

# Screening the Powdery Mildew Susceptible Gene in Melon by Bioinformatics

## 利用生物信息学方法筛选甜瓜感白粉病基因

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# 一、研究背景

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白粉病是瓜类生产上最重要的病害之一，主要危害植株叶片，发病时白粉菌迅速增多并扩散，植株叶片大面积死亡，通常会降低农产品的产量和品质，造成巨大的经济损失。全球大约有 10000 种植物受到约 650 种白粉菌的侵害。



# 一、研究背景

In the 1930s and 1940s, a game-changing type of powdery mildew resistance was discovered. Loss-of-function of the gene *Mildew resistance locus o* (*Mlo*) in barley was found to confer recessively inherited broad-spectrum resistance against the ascomycete phytopathogen ([Jørgensen 1992](#); [Lyngkjær and Carver 2000](#)). In contrast to prototypical resistance (*R*) gene-mediated race-specific resistance, *mlo*-based resistance is non-race specific and, thus, effective against the vast majority of powdery mildew isolates ([Brown 2015](#); [Lyngkjær and Carver 2000](#)).

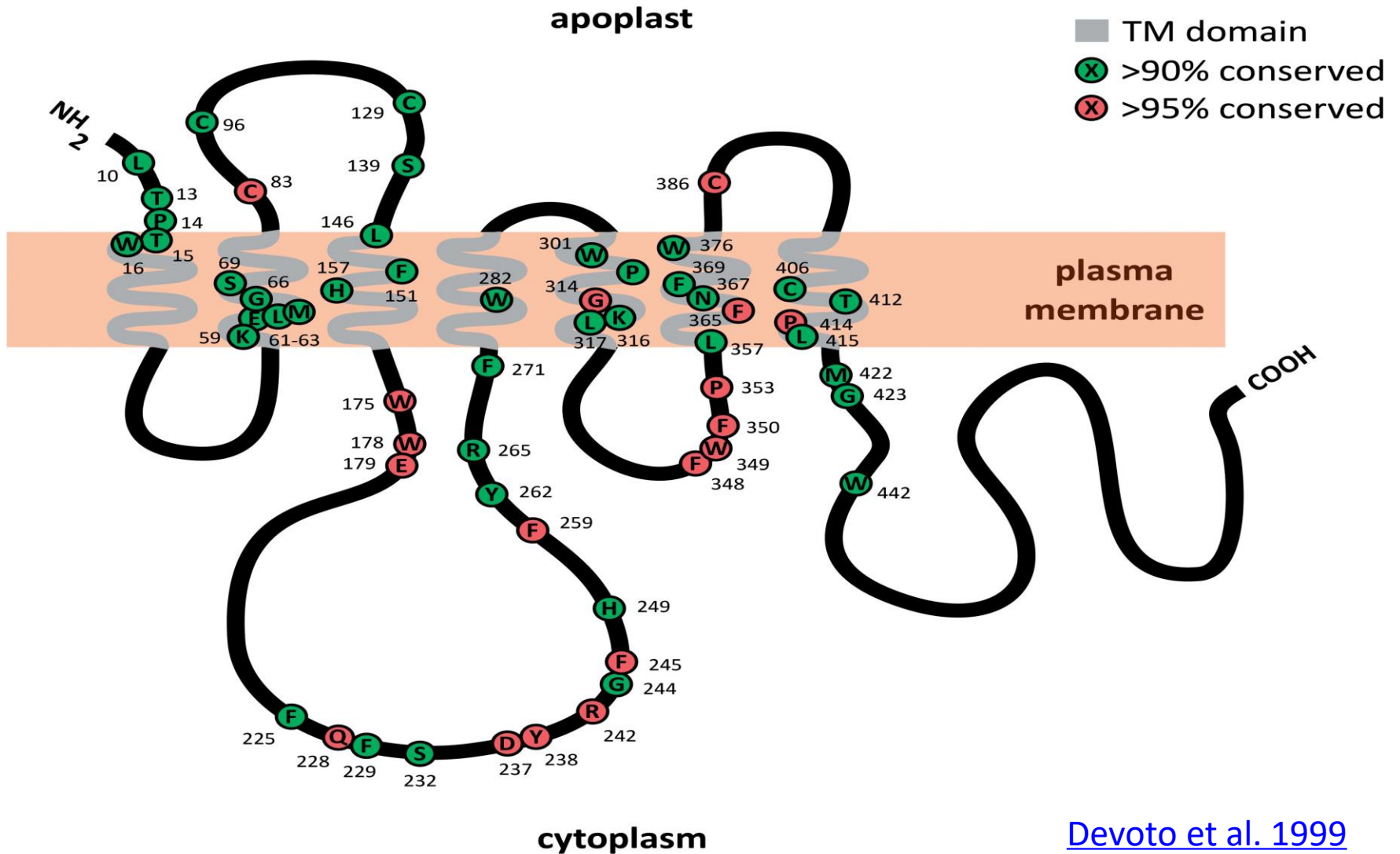
# 一、研究背景

在拟南芥基因组的研究中发现，野生型拟南芥具有 15 个 MLO 家族成员，其中 *AtMLO2*、*AtMLO06* 和 *AtMLO12* 这 3 个基因突变体可以使拟南芥对白粉病菌完全免疫 (Consonni et al., 2006)，其中 *AtMLO2* 在白粉病菌免疫反应中发挥主要作用。

Entry	Entry name	Protein names	Gene names	Organism	Length
Q22752	MLO7_ARATH	MLO-like protein 7	MLO7 NTA, At2g17430, F5J6.19	Arabidopsis thaliana (Mouse-ear cress)	542
O80961	MLO12_ARATH	MLO-like protein 12	MLO12 At2g39200, T16B24.16	Arabidopsis thaliana (Mouse-ear cress)	576
