



# 利用生物信息学分析枯草芽孢杆菌 淀粉样蛋白TasA

**Analysis of Amyloid Protein TasA in *Bacillus subtilis*  
with Bioinformatics**

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# 目录

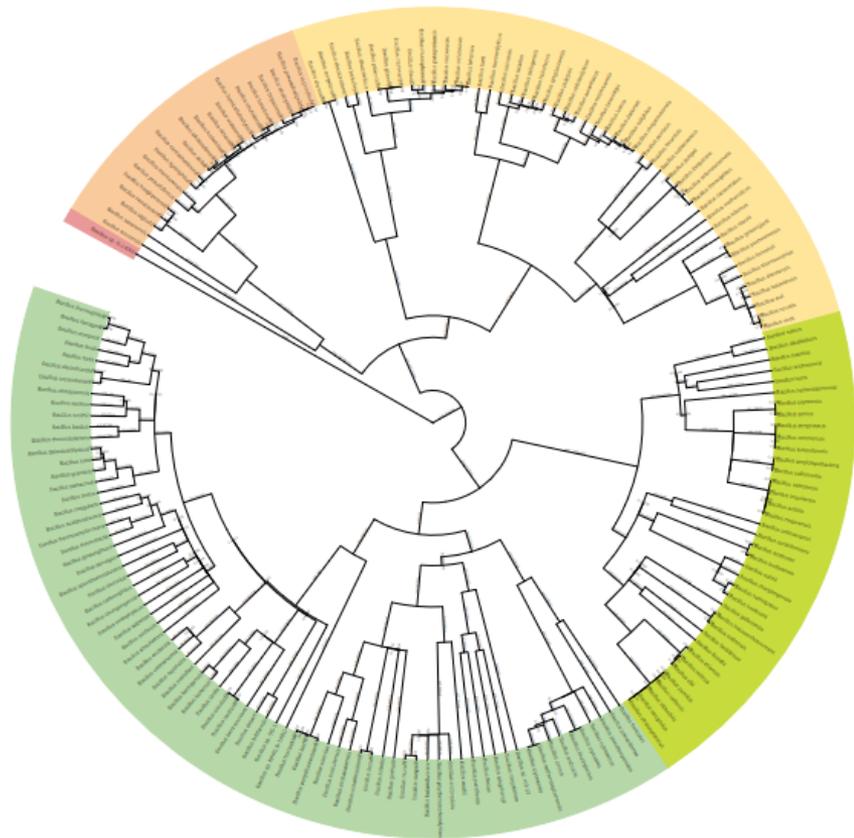
- 1. 研究背景**
- 2. TasA结构分析**
- 3. TasA活性位点预测**
- 4. 结论**



