRPFHWRVTEKKRIRYSIALFSTP
Collard-AOP2	DEEKKLGLPSHMDKNLLTVLYQYEIEGLEVLTKDEKWIQLKPSHNSFVVMAGDSLYALMNGALSRPFHWRVTEKKRIRYSIALFSTP
Bra018521	DEEKKLGLPSHMDKNLFTVLYQYEIEGLEVLTKDEKWIQLKPSHNSFVVMAGDSVYALMNGALFRPFHWRVTEKKRIRYSIALFSTP

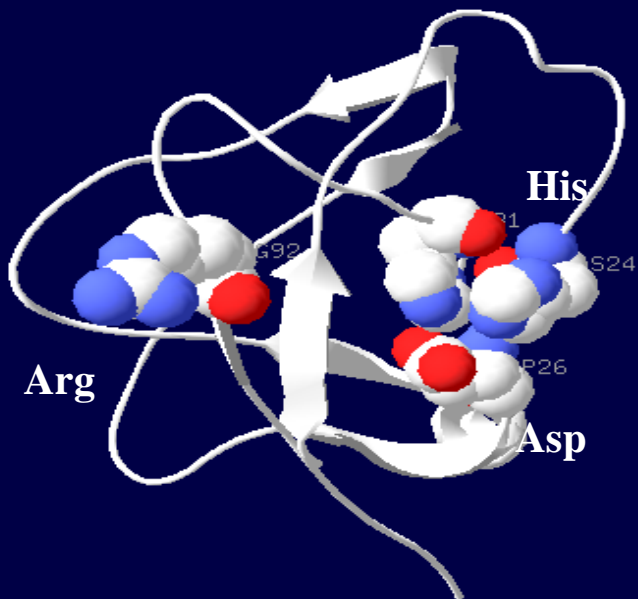
## Predicted features:

METAL	128	Iron (By similarity)	[condition: H]
METAL	130	Iron (By similarity)	[condition: D]
METAL	185	Iron (By similarity)	[condition: H]
BINDING	196	2-oxoglutarate (Potential)	[condition: [RK]]