O49621	MLO1_ARATH	MLO-like protein 1	MLO1 MLO-H1, At4g02600, T10P11.12	Arabidopsis thaliana (Mouse-ear cress)	526
Q9SXB6	MLO2_ARATH	MLO-like protein 2	MLO2 At1g11310, T28P6.4	Arabidopsis thaliana (Mouse-ear cress)	573
Q94KB2	MLO13_ARATH	MLO-like protein 13	MLO13 At4g24250, T22A6.80	Arabidopsis thaliana (Mouse-ear cress)	478
Q94KB7	MLO6_ARATH	MLO-like protein 6	MLO6 At1g61560, T25B24.9	Arabidopsis thaliana (Mouse-ear cress)	583
Q94KB9	MLO3_ARATH	MLO-like protein 3	MLO3 At3g45290, F18N11.50	Arabidopsis thaliana (Mouse-ear cress)	508
O23693	MLO4_ARATH	MLO-like protein 4	MLO4 At1g11000, T19D16.26	Arabidopsis thaliana (Mouse-ear cress)	573
Q22757	MLO8_ARATH	MLO-like protein 8	MLO8 At2g17480, F5J6.21, MJB20.4	Arabidopsis thaliana (Mouse-ear cress)	593
Q94KB4	MLO9_ARATH	MLO-like protein 9	MLO9 At1g42560, F8D11.2, T8D8.5	Arabidopsis thaliana (Mouse-ear cress)	460
Q94KB1	MLO14_ARATH	MLO-like protein 14	MLO14 At1g26700, T24P13.8	Arabidopsis thaliana (Mouse-ear cress)	554
O80580	MLO15_ARATH	MLO-like protein 15	MLO15 At2g44110, F6E13.24	Arabidopsis thaliana (Mouse-ear cress)	496
Q9FI00	MLO11_ARATH	MLO-like protein 11	MLO11 At5g53760, MGN6.12	Arabidopsis thaliana (Mouse-ear cress)	573
O22815	MLO5_ARATH	MLO-like protein 5	MLO5 At2g33670, F4P9.44, T1B8.26	Arabidopsis thaliana (Mouse-ear cress)	501
Q9FKY5	MLO10_ARATH	MLO-like protein 10	MLO10 At5g65970, K2A18.3	Arabidopsis thaliana (Mouse-ear cress)	569

# 一、研究背景

The structure of barley *MLO*.



