

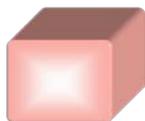
# 小麦抗白粉病基因的生物信息 学分析

**组号：G02**

**组员：徐晓丹 苑鹤 董捷 邵麟惠**

# 目 录

## 研究背景



## PM3蛋白的起源分析



## PM3A蛋白性质分析



## PM3A蛋白结构预测



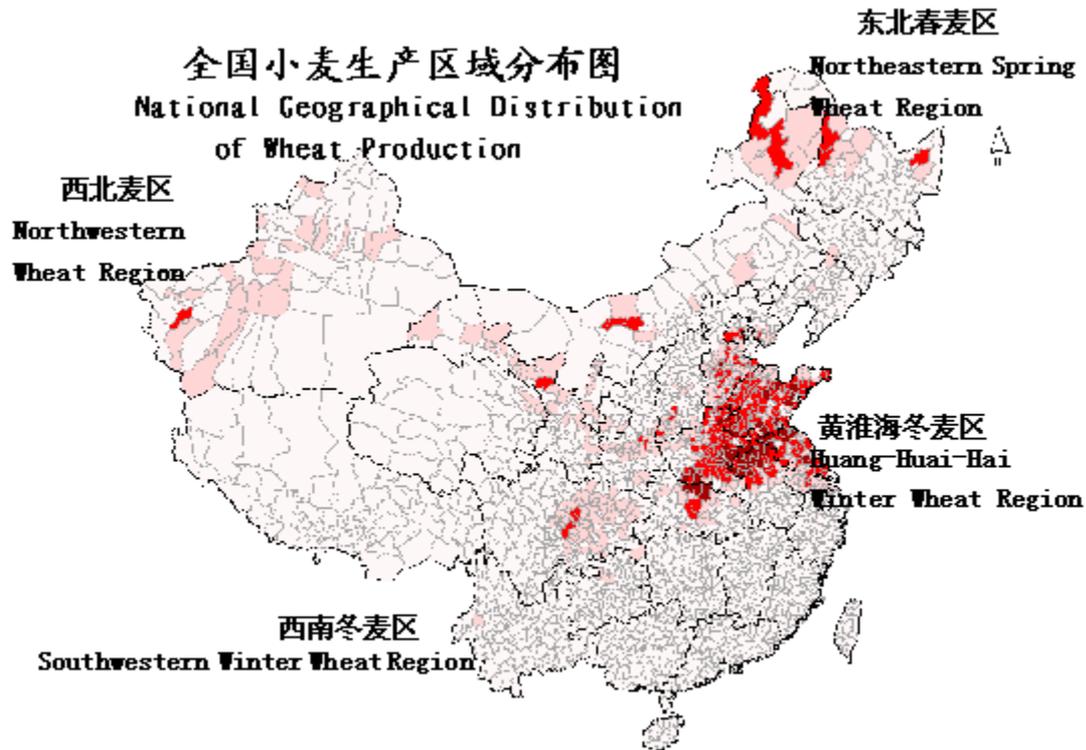
## 致 谢



# 研究背景



- 小麦年种植面积约2700万公顷，占粮食作物种植面积的27%
- 小麦年产1亿吨以上，占粮食作物产量的22%



# 小麦主要病害

抗病育种



photo by fuman

# 小麦抗白粉病基因研究方法

## 常规杂交分析方法

分离规律、独立分配规律应用

基因显隐性、数目、互作特点

核心抗源、鉴别寄主、农家品种、近等基因系

## 基因推导法

Flor (1955) -基因对基因假说

已广泛应用条锈病/叶锈病/白粉病

适用大量材料初步分析

生产品种、重要抗源材料

## 抗白粉病基因定位

分子标记

RFLP、AFLP、SSR

基因布局、分子标记辅助

已正式命名69个抗白粉病基因

## 小麦抗白粉病等位基因

**Pm1: 5个等位基因**

**Pm3: 10个等位基因**

**Pm4: 4个等位基因**

**Pm5: 5个等位基因**

**Pm24: 2个等位基因**

等位基因有何共同特点？起源如何？蛋白质在有什么共同性质？



Pm3的等位基因为例

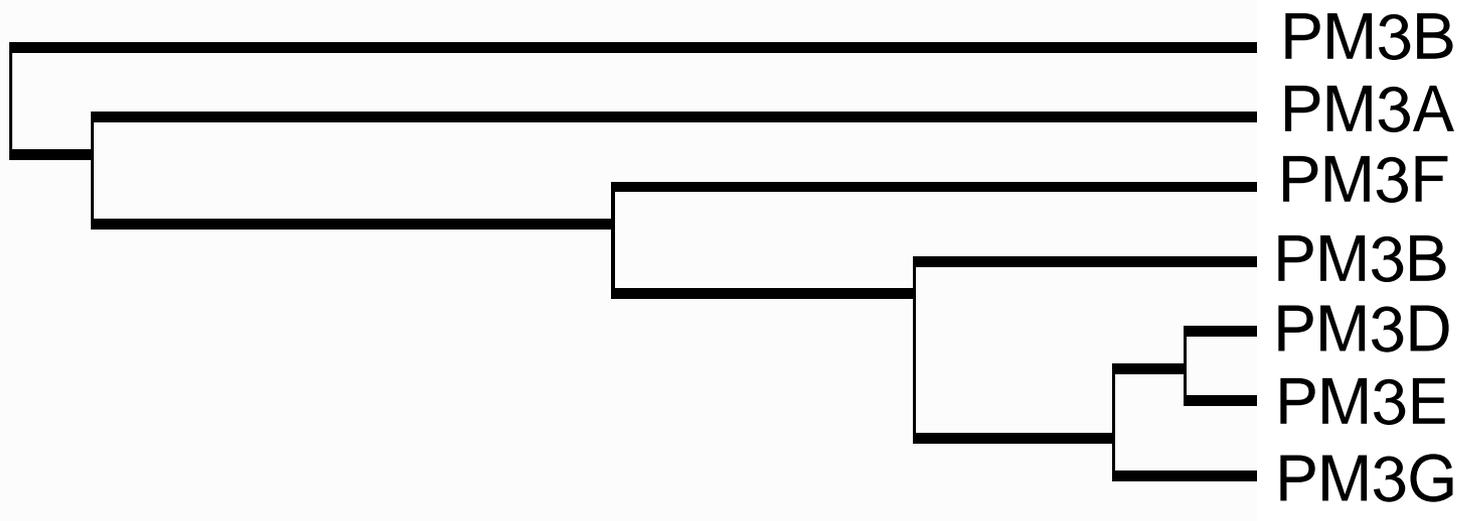
# PM3蛋白的起源分析



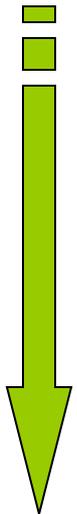
Uniprot搜索获得PM3A、PM3B、PM3C、PM3D、PM3E、  
PM3F、PM3G的7个蛋白

| Entry                  | Entry name   | Protein names                          | Organism                  | Gene names |
|------------------------|--------------|--|---------------------------|------------|
| <a href="#">Q38RI9</a> | Q38RI9_WHEAT | Powdery mildew resistance protein PM3F | Triticum aestivum (Wheat) | Pm3        |
| <a href="#">Q3B9Y3</a> | Q3B9Y3_WHEAT | Powdery mildew resistance protein PM3D | Triticum aestivum (Wheat) | Pm3        |
| <a href="#">Q3B9Y4</a> | Q3B9Y4_WHEAT | Powdery mildew resistance protein PM3A | Triticum aestivum (Wheat) | Pm3        |
| <a href="#">Q15J19</a> | Q15J19_WHEAT | Powdery mildew resistance protein PM3C | Triticum aestivum (Wheat) | Pm3        |
| <a href="#">Q15J18</a> | Q15J18_WHEAT | Powdery mildew resistance protein PM3E | Triticum aestivum (Wheat) | Pm3        |
| <a href="#">Q15J17</a> | Q15J17_WHEAT | Powdery mildew resistance protein PM3G | Triticum aestivum (Wheat) | Pm3        |
