



# 拟南芥BBX家族转录因子BBX14 生物信息学分析

Bioinformatics analysis of Arabidopsis BBX family  
transcription factor BBX14

小组成员：  
任姿蓉 G11B  
齐学袖 G11C  
潘明慧 G11D  
于原 G11A  
汇报人：于原

## BBX家族蛋白——

锌指蛋白的一种，通常具有一个或两个参与蛋白质互作的B-box基序，广泛的存在与真核生物中。

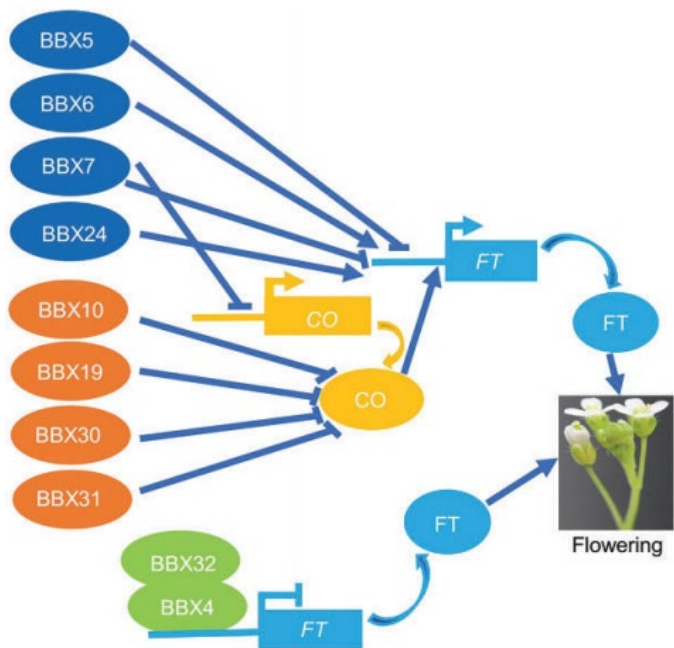


Figure 1. B-box proteins (BBXs) in the regulation of CONSTANCE FLOWERING LOCUS T (CO-FT)-mediated photoperiodic flowering