# 1. 研究背景

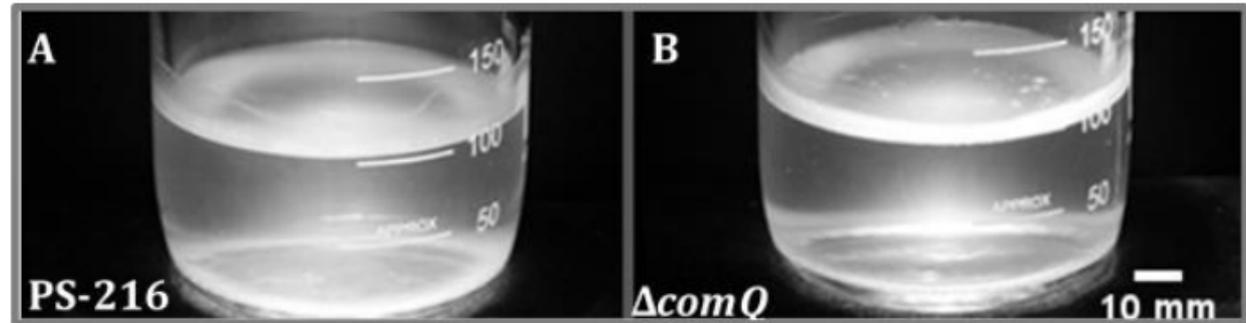
## 1.1 枯草芽孢杆菌

# 枯草芽孢杆菌 *B. subtilis*



细胞生物 → 细菌 → 厚壁菌门 → 杆菌纲 → 芽孢杆菌目  
→ 芽孢杆菌属 → 芽孢杆菌科 → 枯草芽孢杆菌

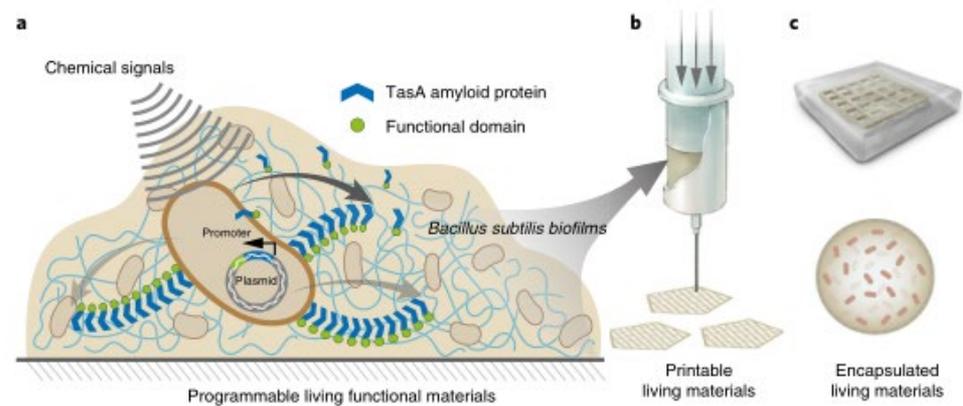
## 1.2 生物膜



枯草芽孢杆菌 *B. subtilis* 作为一种有拮抗作用的生防菌，可以在土壤和空气间产生一层膜状结构，即**生物膜 (Biofilm)**。生物膜有帮助芽孢杆菌在土壤表面和植物根际定殖的作用，进而帮助植物抵御病原菌侵染。

# 1.3 生物膜结构功能

作用：  
 提供附着力，粘合剂，  
 内聚力，结构完整性，  
 保护屏障，酶活性，电  
 子供体/受体



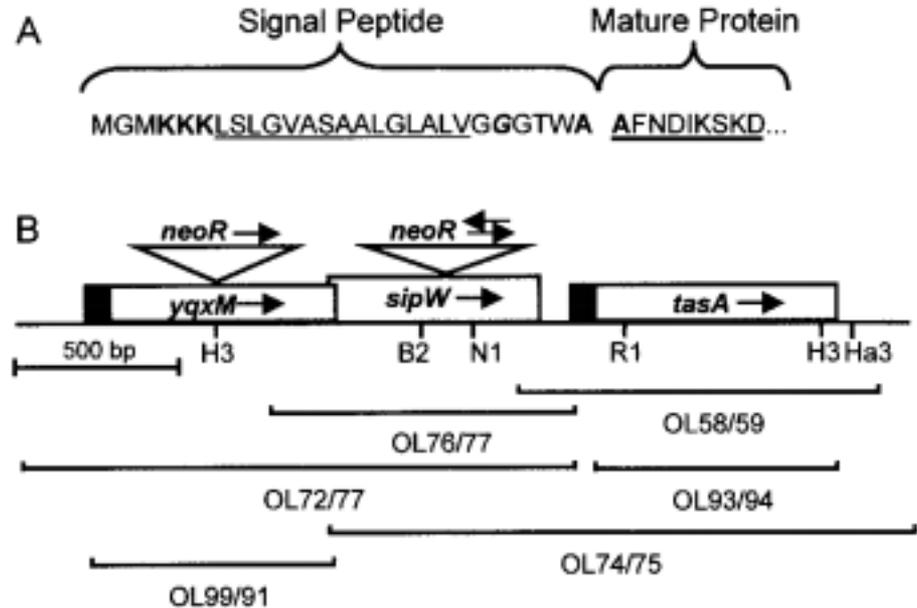
Biofilms → Polysaccharides 多糖  
 Proteins 蛋白质  
 Extracellular DNA 胞外DNA



Microbial Communities(QS)  
 Secretion System  
 Antibacterial Effect

# 1.4 TasA操纵子

TasA是淀粉样蛋白amyloid-like proteins (ALPs)，由细菌分泌系统T5SS产生。T5SS系统分泌蛋白前半部分为信号肽，后半部分为成熟蛋白。有T5SS分泌系统的细菌多为G<sup>-</sup>，但*B.subtilis* spp.为G<sup>+</sup>。