| <a href="#">Q6VUQ9</a> | Q6VUQ9_WHEAT | Powdery mildew resistance protein PM3b | Triticum aestivum (Wheat) | Pm3        |

UniProt在线比对



Identity:93.852%



# Emma多序列比对

## 部分保守序列

|              |        |     |   |     |     |     |     |      |     |     |   |     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------------|--------|-----|---|-----|-----|-----|-----|------|-----|-----|---|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q3B9Y3_WHEAT | MAERVV | MAI | G | PLV | SML | KDK | ASS | YLLD | QYK | VME | G | MEE | Q | H | K | I | L | K | R | K | L | P | A | I | L | D | V | I | T | D | V | E | E | Q | A |
| Q15J17_WHEAT | MAERVV | MAI | G | PLV | SML | KDK | ASS | YLLD | QYK | VME | G | MEE | Q | H | K | I | L | K | R | K | L | P | A | I | L | D | V | I | T | D | V | E | E | Q | A |
| Q15J18_WHEAT | MAERVV | MAI | G | PLV | SML | KDK | ASS | YLLD | QYK | VME | G | MEE | Q | H | K | I | L | K | R | K | L | P | A | I | L | D | V | I | T | D | V | E | E | Q | A |
| Q15J19_WHEAT | MAERVV | MAI | G | PLV | SML | KDK | ASS | YLLD | QYK | VME | G | MEE | Q | H | K | I | L | K | R | K | L | P | A | I | L | D | V | I | T | D | V | E | E | Q | A |
| Q38RI9_WHEAT | MAERVV | MAI | G | PLV | SML | KDK | ASS | YLLD | QYK | VME | G | MEE | Q | H | K | I | L | K | R | K | L | P | A | I | L | D | V | I | T | D | V | E | E | Q | A |
| Q3B9Y4_WHEAT | MAERVV | MAI | G | PLV | SML | KDK | ASS | YLLD | QYK | VME | G | MEE | Q | H | K | I | L | K | R | K | L | P | A | I | L | D | V | I | T | D | V | E | E | Q | A |
| Q6VUQ9_WHEAT | MAERVV | MAI | G | PLV | SML | KDK | ASS | YLLD | QYK | VME | G | MEE | Q | H | K | I | L | K | R | K | L | P | A | I | L | D | V | I | T | D | V | E | E | Q | A |

