



北京大学
PEKING UNIVERSITY

拟南芥突触结合蛋白 synaptotagmin A (SYT1) 分子机制探索

主讲人：张羽飞

小组成员：张一彬 张羽飞 王鹤翔 王玥琛

2021.01.23



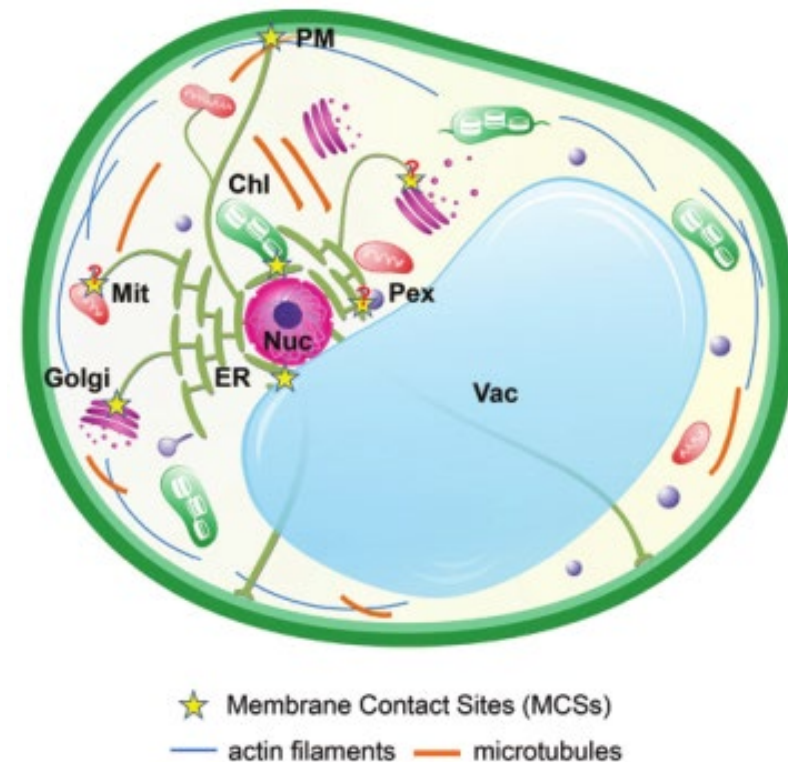
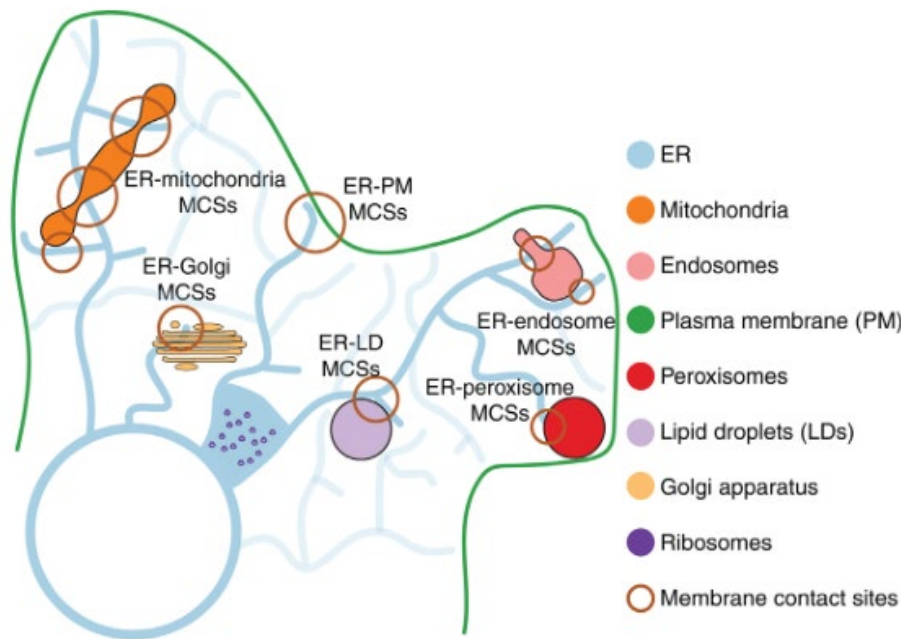
目录