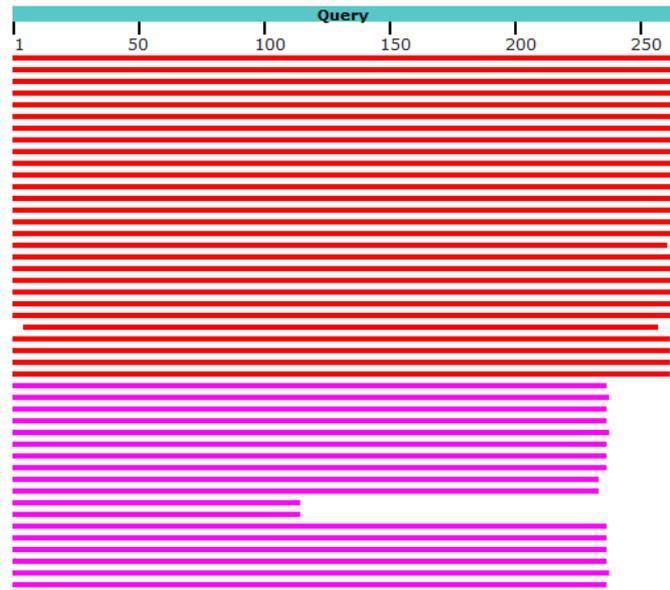
**TasA operon: sipW-tasA-tapA**



## 2. TasA结构分析

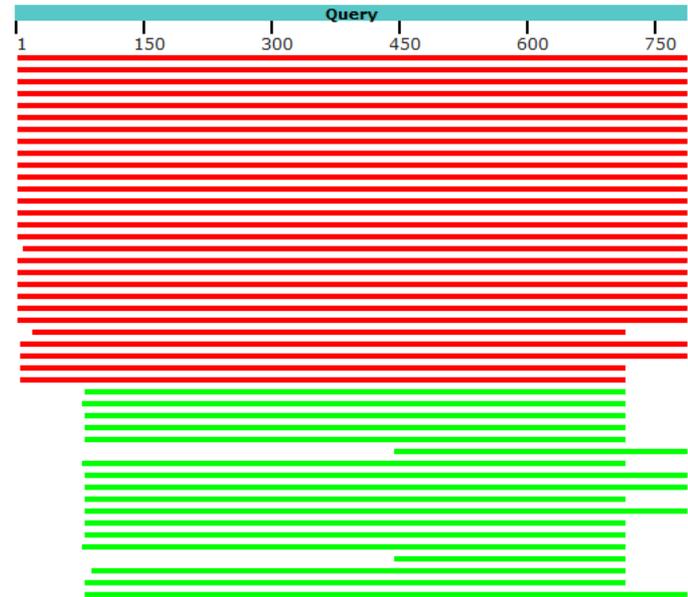
## 2.1 TasA序列比对

Distribution of the top 46 Blast Hits on 46 subject sequences



Blastp

Distribution of the top 46 Blast Hits on 46 subject sequences