## 部分差异序列

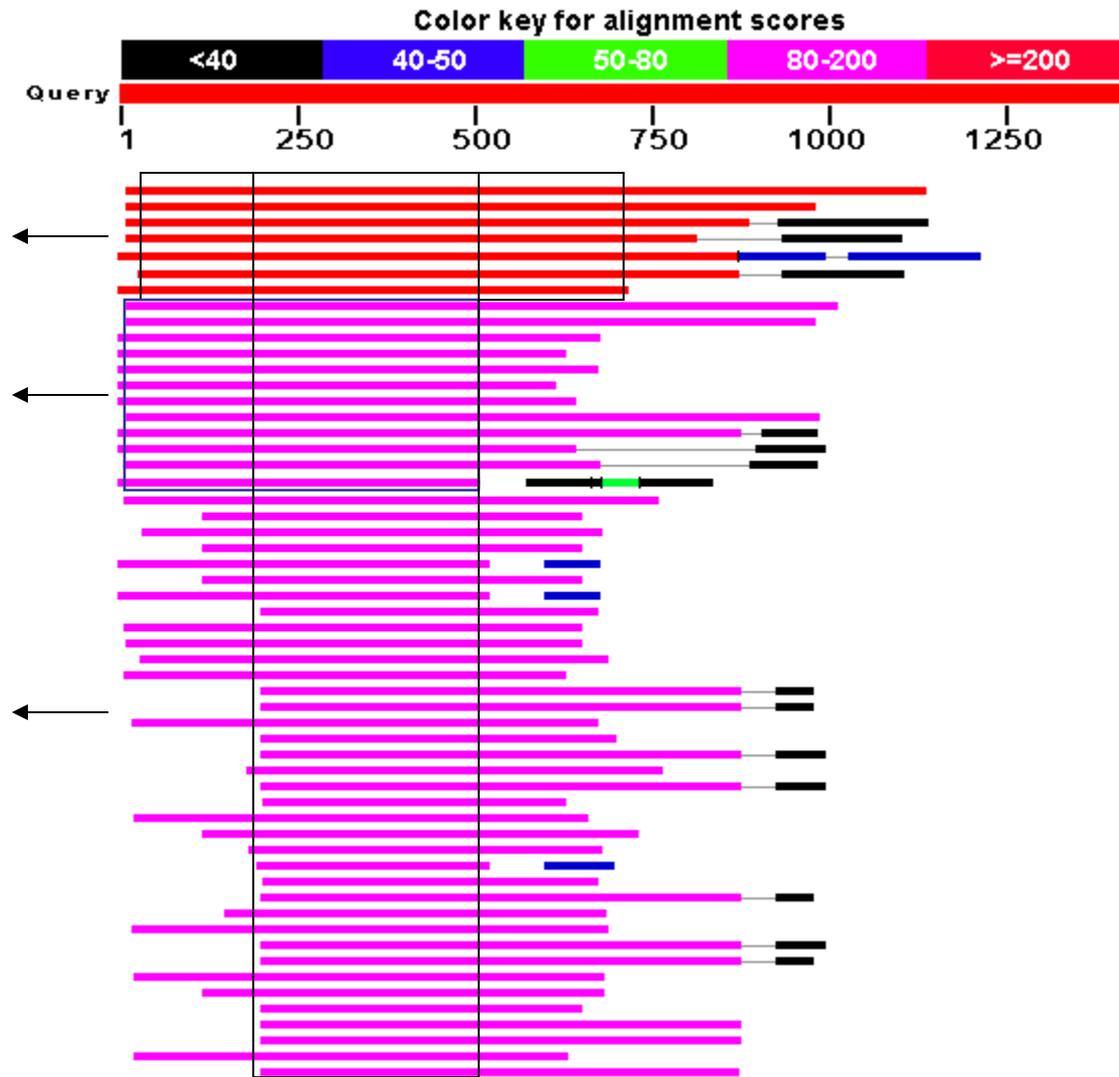
|              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q3B9Y3_WHEAT | H | H | L | R | Y | L | D | L | S | E | S | I | K | A | L | P | E | D | I | S | I | L | N | L | Q | V | L | D | L | S | Y | C | N | Y | L | D | R | L | P | R | Q | M | K | Y | M | T | S | L | C | H | L | Y | T | H | G | W | N |   |
| Q15J17_WHEAT | H | H | L | R | Y | L | D | L | S | E | S | I | K | A | L | P | E | D | I | S | I | L | N | L | Q | V | L | D | L | S | Y | C | N | Y | L | D | R | L | P | R | Q | M | K | Y | M | T | S | L | C | H | L | Y | T | H | G | R | N |   |
| Q15J18_WHEAT | H | H | L | R | Y | L | D | L | S | E | S | I | K | A | L | P | E | D | I | S | I | L | N | L | Q | V | L | D | L | S | Y | C | N | Y | L | D | R | L | P | R | Q | M | K | Y | M | T | S | L | C | H | L | Y | T | H | G | W | N |   |
| Q15J19_WHEAT | H | H | L | R | Y | L | D | L | S | E | S | I | K | A | L | P | E | D | I | S | I | L | N | L | Q | V | L | D | V | S | N | G | R | S | L | E | R | L | P | R | Q | M | K | Y | M | T | S | L | C | H | L | Y | T | H | G | S | K |   |
| Q38RI9_WHEAT | H | H | L | R | Y | L | D | L | S | E | S | R | M | K | A | L | P | E | D | I | S | I | L | N | L | Q | V | L | D | L | S | Y | C | N | Y | L | D | R | L | P | R | Q | M | K | Y | M | T | S | L | C | H | L | Y | T | H | G | R | N |
| Q3B9Y4_WHEAT | H | H | L | R | Y | L | D | L | S | E | S | R | M | K | A | L | P | E | D | I | S | I | L | N | L | Q | V | L | D | L | S | Y | C | N | Y | L | D | R | L | P | R | Q | M | K | Y | M | T | S | L | C | H | L | Y | T | H | G | R | N |
| Q6VUQ9_WHEAT | H | H | L | R | Y | L | D | L | S | E | S | I | K | A | L | P | E | D | I | S | I | L | N | L | Q | V | L | D | L | S | Y | C | N | Y | L | D | R | L | P | R | Q | M | K | Y | M | T | S | L | C | H | L | Y | T | H | G | R | N |   |