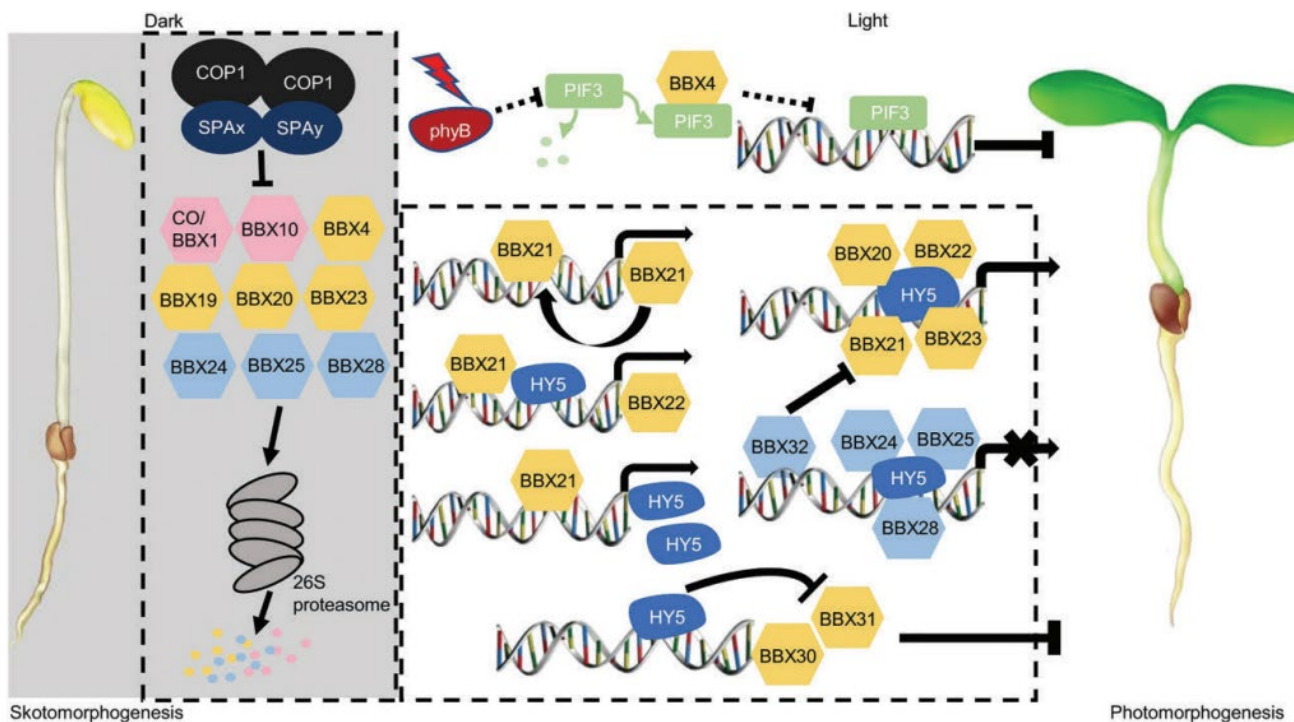


Figure 2. B-box proteins (BBXs) in the control of photomorphogenesis

BBX蛋白  
(拟南芥32个)

- B-box结构域: 40个氨基酸, BBX蛋白N端, 结合Zn离子形成锌指
- CCT结构域: 42-43个氨基酸, BBX蛋白C端, 蛋白质结合功能

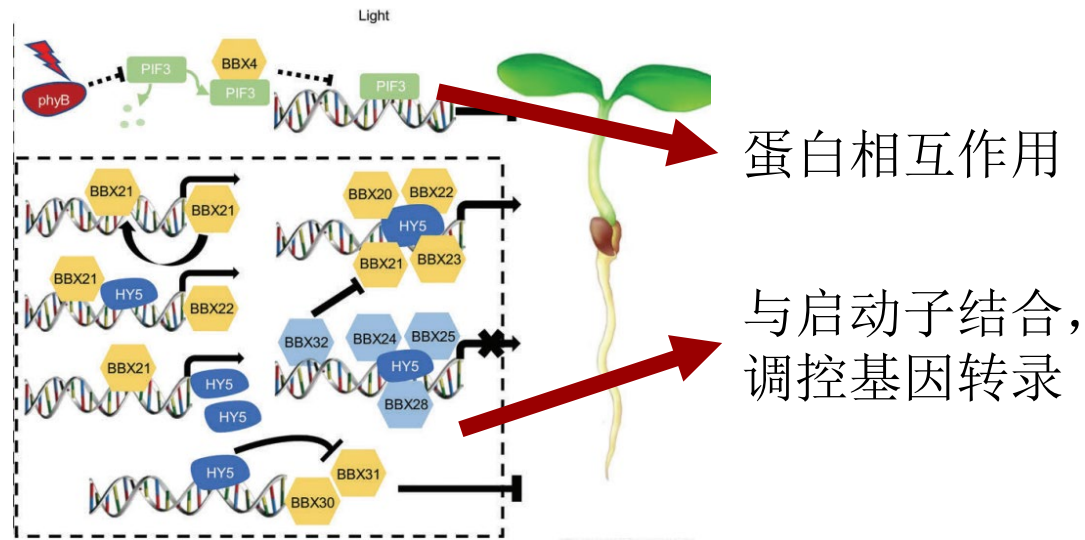
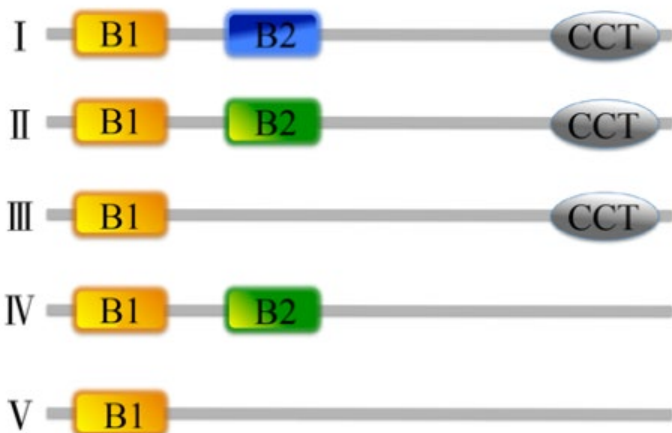


图 1 BBX 蛋白的结构类型

Fig. 1 Structure class of BBX protein.



# 分析结果——序列检索

BLAST Align Download Add to basket Columns

1 to 2 of 2 Show 25

Entry	Entry name	Protein names	Gene names	Organism	Length
M1A433	M1A433_SOLTU	B-box zinc finger protein 14	<b>BBX14</b>	Solanum tuberosum (Potato)	401
A0A178WLD4	A0A178WLD4_ARATH	BBX14	AXX17_At1g62570	Arabidopsis thaliana (Mouse-ear cress)	406

BBX14  
Unreviewed?