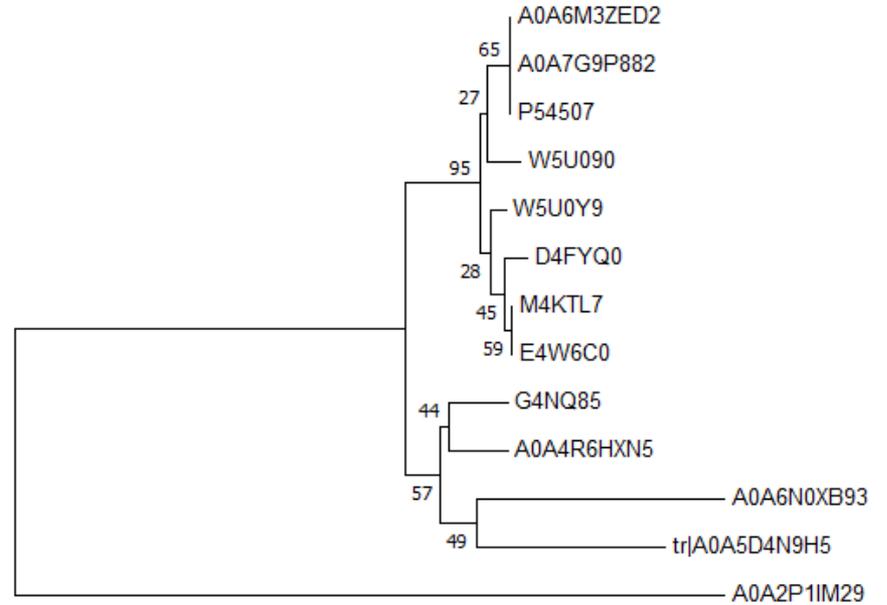


Blastx



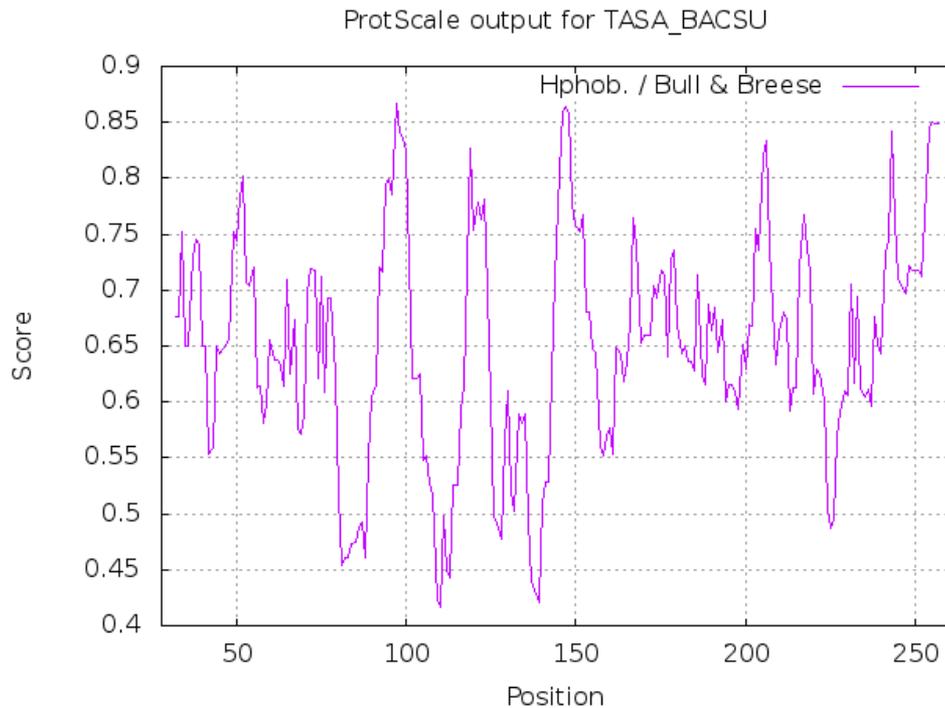
## 2.2 构建系统进化树

序号	Bacillus subtilis直系同源蛋白登录号
1	P54507
2	G4NQ85
3	M4KTL7
4	D4FYQ0
5	E4W6C0
6	A0A6M3ZED2
7	W5U0Y9
8	A0A4R6HXN5
9	A0A6N0XB93
10	A0A5D4N9H5
11	W5U090
12	A0A7G9P882
13	A0A2P1IM29