保守区域非常大：保守区域1-300aa,960-1080aa,1160-1320aa。  
PM3蛋白？小麦上抗白粉蛋白？近缘物种所抗白粉蛋白？



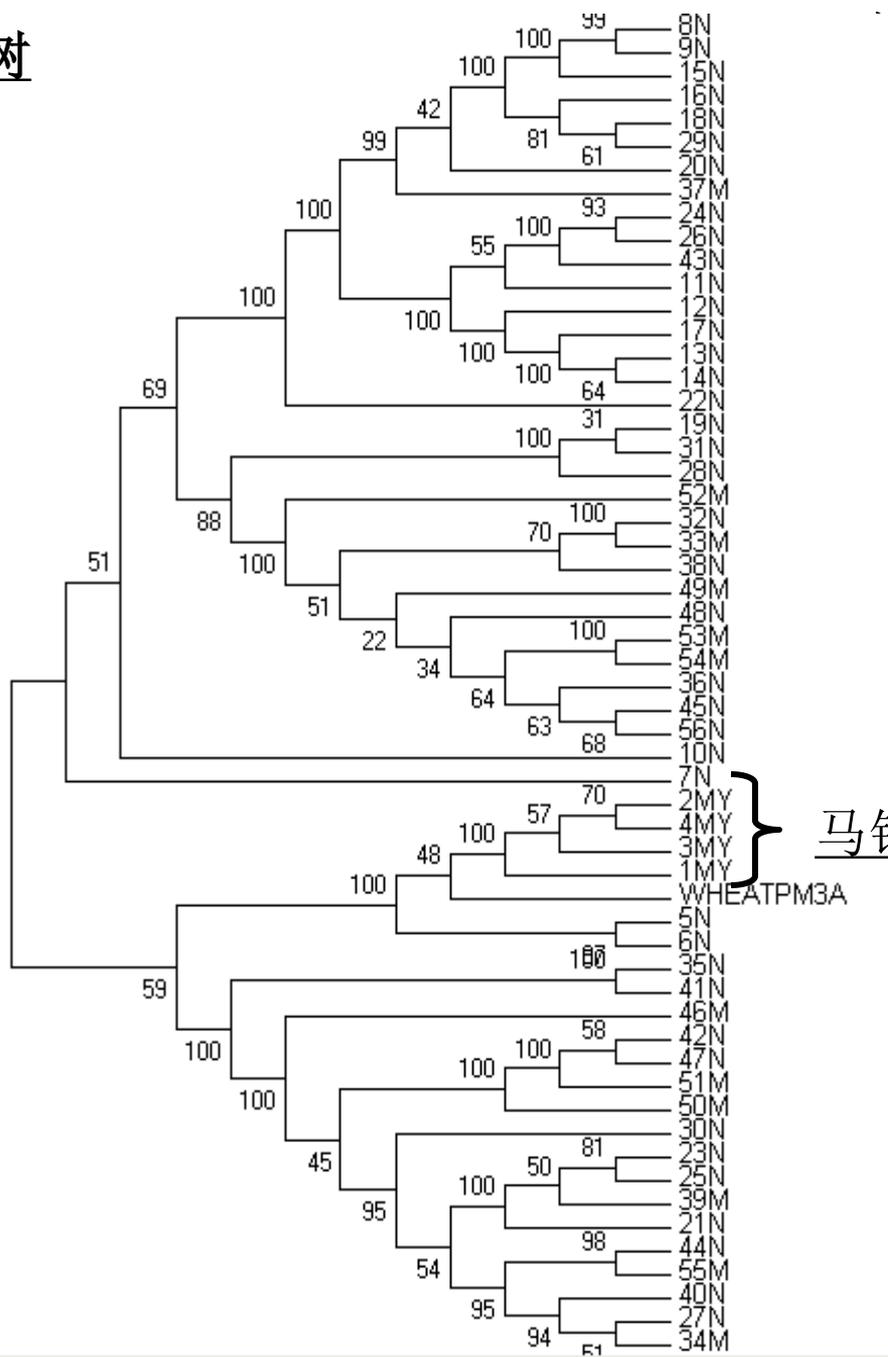
选蛋白PM3A分别与小麦抗白粉蛋白近缘物种蛋白  
比对分析

# Uniprot未搜索到除PM3A蛋白外的小麦抗白粉蛋白 NCBI /BLAST/blastp: PM3A蛋白



搜索到56条蛋白序列

# Mega构建进化树



马铃薯野生种

# PM3A蛋白的性质分析



# Expasy ProtParam tool 蛋白进行理化性质分析

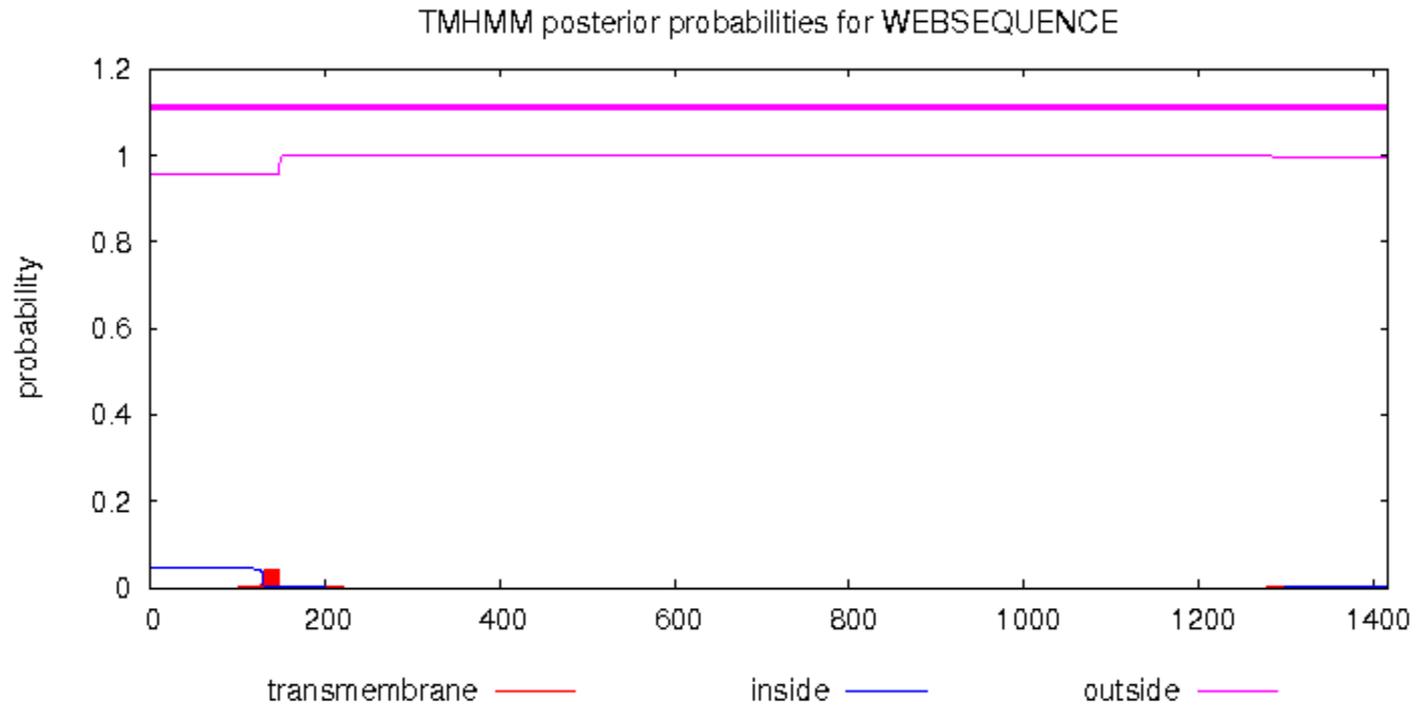
|             |                   |
|-------------|-------------------|
| PM3A-1415aa |                   |
| Ala (A) 86  | 6.10%             |
| Arg (R) 71  | 5.00%             |
| Asn (N) 44  | 3.10%             |
| Asp (D) 62  | 4.40%             |
| Cys (C) 46  | 3.30%             |
| Gln (Q) 52  | 3.70%             |
| Glu (E) 124 | 8.80%             |
| Gly (G) 70  | 4.90%             |
| His (H) 35  | 2.50%             |
| Ile (I) 67  | 4.70%             |
| Leu (L) 201 | 14.20%            |
| Lys (K) 98  | 6.90%             |
| Met (M) 33  | 2.30%             |
| Phe (F) 45  | 3.20%             |
| Pro (P) 77  | 5.40%             |
| Ser (S) 99  | 7.00%             |
| Thr (T) 59  | 4.20%             |
| Trp (W) 20  | 1.40%             |
| Tyr (Y) 33  | 2.30%             |
| Val (V) 93  | 6.60%             |
| Pyl (O) 0   | 0.00%             |
| Sec (U) 0   | 0.00%             |
| 负电荷残基数      | (Asp + Glu) : 186 |
| 正电荷残基数      | (Arg + Lys) : 169 |