- 背景介绍
- SYTs系统发生关系
- SYT1蛋白质结构特性
- SYT1表达特征与功能

1.1 膜接触位点

MCS: Membrane Contact Site

- 由膜蛋白参与“系链”功能
- 蛋白、离子(Ca^{2+})、脂质、信号 (ROS) 交换
- 参与细胞器分裂、融合等过程

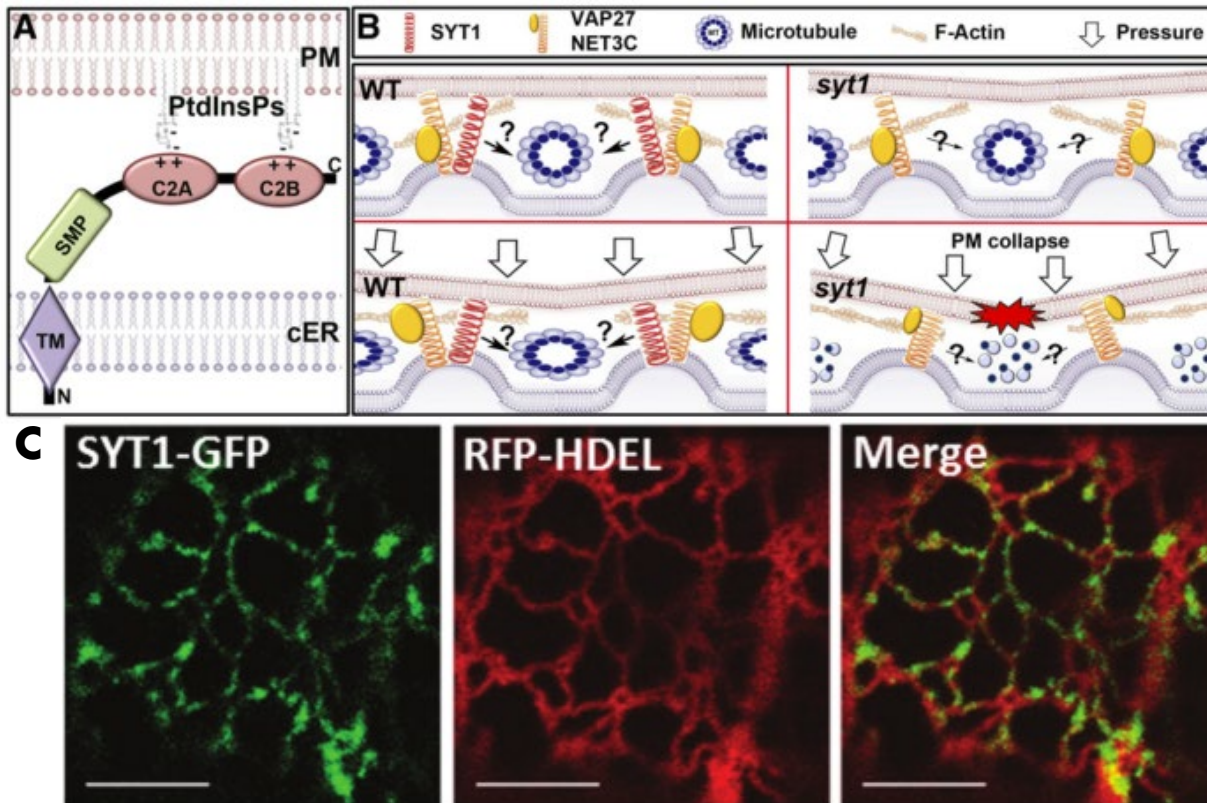


1.2 SYT1



SYT1: SYNAPTOTAGMIN A 突触结合蛋白A

- 在ER-PM接触位点发挥作用，赋予植物细胞的机械稳定性
- 在哺乳动物中，E-SYT s已被证明可以调节钙信号、脂质转移和内吞作用
- 功能突变缺失突变体对NaCl敏感并且导致电解质泄露，同时影响抗冻性
- 调节胞吞作用，可能在膜修复中起作用



(A) The SYT1 TM domain is anchored to the cortical ER the C2 domains dock to the PM. The C2 domains bind PM-localized PtdInsPs.

(B) SYT1 responds to mechanical stress.