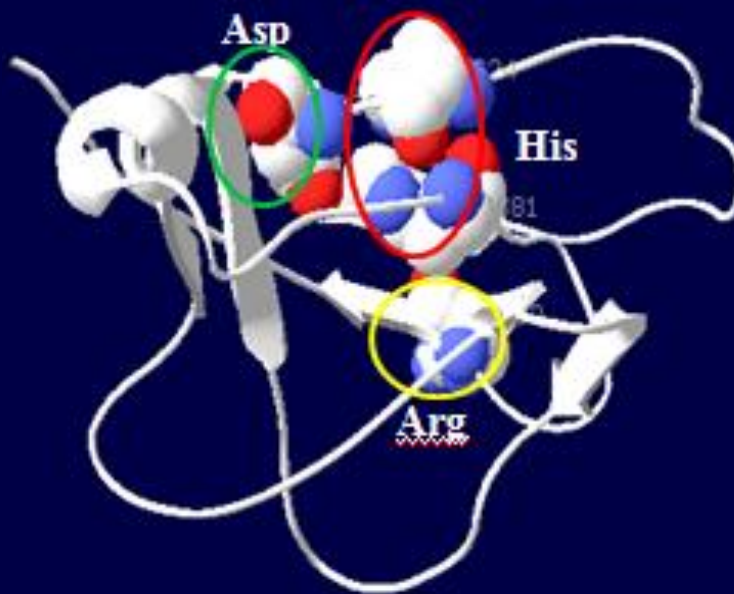
# AOP基因系统进化分析





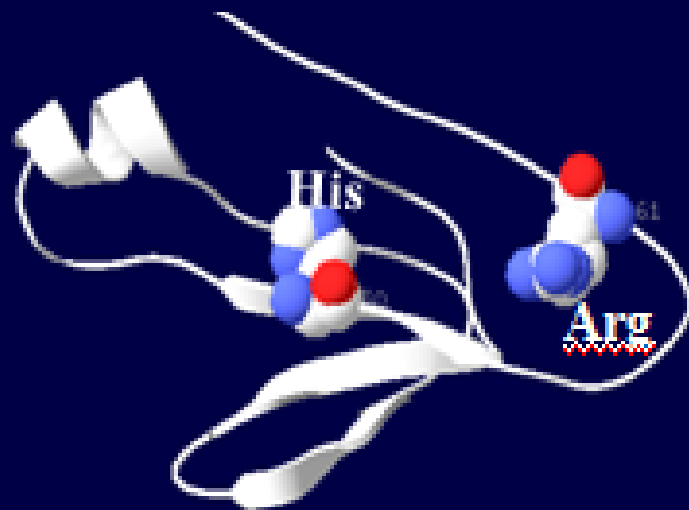
*Bra034180*

*Bra018521*



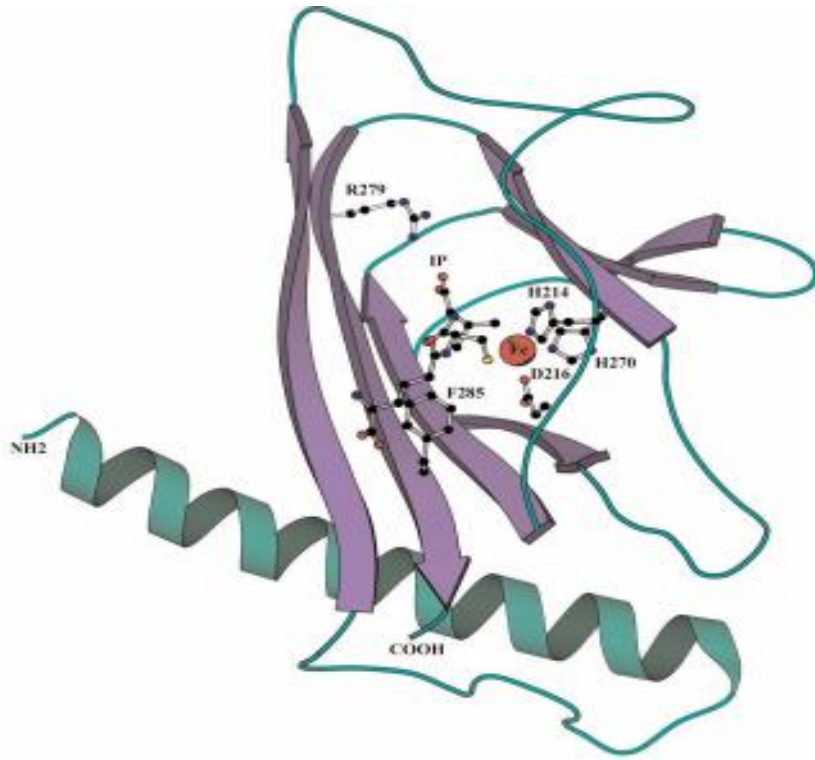
*Bra000848*

通过与拟南芥的作用位点比较，*Bra-AOP2*作用位点可能如图所示。



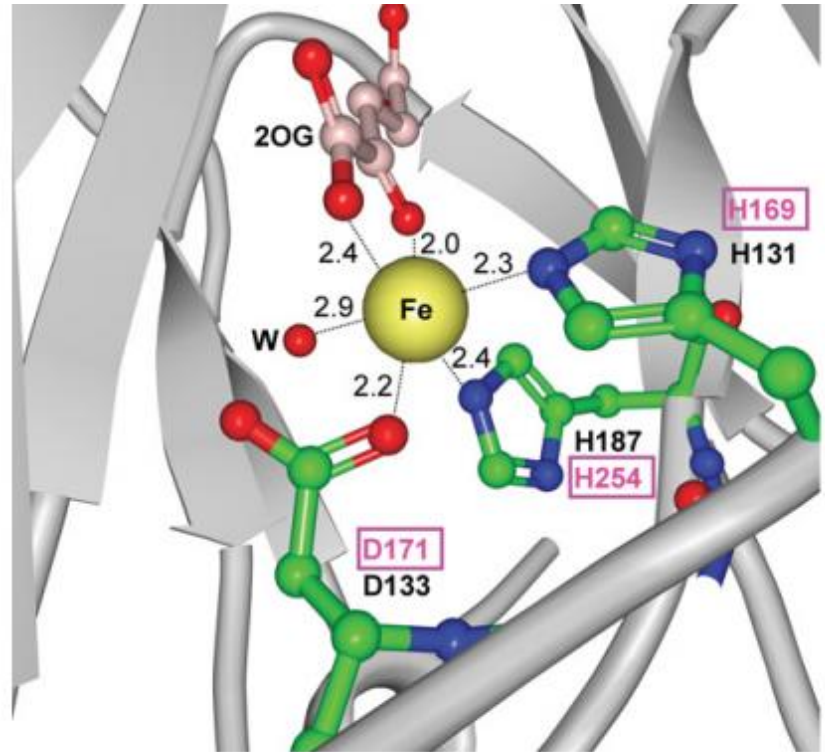


## 2-含氧戊二酸加双氧酶保守结构域



**Figure 2**  
A structural model of the DSBH core of the 2OG-Fe(II) dioxygenase superfamily. This is based on the *Emericella nidulans* isopenicillin N synthase structure (PDB:1ips). The side chains of the amino acid residues implicated in catalysis and in substrate binding are shown (see text) and the Fe(II) ion is indicated by a red circle.