← 谷氨酸（酸性氨基酸类、亲水、极性）

← 亮氨酸（脂肪族类、疏水、非极性）

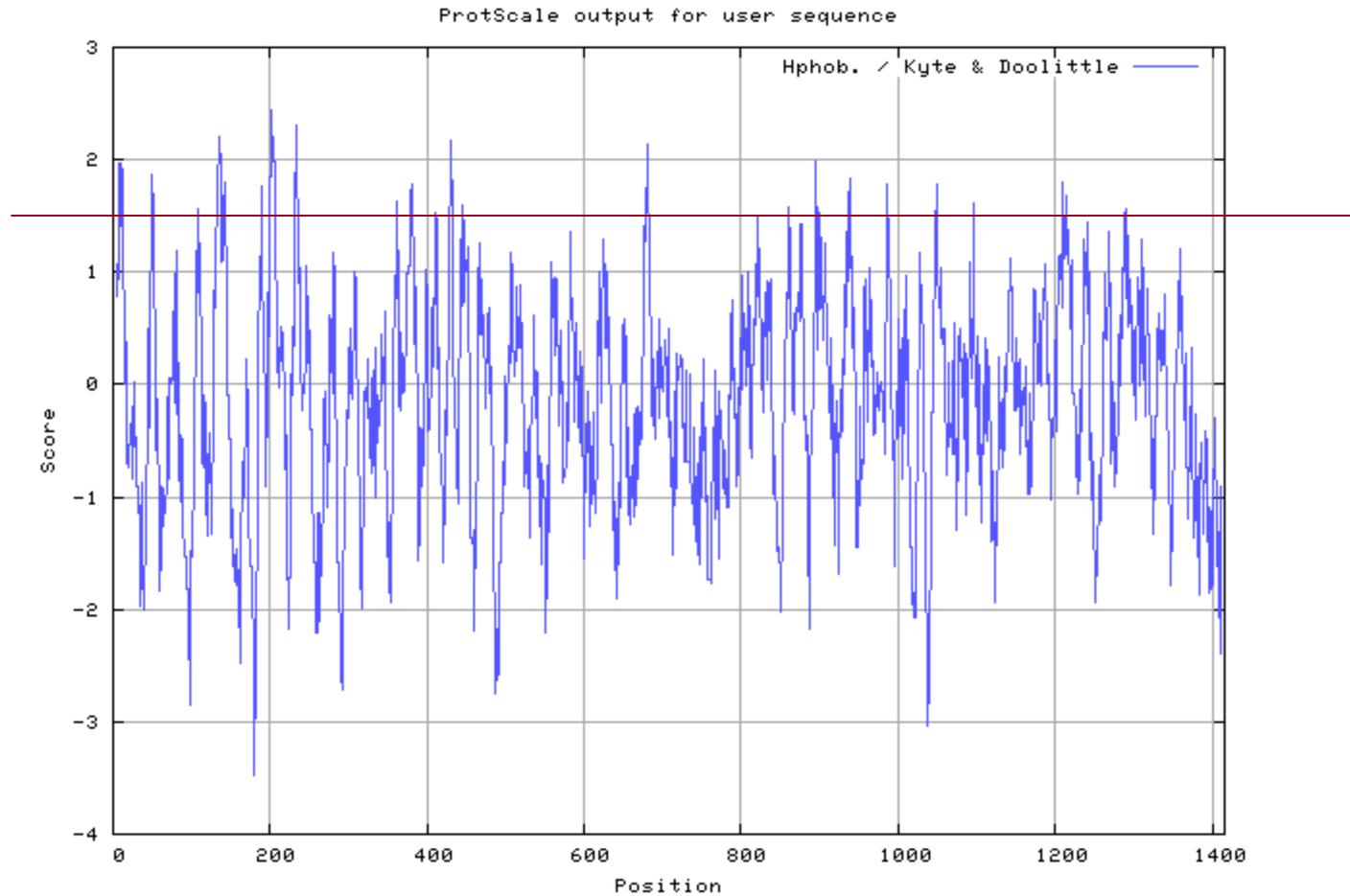
← 丝氨酸（羟基类、亲水、极性）

# TMHMM跨膜结构预测



无跨膜结构

# ProtScale亲疏水性分析



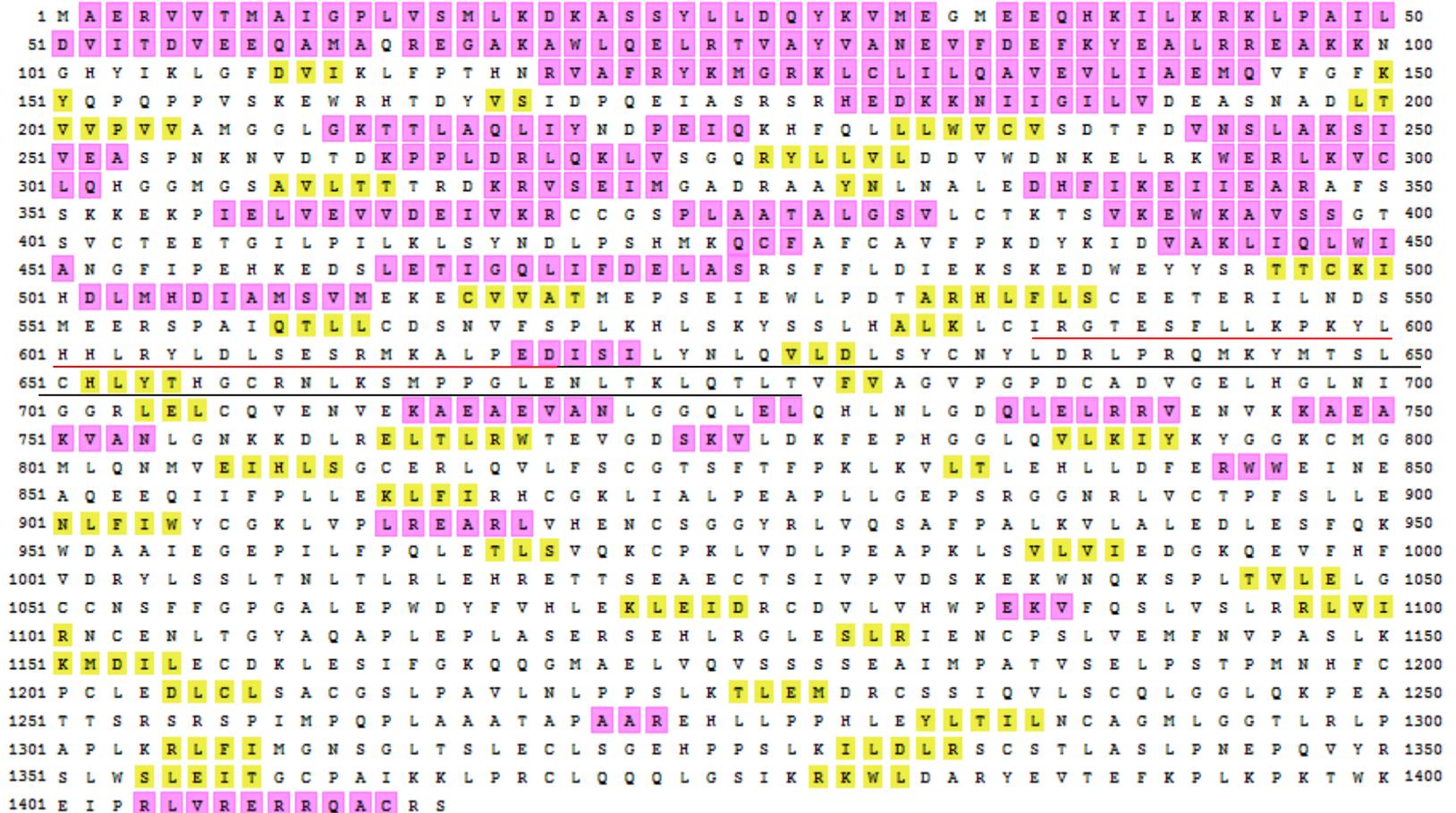
# PM3A蛋白结构预测



# PM3A蛋白二级结构预测 (Bioinformatics Group)

## Secondary Structure Map

Feature predictions are colour coded onto the sequence according to the sequence feature key shown below.