Blast

## Overview

Show all 250

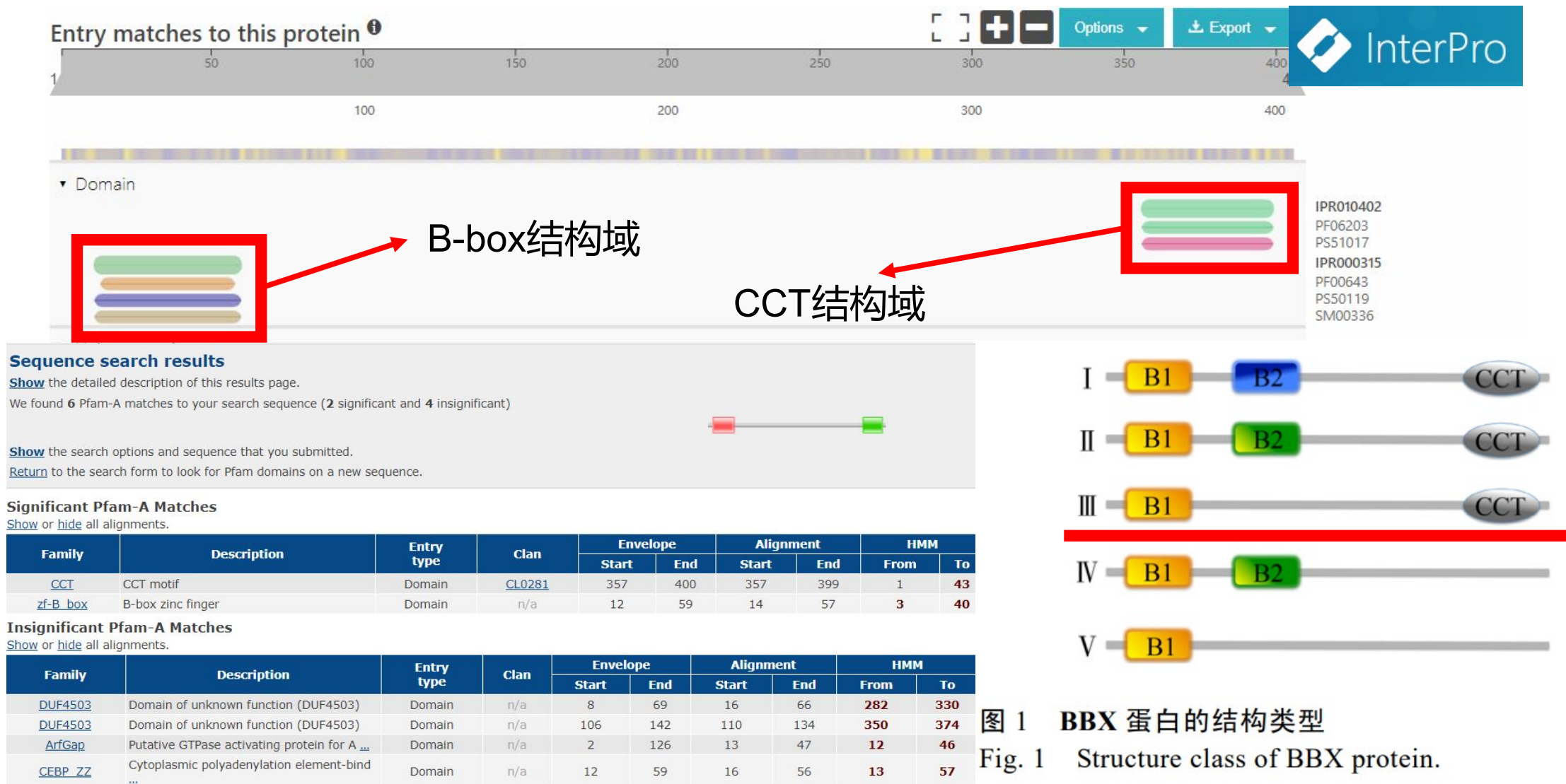
Entry	Protein names	Match hit	Identity
Q8LG76	Zinc finger protein CONSTANS-LIKE 6 (Arabidopsis thaliana)		100.0%
A0A178WLD4	BBX14 (Arabidopsis thaliana)		100.0%
A0A654EM85	B box-type domain-containing protein (Arabidopsis thaliana)		100.0%

COL6  
Reviewed

Plantfdb

Basic Information <a href="#">? help</a> <a href="#">Back to Top</a>	
TF ID	AT1G68520.1
Common Name	BBX14, COL6, T26J14.9
Organism	<i>Arabidopsis thaliana</i>
Taxonomic ID	3702
Taxonomic Lineage	cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetalae; rosids; malvids; Brassicales; Brassicaceae; Camelineae; Arabidopsis