## 2.3 TasA蛋白质分析

### TasA亲疏水性分析

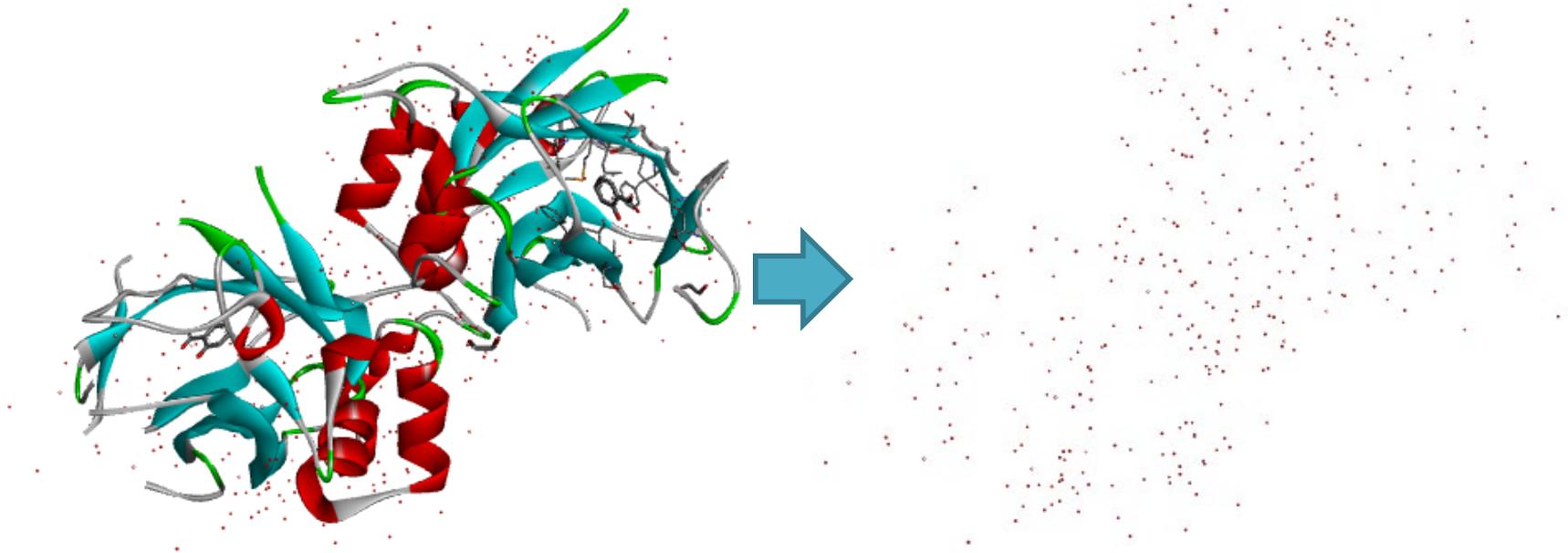


亲疏水性：有的部分亲水性较好，有的部分亲水性较差。

原因：大部分生物膜生长的在水和空气的交界面。

## 2.3 TasA蛋白质分析

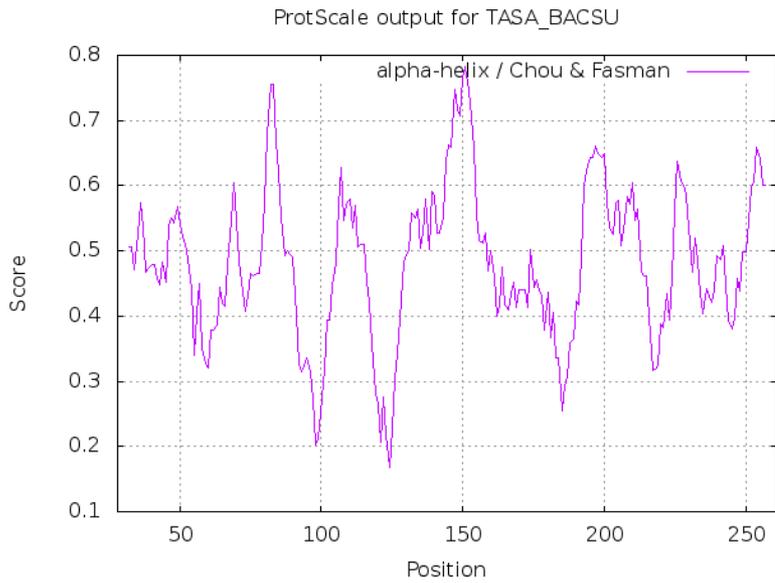
TasA疏水性分析：TasA中包裹许多水分子，亲水性较好



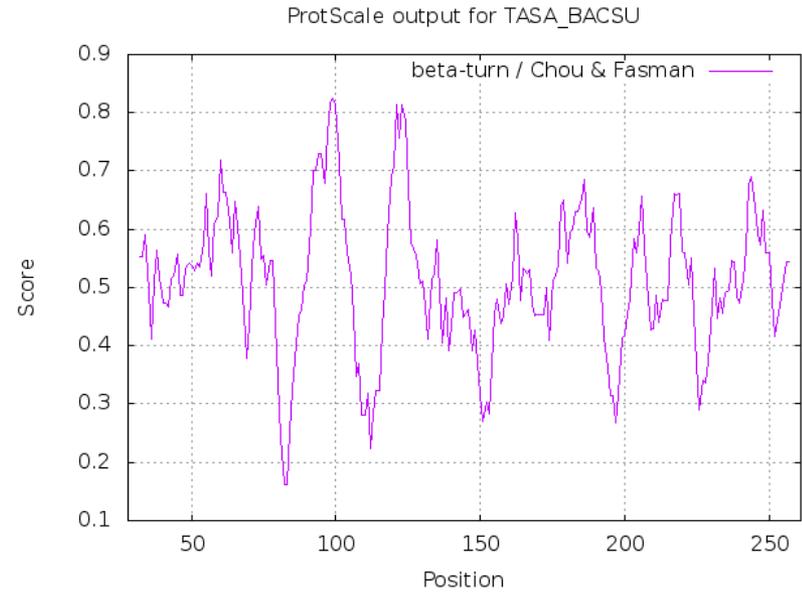
Water

## 2.3 TasA蛋白质分析

## TasA二级结构分析



$\alpha$ -螺旋



$\beta$ -折叠

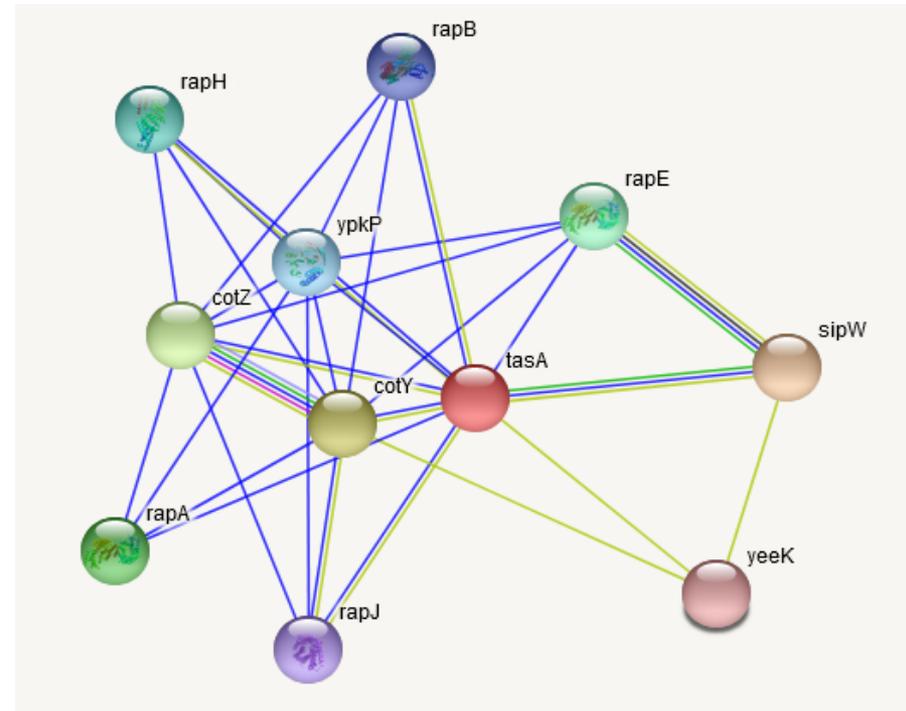


### 3. TasA活性位点预测

# 3.1 TasA已知互作蛋白

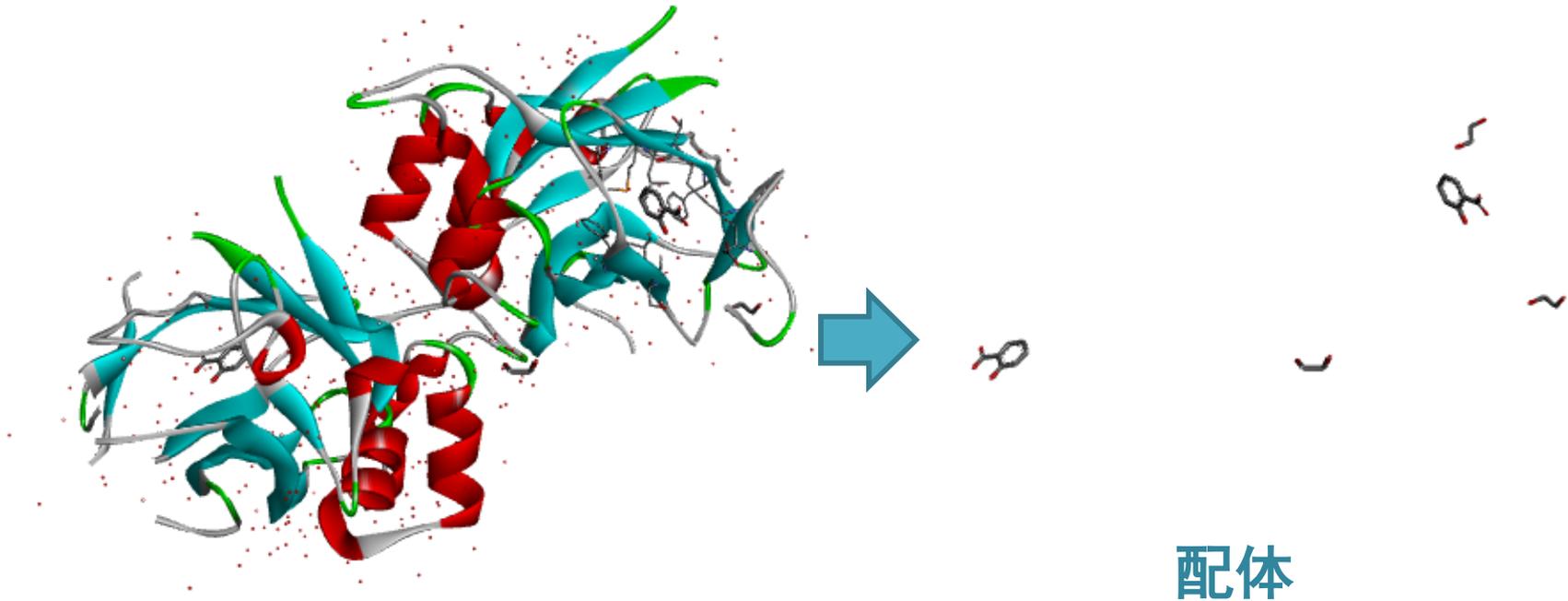
TABLE 1. *B. subtilis* strains used in this study

Strain	Relevant genotype/description <sup>a</sup>	Reference, source, or construction <sup>b</sup>
JH642	<i>trpC2 pheA1</i>	33
168	<i>trpC2</i>	BGSC
NCIB3610	Prototroph	BGSC
BAL984	JH642 <i>trpC2 pheA1 ΔtasA::spc</i>	18
BAL835	JH642 <i>amyE::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 cat</i>	37
DS93	3610 <i>ΔsinIR::spc</i>	21
NRS1314	3610 <i>degU::pBL204 (cat)</i>	39
NRS1647	3610 <i>abrB::Tn10 (mIs)</i>	40
NRS2097	3610 <i>yuaB::cat</i>	40
NRS2242	3610 <i>sacA::P<sub>sp-σ<sub>58</sub></sub>gfp (kan)</i>	31
NRS2271	JH642 <i>sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	pNW511 → JH642
NRS2275	JH642 <i>sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	pNW510 → JH642
NRS2276	3610 <i>abrB::Tn10 (mIs) yuaB::cat</i>	NRS2095 → NRS1647
NRS2283	JH642 <i>P<sub>sp-σ<sub>58</sub></sub>yuaB-lacI (spc)</i>	40
NRS2289	3610 <i>sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 NRS2271 → 3610
NRS2290	3610 <i>sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 NRS2275 → 3610