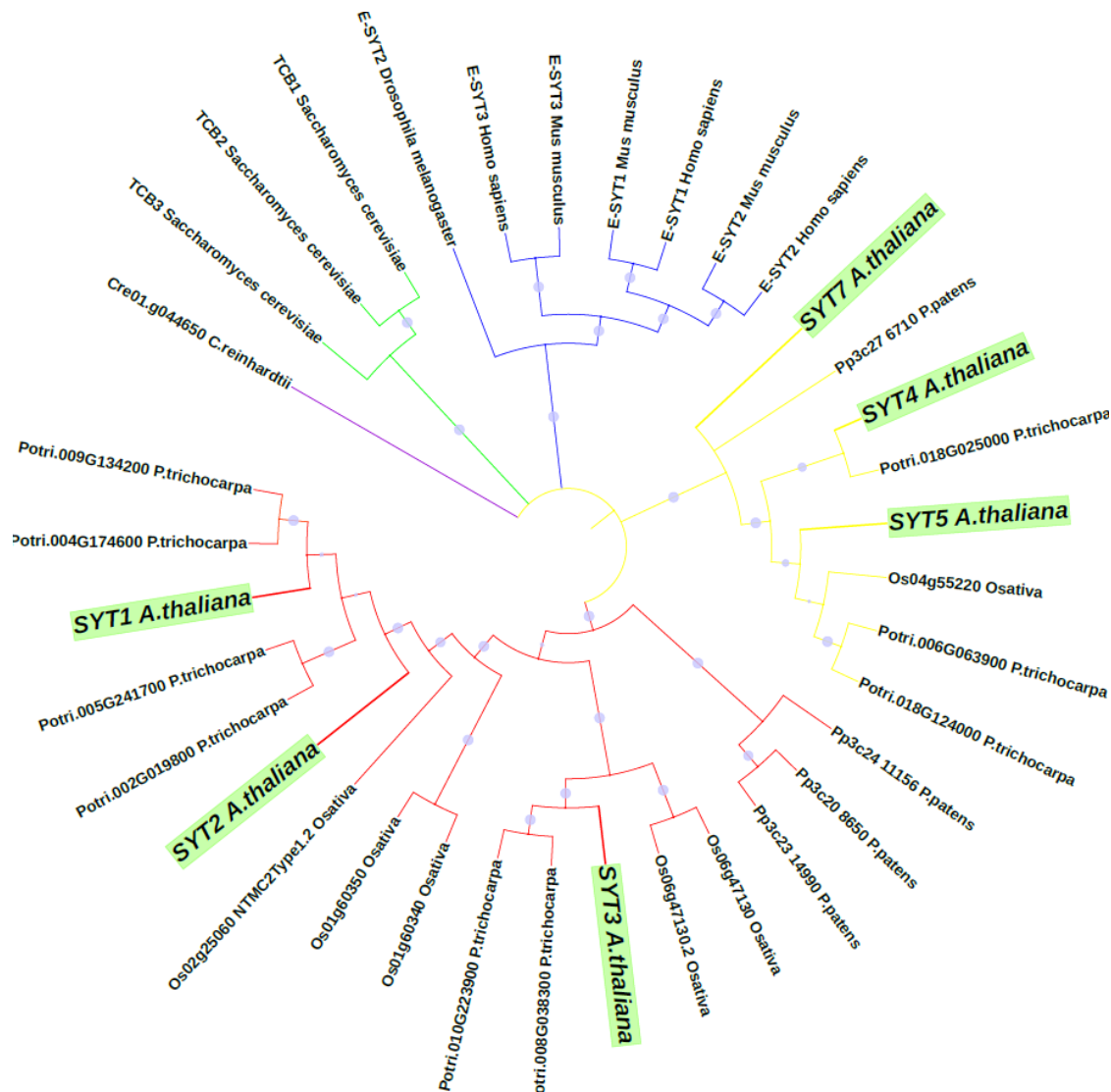
(C) Co-expression of SYT1-GFP and RFP-HDEL shows that the stable SYT1 puncta are localized on ER tubules and cisternae in *N. benthamiana* leaf epidermis.