BBX14=COL6





<input checked="" type="checkbox"/>	<a href="#">RecName: Full=Zinc finger protein CONSTANS-LIKE 16 [Arabidopsis thaliana]</a>	<a href="#">Arabidopsis thali...</a>	467	467	98%	4e-163	61.93%	417	<a href="#">Q8RWD0.2</a>
<input checked="" type="checkbox"/>	<a href="#">RecName: Full=Zinc finger protein CONSTANS-LIKE 7 [Arabidopsis thaliana]</a>	<a href="#">Arabidopsis thali...</a>	211	211	97%	2e-63	36.85%	392	<a href="#">Q9C9A9.1</a>
<input checked="" type="checkbox"/>	<a href="#">RecName: Full=Zinc finger protein CONSTANS-LIKE 8 [Arabidopsis thaliana]</a>	<a href="#">Arabidopsis thali...</a>	95.5	174	46%	8e-21	52.50%	319	<a href="#">Q9M9B3.2</a>

BBX15/COL16、BBX16/COL7、BBX17/COL8  
BBX家族类型III



Sequences producing significant alignments:

			Score (Bits)	E Value	
AT1G68520.1	Symbols:BBX14	B-box domain protein 14	Chr1:2570...	737	0.0
AT1G25440.1	Symbols:BBX15	B-box domain protein 15	Chr1:8933...	442	3e-154
AT1G73870.1	Symbols:COL7, BBX16	CONSTANS-LIKE 7, B-box domain p...	198	2e-59	
AT1G49130.1	Symbols:BBX17	B-box domain protein 17	Chr1:1817...	95.5	1e-21
AT1G49130.2	Symbols:BBX17	B-box domain protein 17	Chr1:1817...	95.1	1e-21

**BBX16:** 高 R/FR 比值下促进拟南芥的分枝，低R/FR比值下增强植株的避荫效应；上调生长素合成抑制因子SUR2的表达，调控植物的分枝特性以应对遮荫条件；BBX16受ABA及其早期信号影响而下调。

## 信号肽分析——SignalP

Protein type	Signal Peptide (Sec/SPI)	Other
Likelihood	0.0111	0.9889

## 亚细胞定位——PSORT

### Final Results

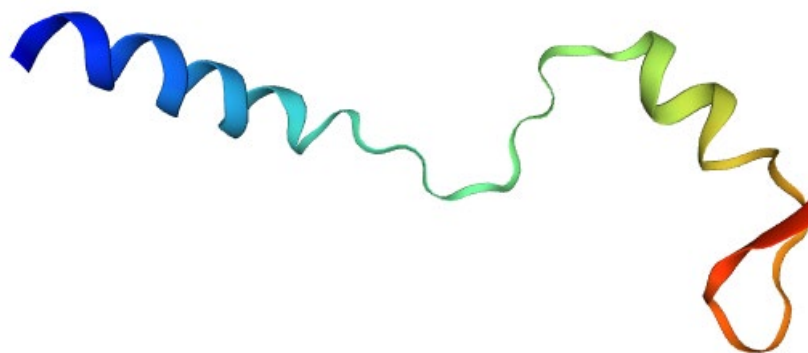
```
nucleus — Certainty= 0.880 (Affirmative) < succ>
mitochondrial matrix space — Certainty= 0.100 (Affirmative) < succ>
lysosome (lumen) — Certainty= 0.100 (Affirmative) < succ>
endoplasmic reticulum (membrane) — Certainty= 0.000 (Not Clear) < succ>
```