(L Aravind and Eugene V Koonin,2001)

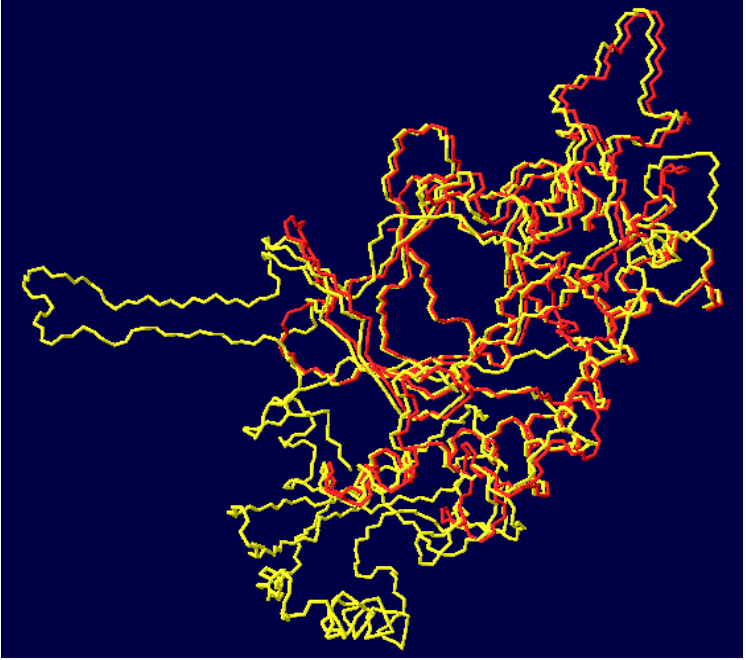


**Figure 2** Close-up view of the catalytic centre of AlkB in the presence of bound 2OG (PDB code 2FD8) [50]

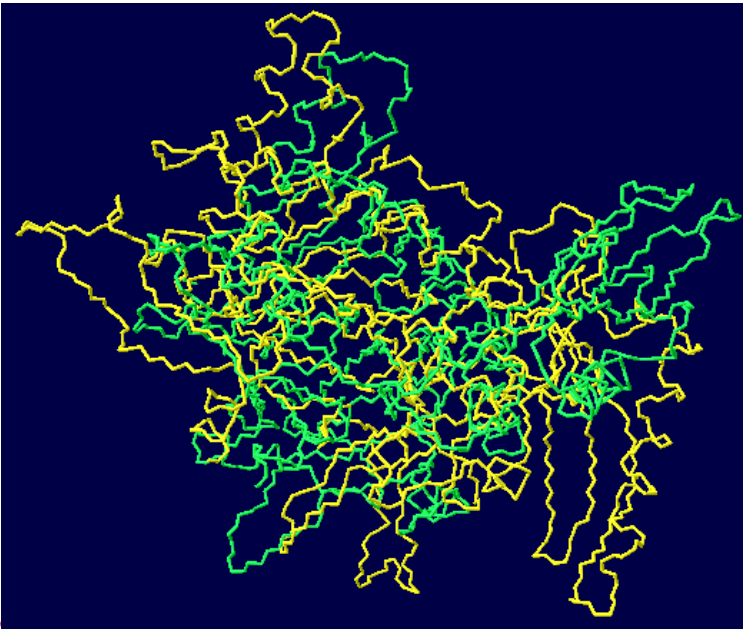
The amino acid residues that complex the Fe metal are indicated in black (H131, D133, H187). A water molecule (W) weakly interacting with the Fe ion ( $\text{Fe}-\text{H}_2\text{O} = 2.9 \text{ \AA}$ ;  $1 \text{ \AA} = 0.1 \text{ nm}$ ) is also shown. The amino acid residues of ALKBH4 thought to form a similar Fe metal-binding triad (H169, D171, H254) [19] are indicated by boxed magenta labels.