## 二、研究目的与意义



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### 研究目的

通过生物信息学方法初步筛选出甜瓜的感白粉病基因，再通过实验敲除筛选的目标基因，从而验证该基因的功能。

### 研究意义

通过生物信息学方法，缩小甜瓜感白粉病基因的筛选范围，提高后期实验敲除验证的可行性，为分子育种途径培育抗白粉病甜瓜品种奠定基础。

### 三、甜瓜和拟南芥 *MLO* 同源聚类分析

# 三、甜瓜和拟南芥 *MLO* 同源聚类分析

## 3.1 甜瓜和拟南芥 *MLO* 家族蛋白序列的获取

Entry	Entry name	Protein names	Gene names	Organism	Length
A0A1S3BJ31	A0A1S3BJ31_CUCME	MLO-like protein	LOC103490639 MLO	Cucumis melo (Muskmelon)	572
A0A1S3B2W6	A0A1S3B2W6_CUCME	MLO-like protein	LOC103485198 MLO	Cucumis melo (Muskmelon)	567
A0A1S3BJP0	A0A1S3BJP0_CUCME	MLO-like protein	LOC103490639 MLO	Cucumis melo (Muskmelon)	491
G7Z0K6	G7Z0K6_CUCME	MLO-like protein	LOC103489476 MLO, Mlo1	Cucumis melo (Muskmelon)	570
J9PC91	J9PC91_CUCME	MLO-like protein	LOC103499008 MLO, Mlo1	Cucumis melo (Muskmelon)	516
J9PC13	J9PC13_CUCME	MLO-like protein	MLO	Cucumis melo (Muskmelon)	487
A0A1S3CMI3	A0A1S3CMI3_CUCME	MLO-like protein	LOC103502614 MLO	Cucumis melo (Muskmelon)	542
A0A1S3AZK9	A0A1S3AZK9_CUCME	MLO-like protein	LOC103484488 MLO	Cucumis melo (Muskmelon)	545
A0A1S3CK02	A0A1S3CK02_CUCME	MLO-like protein	LOC103501836 MLO	Cucumis melo (Muskmelon)	580
A0A1S3BV19	A0A1S3BV19_CUCME	MLO-like protein	LOC103493493 MLO	Cucumis melo (Muskmelon)	568
A0A1S3CKB5	A0A1S3CKB5_CUCME	MLO-like protein	LOC103501936 MLO	Cucumis melo (Muskmelon)	592
A0A1S3C3K8	A0A1S3C3K8_CUCME	MLO-like protein	LOC103496098 MLO	Cucumis melo (Muskmelon)	556
A0A1S3BJW6	A0A1S3BJW6_CUCME	MLO-like protein	LOC103490688 MLO	Cucumis melo (Muskmelon)	540
A0A1S3CJV7	A0A1S3CJV7_CUCME	MLO-like protein	LOC103501783 MLO	Cucumis melo (Muskmelon)	585
A0A1S3C8N3	A0A1S3C8N3_CUCME	MLO-like protein	LOC103498051 MLO	Cucumis melo (Muskmelon)	553
A0A1S3BKJ6	A0A1S3BKJ6_CUCME	MLO-like protein	LOC103490688 MLO	Cucumis melo (Muskmelon)	539
A0A1S3BKT4	A0A1S3BKT4_CUCME	MLO-like protein	LOC103490688 MLO	Cucumis melo (Muskmelon)	528
A0A1S3JB4	A0A1S3JB4_CUCME	MLO-like protein	LOC103490688 MLO	Cucumis melo (Muskmelon)	474