BIOZENTRUM

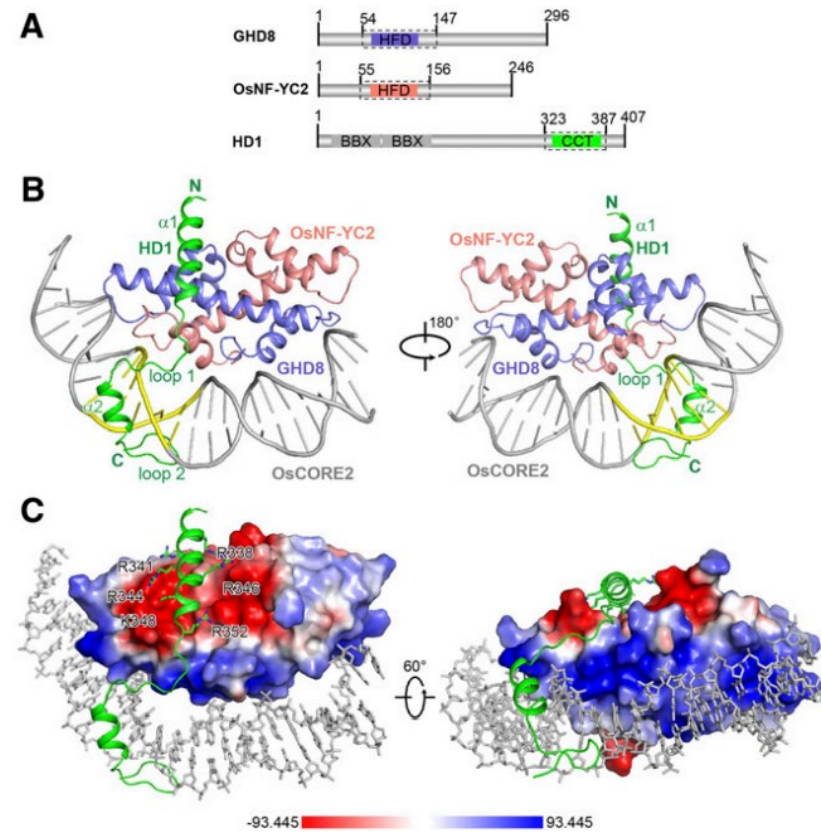
University of Basel  
The Center for Molecular Life Sciences