(Linn G. JØRNSTAD,et al,2011)

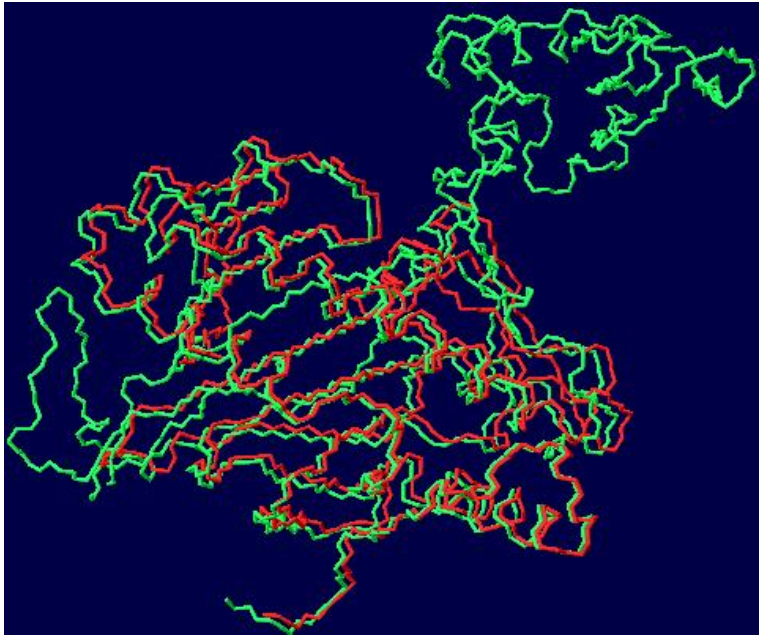




*Bra034180&bra000848*



*Bra034180&bra018521*



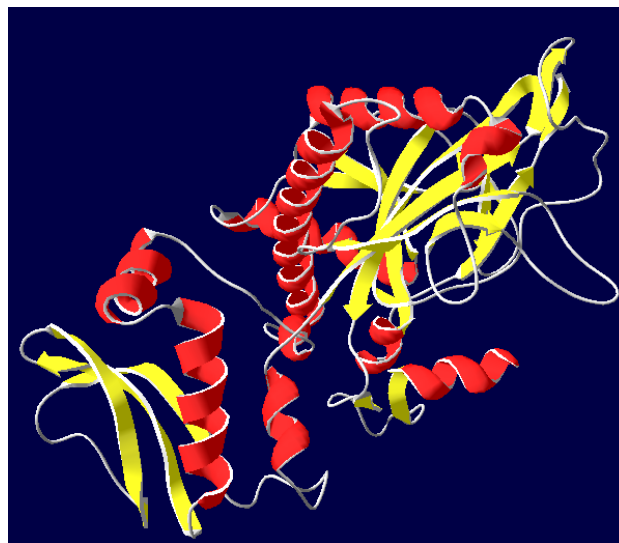
*Bra018521&bra018521*



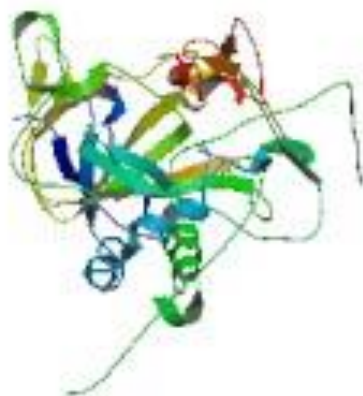
# *Bra-AOP2*蛋白高级结构预测



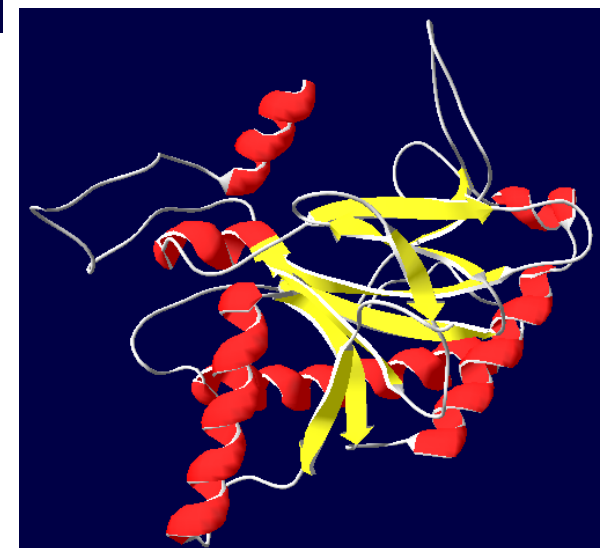