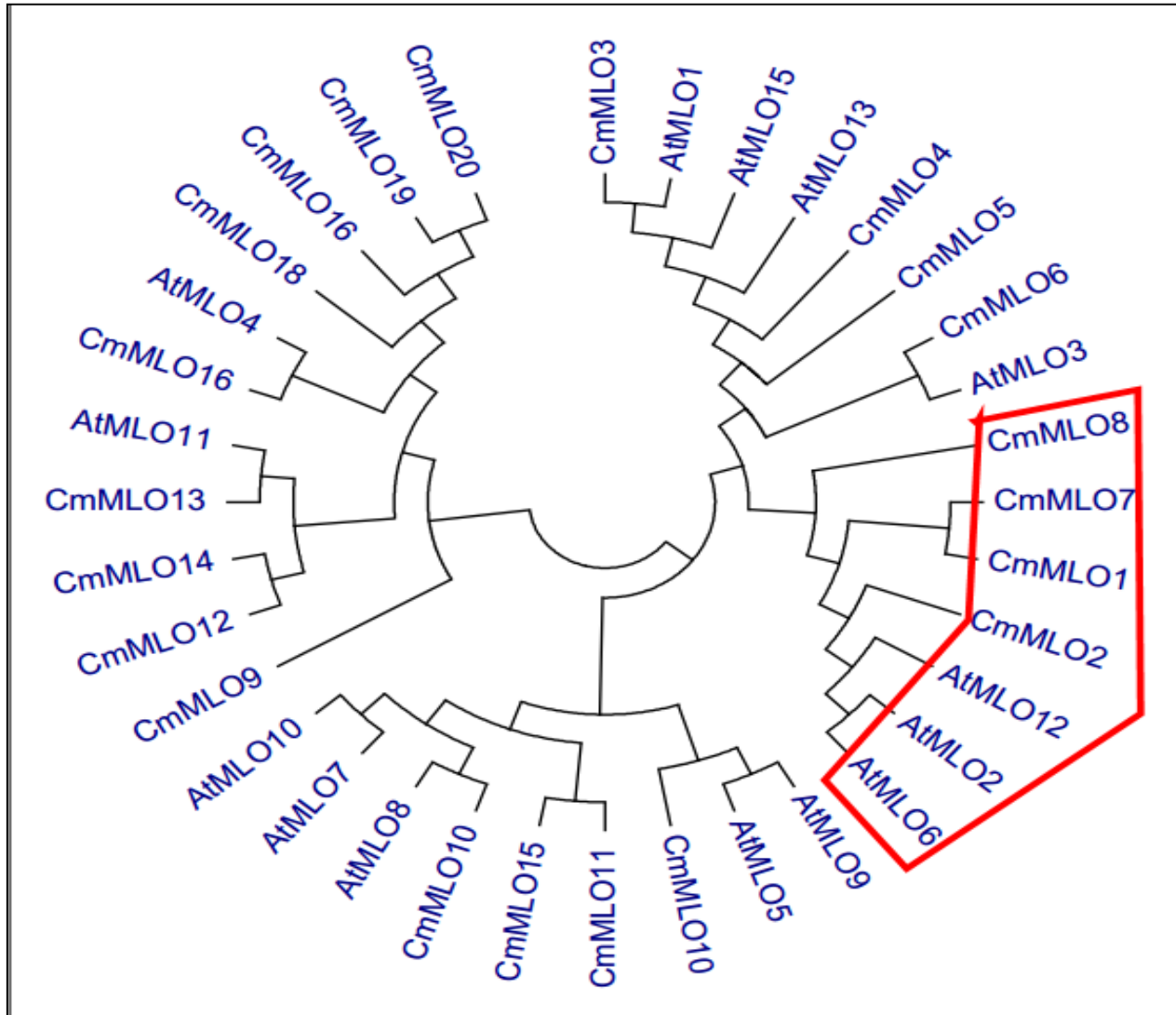
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# 三、甜瓜和拟南芥 *MLO* 同源聚类分析

## 3.2 利用 MEGA7 建分子系统发生树



## 四、不同作物感白粉病蛋白的 序列比对

## 四、不同作物感白粉病蛋白的序列比对

- 4.1 从 Uniprot 搜索蛋白序列

Species	MLO
<i>Arabidopsis thaliana</i>	<i>AtMLO2/ AtMLO6/AtMLO12</i>
<i>Solanum lycopersicum</i>	<i>SlMLO1</i>
<i>Capsicum Annuum</i>	<i>CaMLO2</i>
<i>Cucumis melo</i>	<i>CmMLO1/CmMLO2CmMLO7</i>