BBX14预测结构



## BBX14模板——HD1



**Figure 3.** Overall Structure of the DNA-Bound HD1<sup>CCT</sup>/GHD8/OsNF-YC2 Complex.

# 分析结果——启动子分析

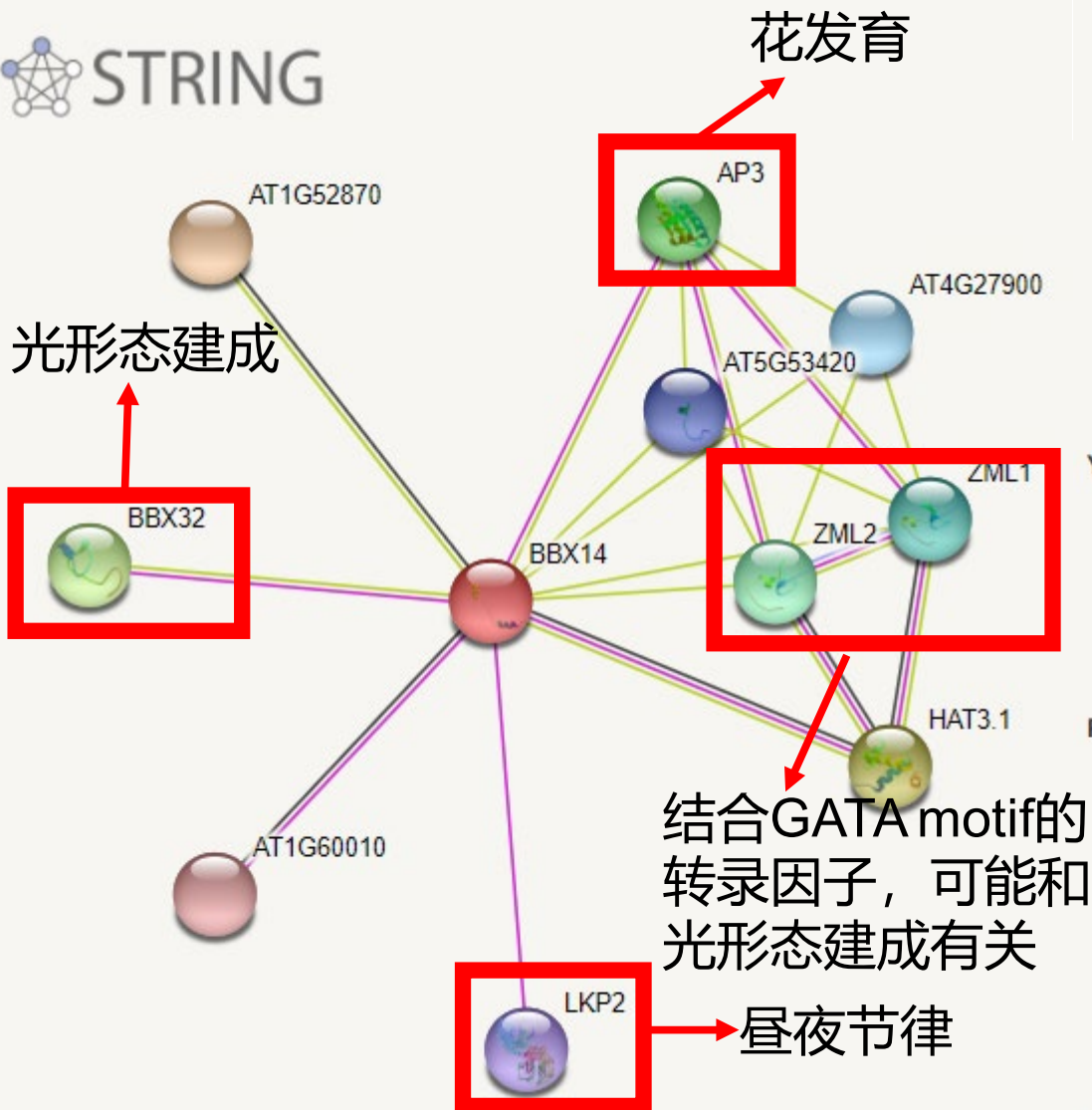


Motifs Found

- + ■ AAAC-motif
- + ■ AAAC-motif
- + ■ AACAA\_motif
- + ■ AAGAA-motif
- + ■ ABRE
- + ■ ABRE3a
- + ■ ABRE4
- + ■ ACE
- + ■ ARE
- + ■ Box 4
- + ■ CAAT-box
- + ■ CCAAT-box
- + ■ G-box
- + ■ GARE-motif
- + ■ GT1-motif
- + ■ LTR
- + ■ MRE
- + ■ MYB
- + ■ MYB recognition site
- + ■ MYC
- + ■ Myb-binding site
- + ■ O2-site
- + ■ TATA-box
- + ■ TCA
- + ■ TGA-element
- + ■ Unnamed\_\_4
- + ■ Unnamed\_\_6
- + ■ circadian

Motif	功能	概况
AAAC-motif	light responsive element	光响应
Box 4	part of a conserved DNA module involved in light responsiveness	
ACE	cis-acting element involved in light responsiveness	
G-box	cis-acting regulatory element involved in light responsiveness	
GT1-motif	light responsive element	
LTR	cis-acting element involved in low-temperature responsiveness	
ABRE	cis-acting element involved in the abscisic acid responsiveness	植物激素
GARE-motif	gibberellin-responsive element	
TGA-element	auxin-responsive element	昼夜节律
circadian	cis-acting regulatory element involved in circadian control	
MRE	MYB binding site involved in light responsiveness	
CCAAT-box	MYBHv1 binding site	结合位点

# 分析结果——基因相互作用



## Functional enrichments in your network

Note: some enrichments may be expected here (why?)

[explain columns](#)

GO-term	description	count in network	strength	false discovery rate
GO:0045944	positive regulation of transcription by RNA polymerase II	3 of 172	1.64	0.0016
GO:0006366	transcription by RNA polymerase II	2 of 134	1.57	0.0053
GO:0045893	positive regulation of transcription, DNA-templated	4 of 368	1.43	0.0016
GO:0009908	flower development	2 of 404	1.09	0.0311
GO:0030154	cell differentiation	3 of 680	1.04	0.0078
GO:0006355	regulation of transcription, DNA-templated	6 of 2167	0.84	0.0016
GO:0009791	post-embryonic development	3 of 1164	0.81	0.0287
GO:0006351	transcription, DNA-templated	5 of 1957	0.8	0.0028
GO:0032502	developmental process	5 of 2492	0.7	0.0068
GO:0050794	regulation of cellular process	7 of 4167	0.62	0.0019
GO:0044260	cellular macromolecule metabolic process	6 of 5262	0.45	0.0283

(less ...)

## Your Input:

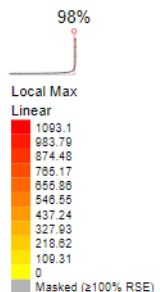
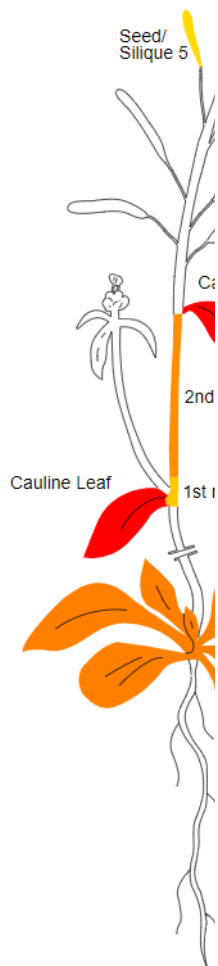
● BBX14  
*B-box type zinc finger protein with CCT domain; Its function is described as sequence-specific DNA binding transcription factor activity, zinc ion binding; Involved in regulation of transcription; Located in intracellular; Expressed in 21 plant structures; Expressed during 13 growth stages; Contains the following InterPro domains: CCT domain (InterPro:IPR010402), Zinc finger, B-box (InterPro:IPR000315); BEST Arabidopsis thaliana protein match is: B-box type zinc finger protein with CCT domain (TAIR:AT1G25440.1); Has 3472 Blast hits to 2352 proteins in 127 species: Archae - 0; Bacteria [...]* (406 aa)