*Bra034180*



*Bra018521*



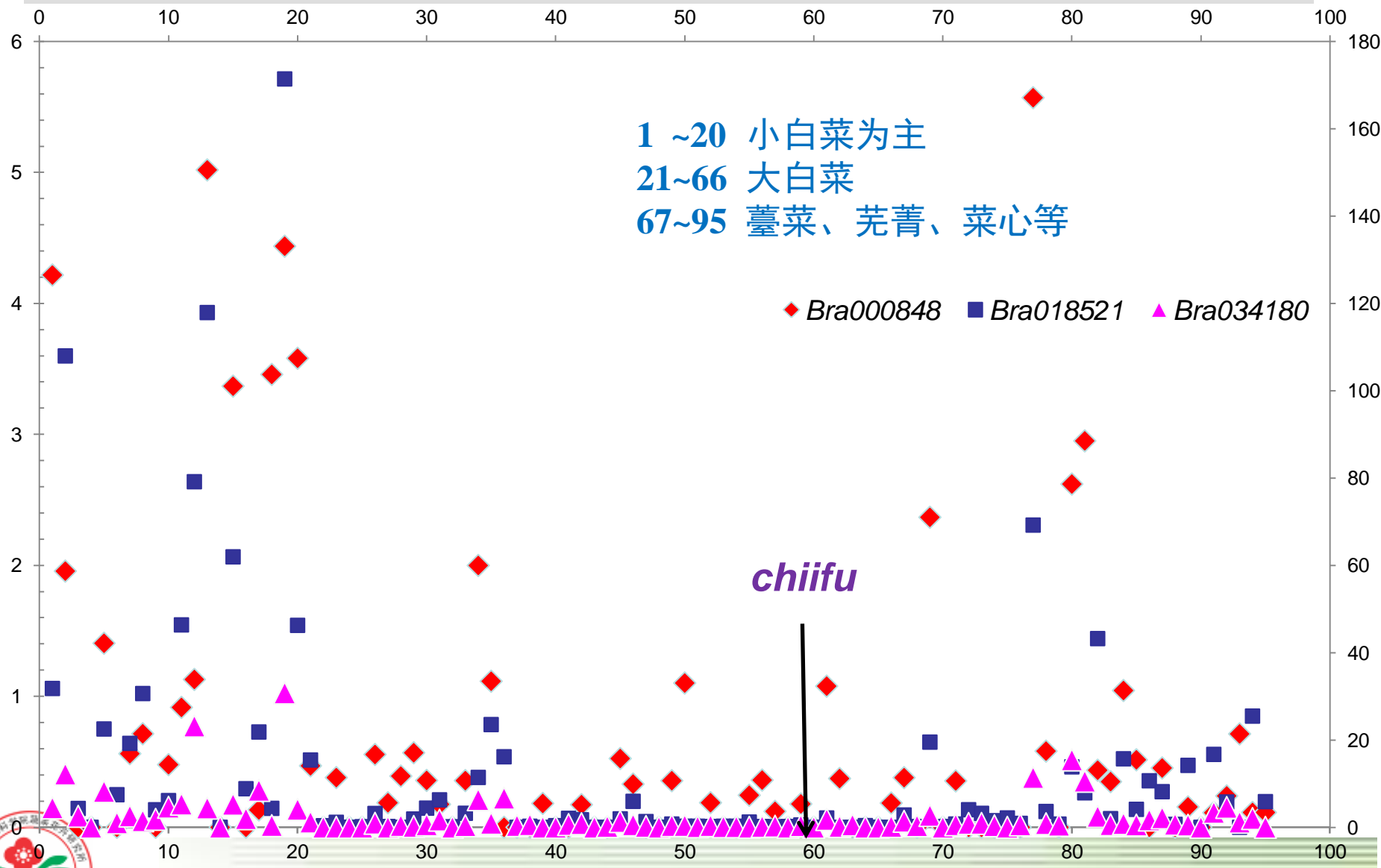
*AT-AOP2*



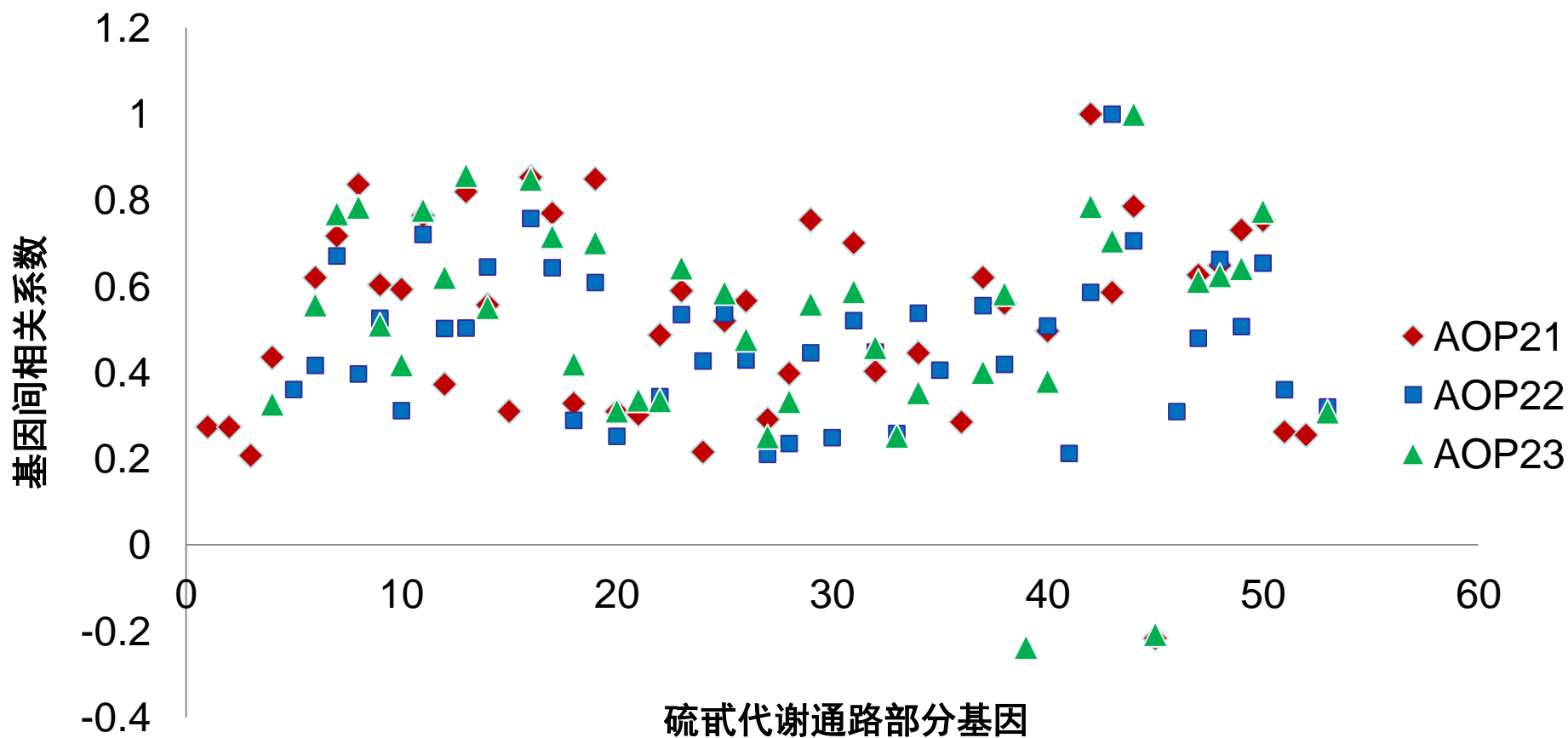
*Bra000848*



# Bra- AOP2表达谱数据



# 硫代代谢调控通路对Bra-AOP2的影响



# 小结

- 白菜chiifu材料中三个*AOP2*基因结构极为相似，尤其是第一个与第三个外显子比较保守，第二个外显子间变化差异较大；
- 对其蛋白一级结构的预测表明，其主要保守结构域*pfam*主要位于第二和第三外显子上，且均具备关键保守结构位点；
- 从其进化起源来看，*Bra-AOP2*中有两个拷贝与*Collard-AOP2*亲缘关系较近，另一个与*B. juncea*的较近；在拟南芥中*AOP2*与*AOP3*亲缘关系较近，*AOP1*可能是二者共同的祖先；
- 在硫代代谢调控过程中，上游很多基因共同调控*Bra-AOP2*表达，除其下游*GS-OH*基因对其有负调控作用外，其他大部分基因对其有正调控作用。



谢谢!