**Arabidopsis**



**Tomato**



**Pepper**









## 四、不同作物感白粉病蛋白的序列比对

- 4.3 *CmMLO1/CmMLO2/CmMLO7* 在重要位点的特异突变

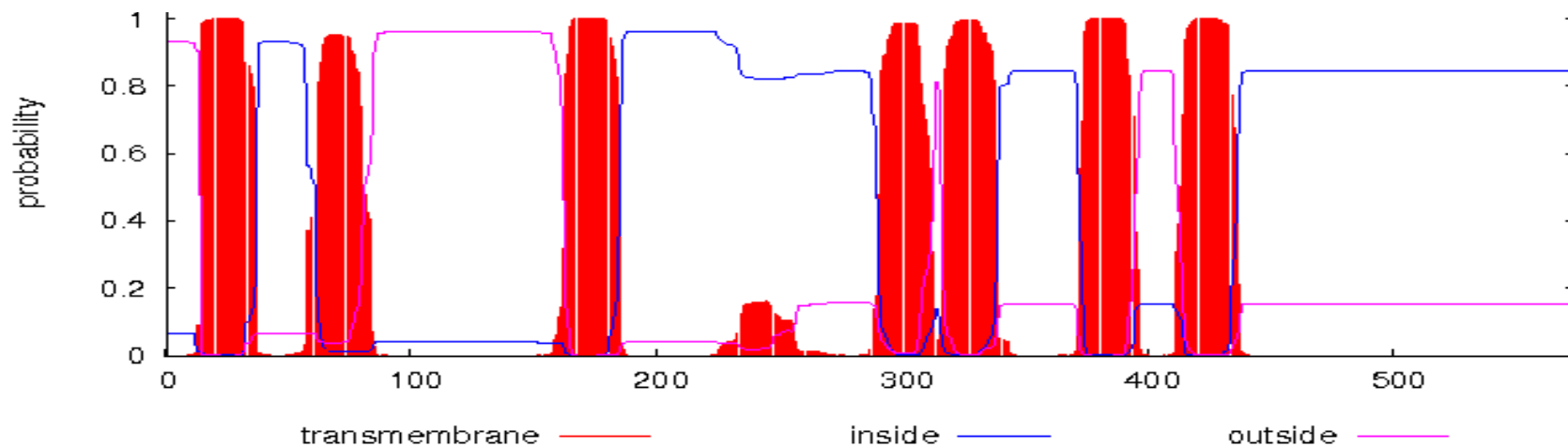
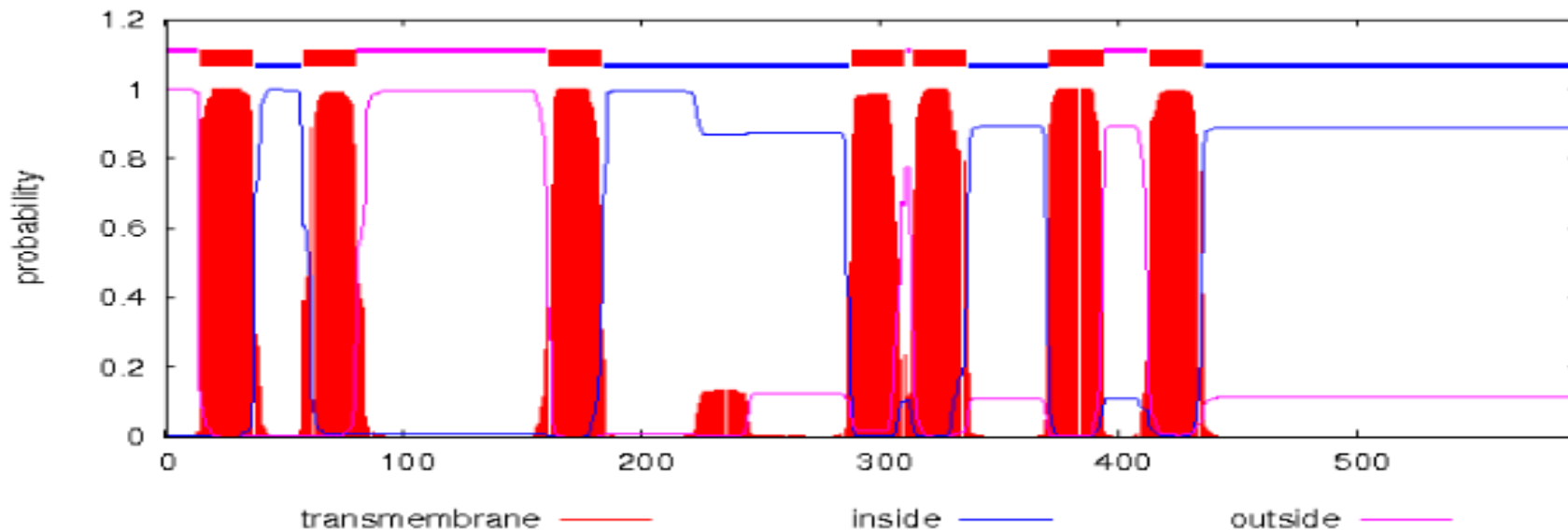
蛋白质	特异突变数目
<i>CmMLO1</i>	2
<i>CmMLO2</i>	11
<i>CmMLO7</i>	3