## Predicted Functional Partners:

- AT1G52870 *Peroxisomal membrane 22 kDa (Mpv17/PMP22) family protein; Its function is described as molecular\_function unk...*
- HAT3.1 *Homeodomain-like protein with RING/FYVE/PHD-type zinc finger domain; Encodes a member of the PHD-finger hom...*
- BBX32 *B-box zinc finger protein 32; Repressor of light-mediated regulation of seedling development. Functions by suppressi...*
- AP3 *K-box region and MADS-box transcription factor family protein; Probable transcription factor involved in the genetic ...*
- ZML2 *GATA transcription factor 28; Transcriptional activator that specifically binds 5'-GATA-3' or 5'-GAT-3' motifs within ge...*
- ZML1 *GATA transcription factor 24; Transcriptional activator that specifically binds 5'-GATA-3' or 5'-GAT-3' motifs within ge...*
- AT4G27900 *Uncharacterized protein AT4g27900; CCT motif family protein; Its function is described as molecular\_function unkno...*
- AT5G53420 *Uncharacterized protein At5g53420; CCT motif family protein; Its function is described as molecular\_function unkno...*
- LKP2 *LOV KELCH protein 2; Component of an E3 ubiquitin ligase complex that plays a central role in blue light-dependent ...*
- AT1G60010 *Uncharacterized protein At1g60010/T2K10\_6; Unknown protein; Its function is described as molecular\_function unk...*

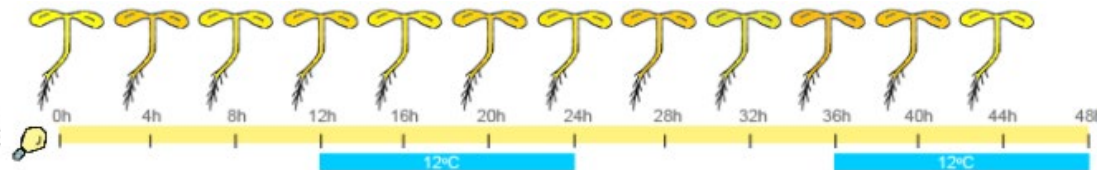
# 分析结果——基因表达

AtGenExpress eFP: AT1G68520



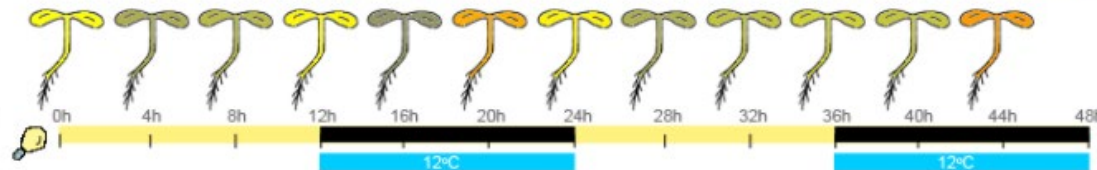
**LLHC**

Michael et al., 2008  
7d old Col-0 seedlings  
agar grown, no sucrose  
continuous light, 100  $\mu$ E  
22°C/12°C cycles



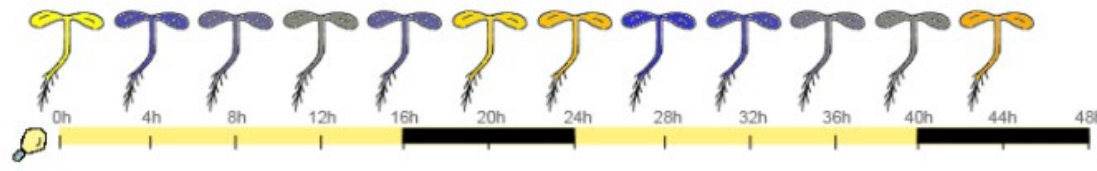
**LDHC**

Michael et al., 2008  
7d old Col-0 seedlings  
agar grown, no sucrose  
12h light, 100  $\mu$ E  
22°C/12°C cycles