NRS2291	3610 <i>ΔsinIR::spc yuaB::cat</i>	SPP1 DS93 → NRS2097
NRS2292	3610 <i>yuaB::cat sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 NRS2271 → NRS2097
NRS2296	3610 <i>abrB::Tn10 (mIs) sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 NRS2275 → NRS1647
NRS2298	3610 <i>degU::cat amyE::P<sub>sp-σ<sub>58</sub></sub>yuaB-lacI (spc)</i>	SPP1 NRS2283 → NRS1314
NRS2299	3610 <i>yuaB::cat amyE::P<sub>sp-σ<sub>58</sub></sub>yuaB-lacI (spc)</i>	40
NRS2302	3610 <i>abrB::Tn10 (mIs) yuaB::cat sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 NRS2275 → NRS2276
NRS2388	168 <i>sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	31
NRS2393	3610 <i>yuaB::cat sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 NRS2388 → NRS 2097
NRS2394	3610 <i>sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	31
NRS2398	3610 <i>yuaB::cat sacA::P<sub>sp-σ<sub>58</sub></sub>gfp (kan)</i>	SPP1 2095 → NRS2242
NRS2415	3610 <i>tasA::spc</i>	SPP1 BAL984 → 3610
NRS2417	3610 <i>yuaB::cat amyE::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 cat</i>	SPP1 BAL835 → NRS2097
NRS2418	3610 <i>abrB::Tn10 (mIs) yuaB::cat sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 NRS2388 → NRS2276
NRS2426	3610 <i>abrB::Tn10 (mIs) sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 NRS1128 → NRS2394
NRS2427	3610 <i>ΔsinIR::spc sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 DS93 → NRS2290
NRS2428	3610 <i>ΔsinIR::spc yuaB::cat sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 DS93 → NRS2293