# 五、蛋白质结构分析

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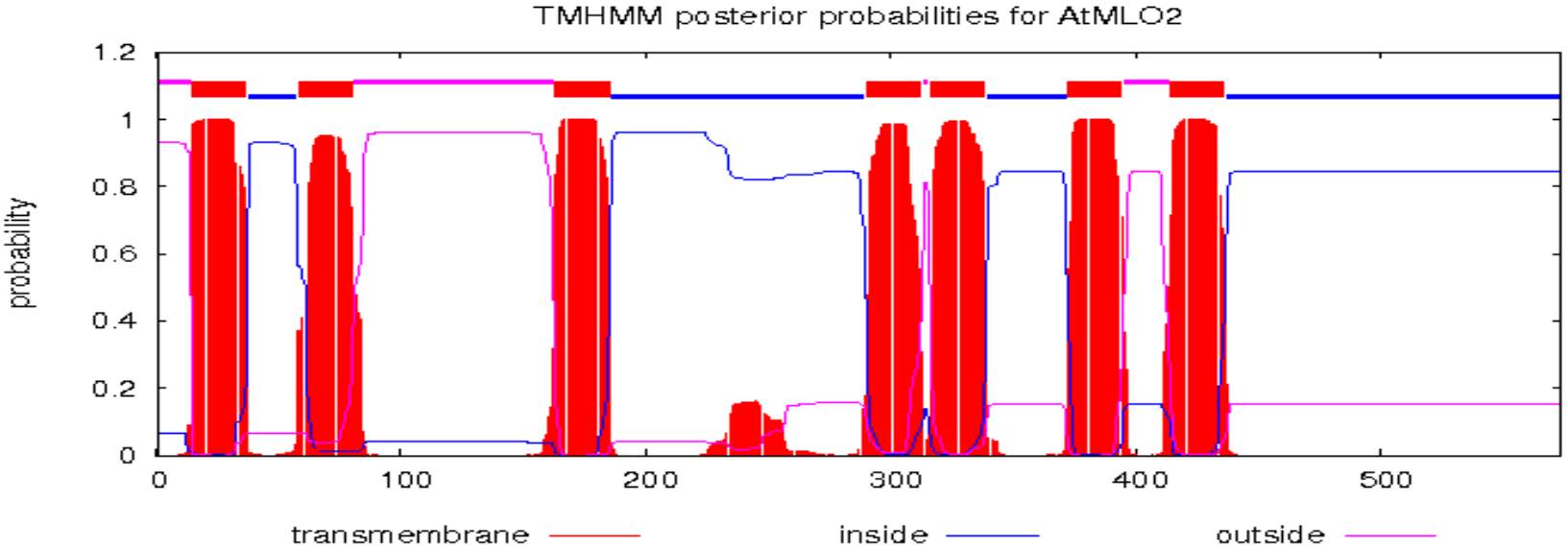