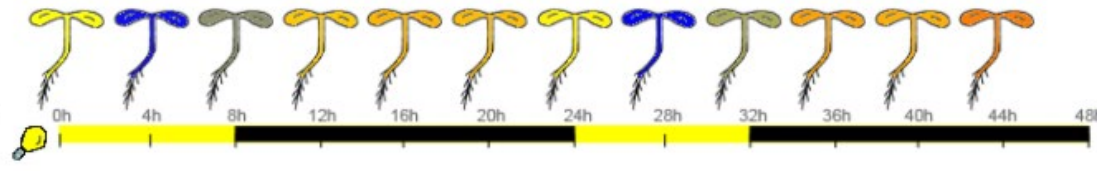
**Long Day**

Michael et al., 2008  
7d old Ler seedlings  
agar grown, 3% sucrose  
16h light, 90  $\mu$ E  
22°C



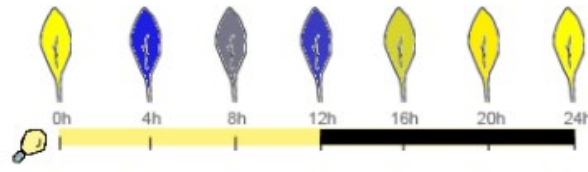
**Short Day**

Michael et al., 2008  
7d old Ler seedlings  
agar grown, 3% sucrose  
8h light, 180  $\mu$ E  
22°C



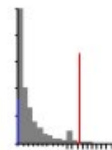
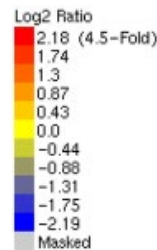
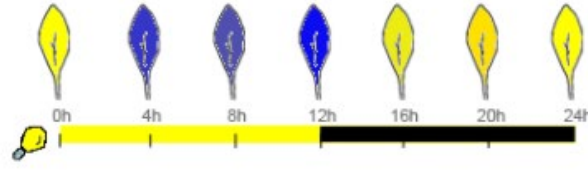
**LDHH\_ST**

Blaesing et al., 2005  
35d old Col-0 leaves  
soil grown, duplicates  
12h light, 130  $\mu$ E  
22°C

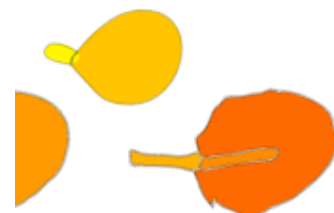


**LDHH\_SM**

Smith et al., 2004  
29d old Col-0 leaves  
soil grown, duplicates  
12h light, 180  $\mu$ E  
20°C



Young leaf  
(petiole/lamina)



Intermediate leaf 2  
(petiole/vein/lamina)



Mature leaf  
(vein/lamina/whole)



Parts  
of leaf

## 总结

- 1、BBX14，又名COL6，主要具有BBX和CCT两个结构域，属于BBX家族类型III。
- 2、与BBX14同属于类型III的BBX家族蛋白有BBX15、BBX16、BBX17。
- 3、BBX14可能参与植物的光响应和冷响应，并受植物激素和昼夜节律调控，有可能参与植物的光保护，主要在成熟叶片中表达。
- 4、通路上游，BBX14可能受到MYBH和MYB家族转录因子调控，通路的光感受器可能是光敏色素；通路下游，BBX14可能与其他蛋白相互作用参与基因的转录调控。

## 启示

- 1、BBX14主要在成熟叶片中表达——研究对象
- 2、BBX14可能受到光、温度、植物激素和昼夜节律调控——实验处理
- 3、BBX14可能与光敏色素有关——红光和远红光、光敏色素相关通路
- 4、BBX14可能与光保护相关——光胁迫与光保护基因

- [1] Song Z , Bian Y , Liu J , et al. B-box proteins: Pivotal players in light-mediated development in plants[J]. Journal of Integrative Plant Biology, 2020.
- [2] 杨宁, 从青, 程龙军. 植物BBX转录因子基因家族的研究进展[J]. 生物工程学报, 2020, 036(004):666-677.
- [3] Shen C , Liu H , Guan Z , et al. Structural Insight into DNA Recognition by CCT/NF-YB/YC Complexes in Plant Photoperiodic Flowering[J]. The Plant Cell, 2020, 32(11):tpc.00067.2020.
- [4] Huang J , Zhao X , Chory J . The Arabidopsis Transcriptome Responds Specifically and Dynamically to High Light Stress[J]. Cell Reports, 2019, 29(12):4186-4199.e3.

# Acknowledgement

- **Dr. Jingchu Luo;**
- **Qian pan; Dechang Yang;**
  
- **G11A Yuan Yu ;**
- **G11B Zirong Ren;**
- **G11C Xuexiu Qi;**
- **G11D Minghui Pan**
- **All the classmates.**



北京大学  
PEKING UNIVERSITY

**欢迎老师和同学的批评与指导**