NRS2429	3610 <i>ΔsinIR::spc sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 DS93 → NRS2394
NRS2430	3610 <i>ΔsinIR::spc yuaB::cat sacA::P<sub>sp-σ<sub>58</sub></sub>gfp mut2 (kan)</i>	SPP1 DS93 → NRS2393
NRS2440	168 <i>amyE::P<sub>sp-σ<sub>58</sub></sub>gfp-Δ2-28-yuaB-lacI (spc)</i>	pNW616 → 168
NRS2441	168 <i>amyE::P<sub>sp-σ<sub>58</sub></sub>gfp-wspBss-yuaB-lacI (spc)</i>	pNW617 → 168
NRS2442	168 <i>amyE::P<sub>sp-σ<sub>58</sub></sub>gfp-wspAss-yuaB-lacI (spc)</i>	pNW618 → 168
NRS2446	3610 <i>yuaB::cat amyE::P<sub>sp-σ<sub>58</sub></sub>gfp-Δ2-28-yuaB-lacI (spc)</i>	SPP1 NRS2440 → NRS2097
NRS2447	3610 <i>yuaB::cat amyE::P<sub>sp-σ<sub>58</sub></sub>gfp-wspBss-yuaB-lacI (spc)</i>	SPP1 NRS2441 → NRS2097
NRS2448	3610 <i>yuaB::cat amyE::P<sub>sp-σ<sub>58</sub></sub>gfp-wspAss-yuaB-lacI (spc)</i>	SPP1 NRS2442 → NRS2097
NRS2450	3610 <i>epsA-O::tet</i>	4
NRS2451	3610 <i>epsA-O::tet tasA::spc</i>	SPP1 NRS2450 → NRS2415
NRS2452	3610 <i>epsA-O::tet yuaB::cat</i>	SPP1 NRS2450 → NRS2097
NRS2453	3610 <i>epsA-O::tet tasA::spc yuaB::cat</i>	SPP1 NRS2450 → NRS2452
NRS2748	3610 <i>yuaB::cat abrB::Tn10 (mIs) amyE::P<sub>sp-σ<sub>58</sub></sub>yuaB-lacI (spc)</i>	SPP1 NRS1128 → NRS2299
NRS2749	3610 <i>yuaB::cat ΔsinIR::kan amyE::P<sub>sp-σ<sub>58</sub></sub>yuaB-lacI (spc)</i>	SPP1 NRS1858 → NRS2299
NRS2976	168 <i>sacA::P<sub>sp-σ<sub>58</sub></sub>yuaB (kan)</i>	pNW518 → 168
NRS2980	3610 <i>epsA-O::tet tasA::spc sacA::P<sub>sp-σ<sub>58</sub></sub>yuaB (kan)</i>	SPP1 NRS2976 → NRS2451