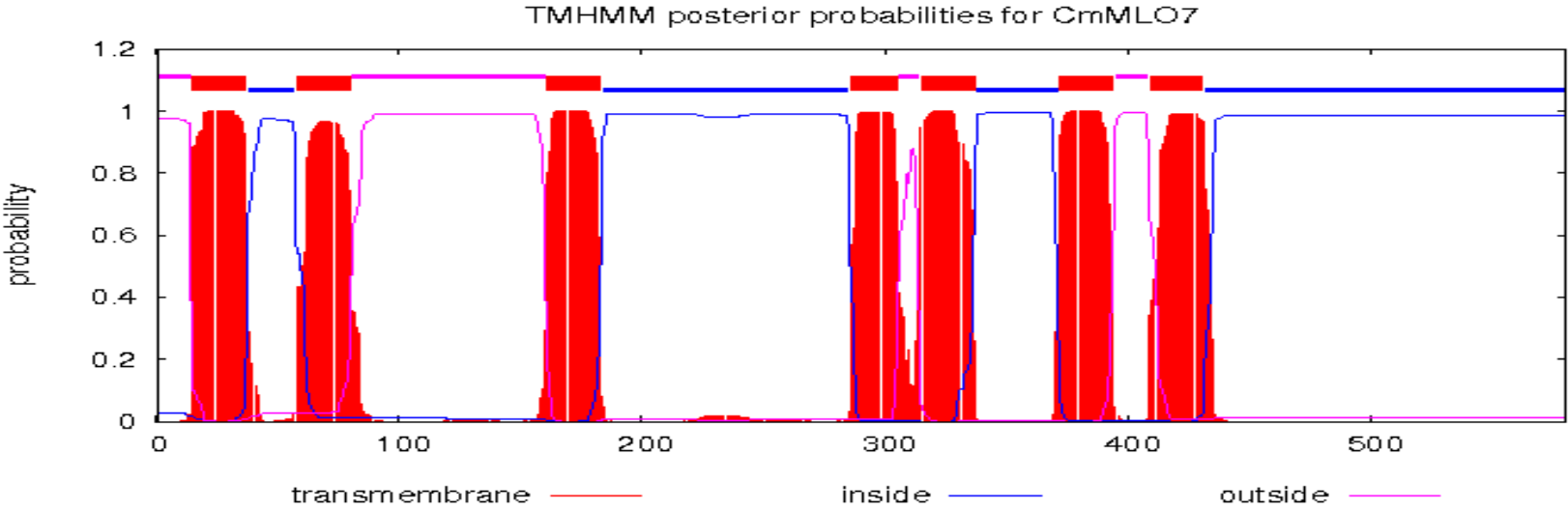
## 5.1 *CmMLO1* / *CmMLO2* 与 *AtMLO2* 跨膜结构预测与对比