Key

Helix

Sheet

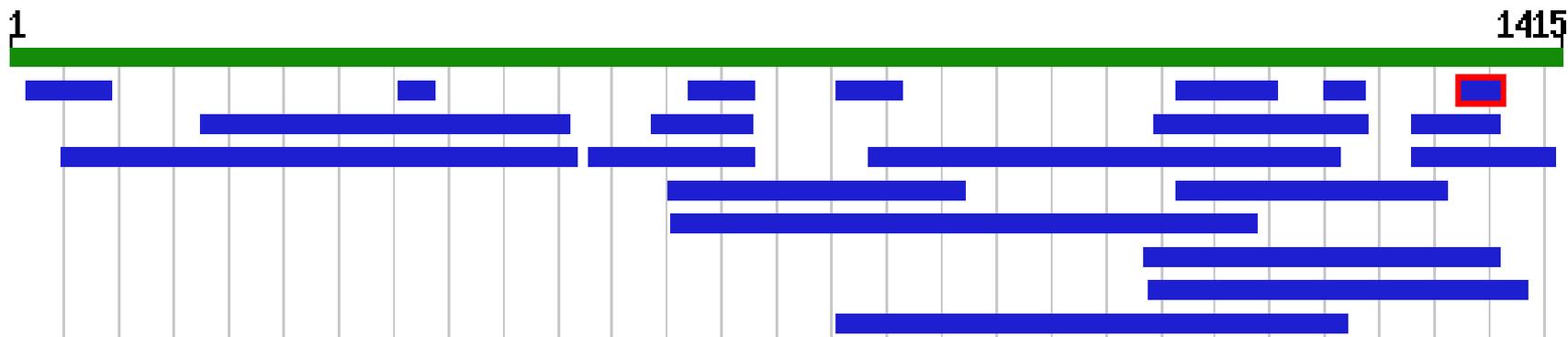
Annotations

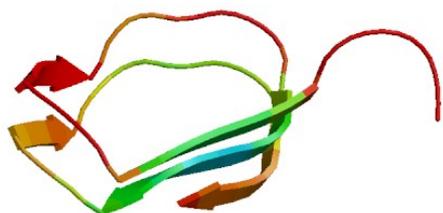
M

L

# PM3A蛋白三级结构预测（SWISS-MODEL）

Workunit: P000001 PM3A - Overview



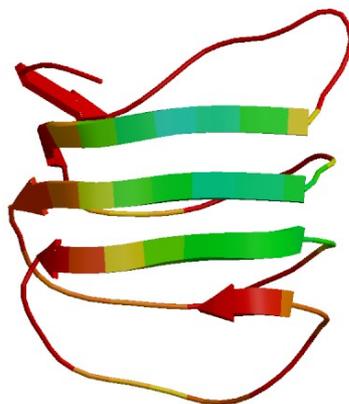
**Model information:**

Modelled residue range: 620 to 678  
Based on template: [1ogqA]\* (1.70 Å)  
Sequence Identity [%]: 30.65  
Evalue: 1.40e-10

**Quality information:**

QMEAN Z-Score: -1.58

[details]\*

**Model information:**

Modelled residue range: 586 to 677  
Based on template: [2o6sB]\* (1.50 Å)  
Sequence Identity [%]: 30.53  
Evalue: 1.20e-9

**Quality information:**

QMEAN Z-Score: -2.67

[details]\*



# 参考文献

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- Zeller FJ, Hsam SLK (1998). Progress in breeding for resistance to powdery mildew in common wheat (*Triticum aestivum* L.). pp. 178-180. In Slinkard, A. E. (ed). *Proceedings of the 9th International Wheat Genetics Symposium*. Vol.1. University of Saskatchewan, Saskatoon, Canada
- Rapid generation of new powdery mildew resistance genes after wheat domestication. Yahiaoui N., Brunner S., Keller B. *Plant J*. 47:85-98(2006)
- Genome analysis at different ploidy levels allows cloning of the powdery mildew resistance gene Pm3b from hexaploid wheat. Yahiaoui N., Srichumpa P., Dudler R., Keller B. *Plant J*. 37:528-538(2004)
- Allelic series of four powdery mildew resistance genes at the Pm3 locus in hexaploid bread wheat. Srichumpa P., Brunner S., Keller B., Yahiaoui N. *Plant Physiol*. 139:885-895(2005)



谢谢罗老师!

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