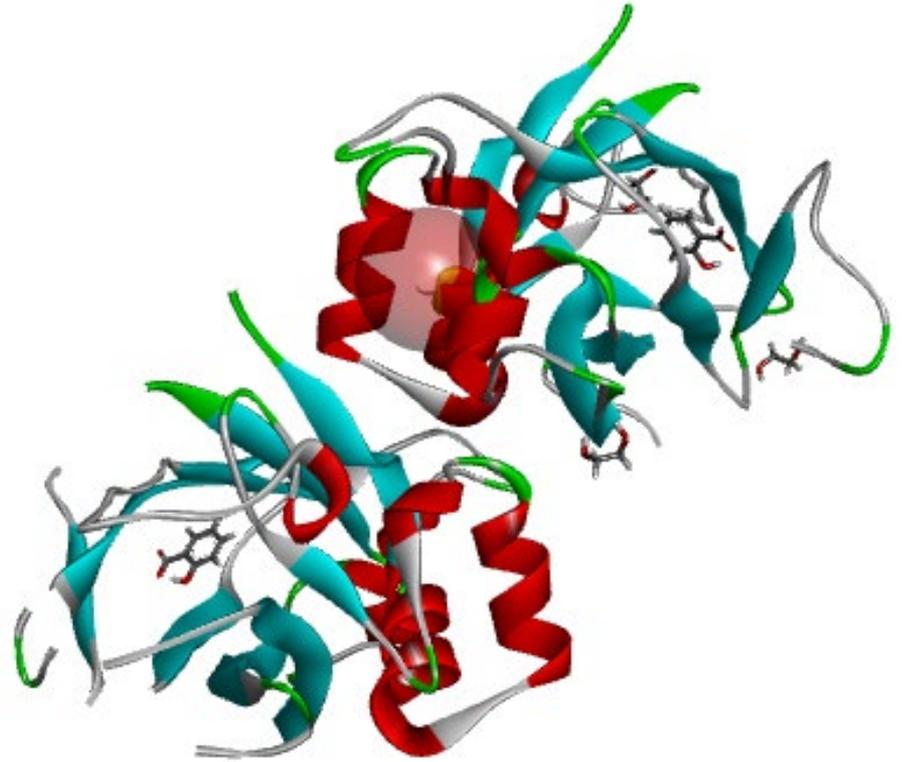
## 3.2 TasA蛋白活性区域

## 配体和其他可能产生互作的部分

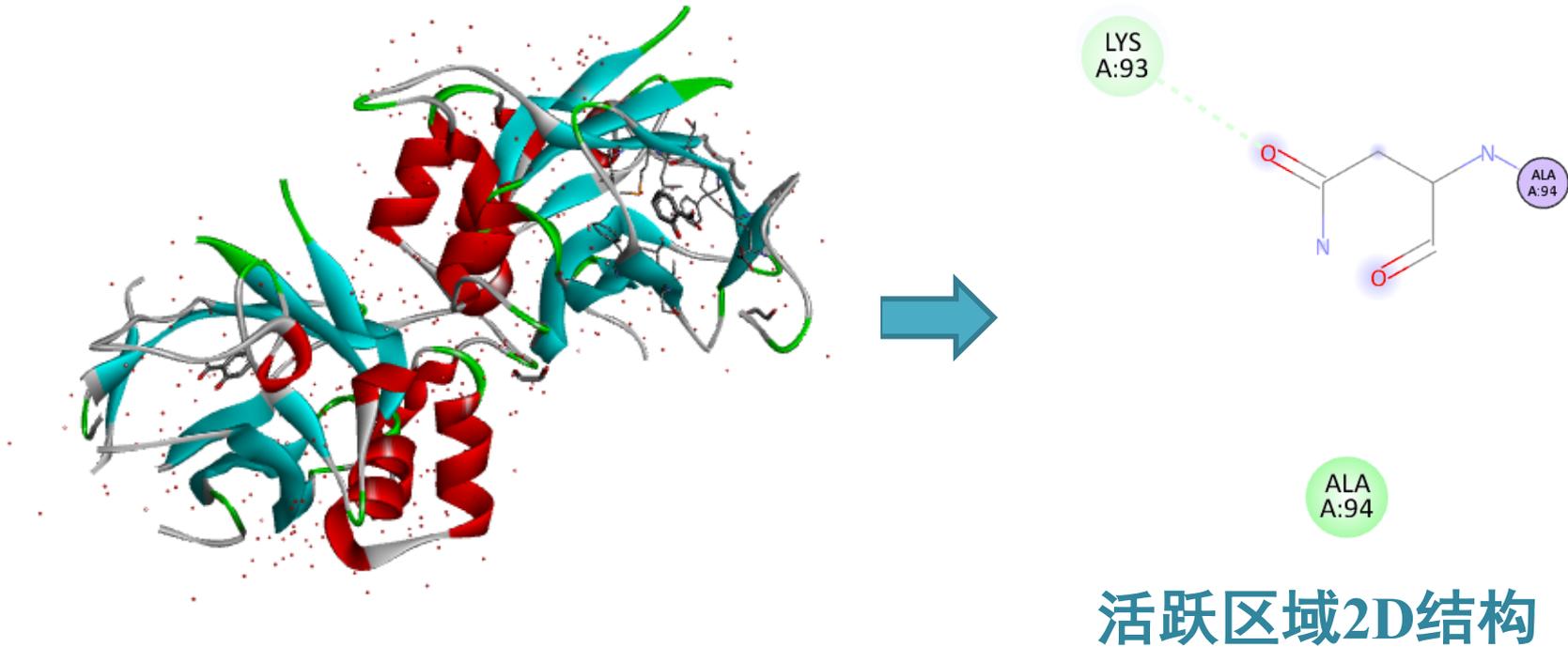


### 3.3 TasA蛋白互作相关结构

使用Discovery studio预测可能的结合区  
红色部分为活性区域，即结合位点



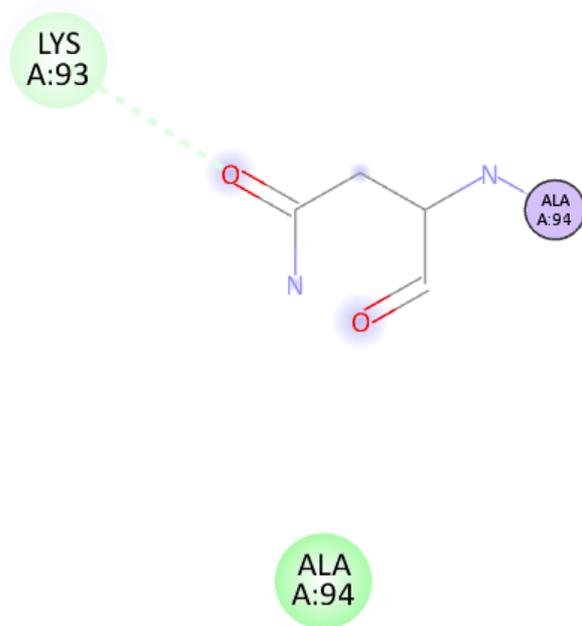
### 3.3 TasA蛋白互作预测





## 4. 结论

## 4.结论



**结论：**  
第93位赖氨酸和第94位丙氨酸是TasA的活性位点，如果发生互作可能在这个位置结合。

**THANK YOU !**