TMHMM posterior probabilities for *CmMLO1*



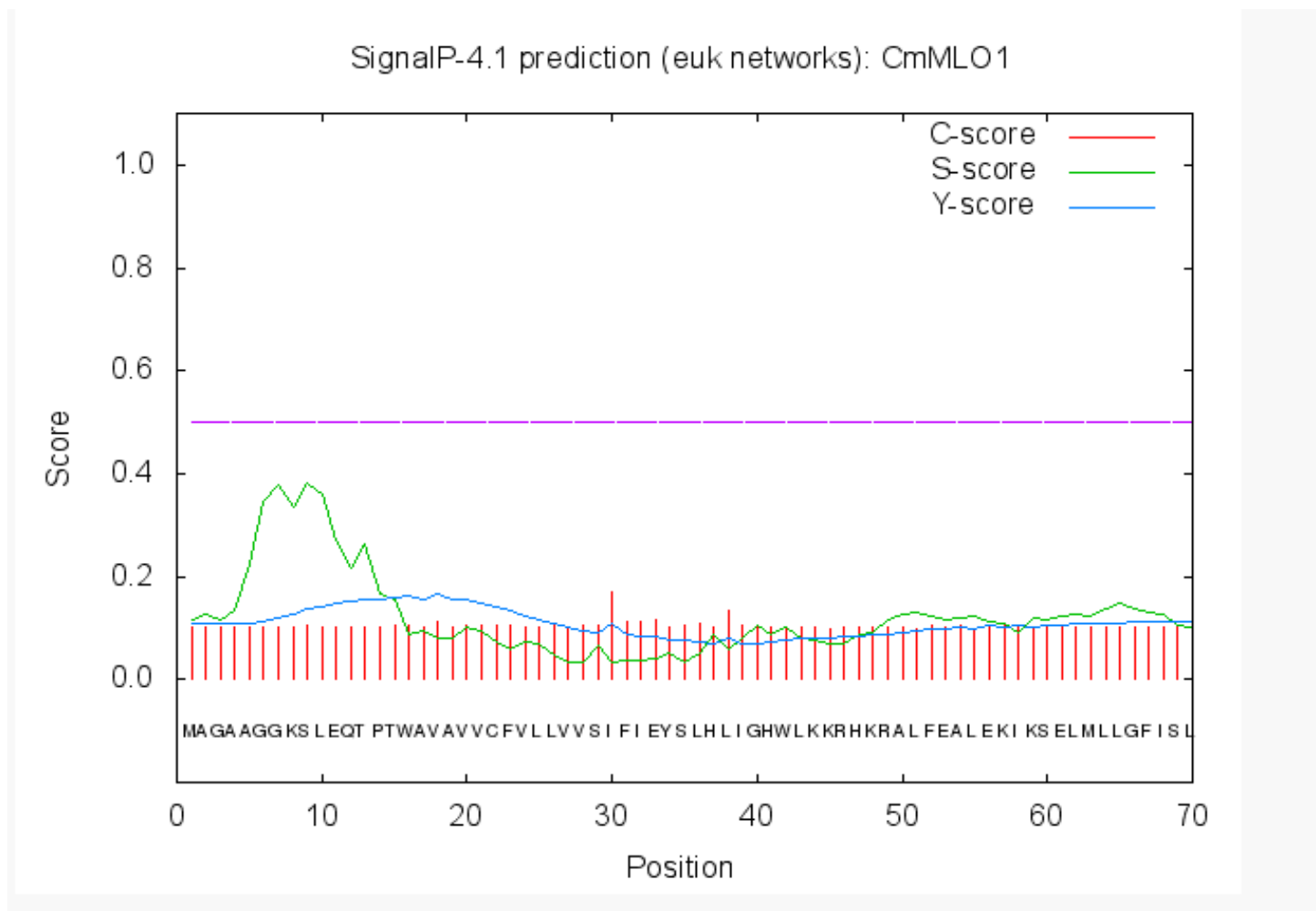
# 五、蛋白质结构分析

## 5.1 *CmMLO1 / CmMLO2* 与 *AtMLO2* 跨膜结构预测与对比



# 五、蛋白质结构分析

## 5.2 *CmMLO1* 的信号肽预测



# 六、总结

## 总结:

1、通过甜瓜和拟南芥 *MLO* 家族蛋白的同源聚类分析，从甜瓜 *MLO* 家族种筛选出 *CmMLO1*、*CmMLO2*、*CmMLO7* 作为甜瓜感白粉病候选基因。

1、通过拟南芥、番茄、辣椒的感白粉病蛋白与甜瓜 *CmMLO1*、*CmMLO2*、*CmMLO7* 的多序列比对，筛选出 *CmMLO1*、*CmMLO7* 作为甜瓜感白粉病候选基因。

3、通过 *CmMLO1* / *CmMLO2* 与 *AtMLO2* 的蛋白跨膜结构预测与对比，筛选出 *CmMLO1* 作为甜瓜感白粉病候选基因。



Thank You!