2.1 SYTs系统发生关系



BLASTp
MEGA-X
iTOL

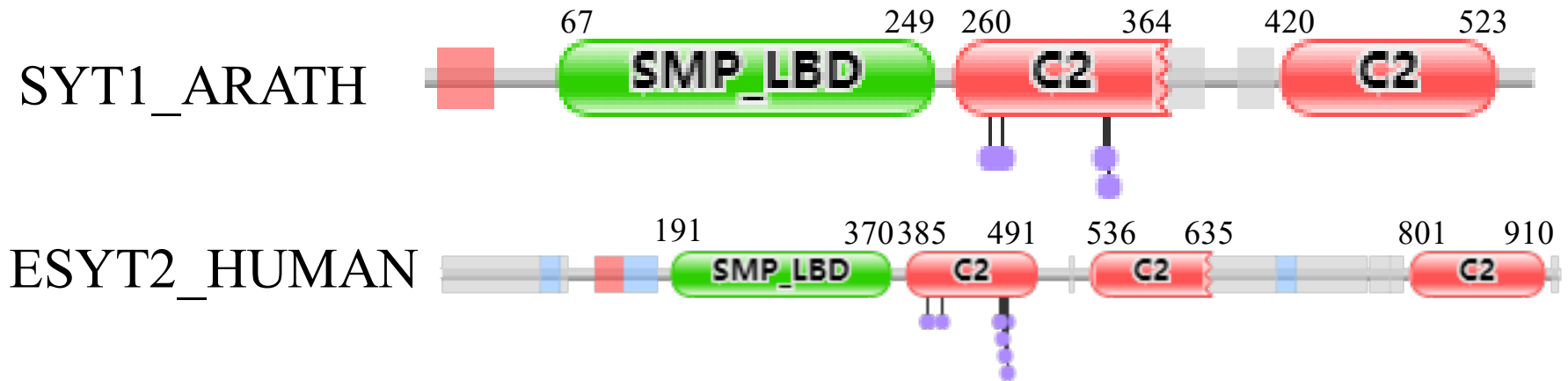
- 植物
Arabidopsis thaliana
Populus trichocarpa
Oryza sativa
Physcomitrella patens
Chlamydomonas reinhardtii
- 动物
human
house mouse
Drosophila melanogaster
- 细菌
E. coli
- 真菌
Saccharomyces cerevisiae



3.1 动植物SYT结构域



Pfam InterPro



C2: The C2 domain is a **Ca²⁺-dependent membrane-targeting module** found in many cellular proteins involved in signal transduction or membrane trafficking.

SMP: SMP is a proposed **lipid-binding** module, i.e. a synaptotagmin-like, mitochondrial-lipid-binding domain found in eukaryotes.

The C2 domain is thought to be involved in **calcium-dependent phospholipid binding** and in membrane targetting processes such as **subcellular localisation**.

The SMP domain has a **beta-barrel structure** like protein modules in the tubular-lipid-binding (TULIP) superfamily. It **dimerises** to form an approximately 90-Angstrom-long cylinder traversed by a channel lined entirely with hydrophobic residues.

The 3D structure of the C2 domain of synaptotagmin has been reported, the domain forms an **eight-stranded beta sandwich**. Calcium binds in a **cup-shaped depression** formed by the N- and C-terminal loops of the C2-key motif

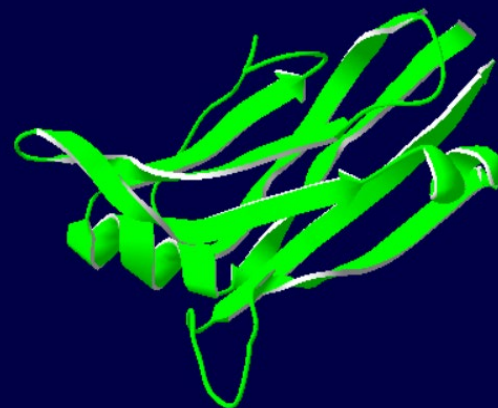
3.3 动植物SYTs结构域3D结构



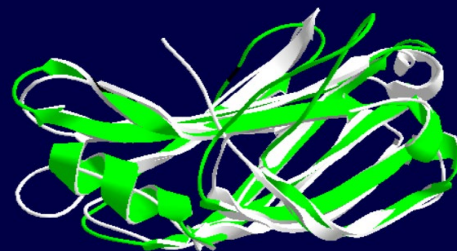
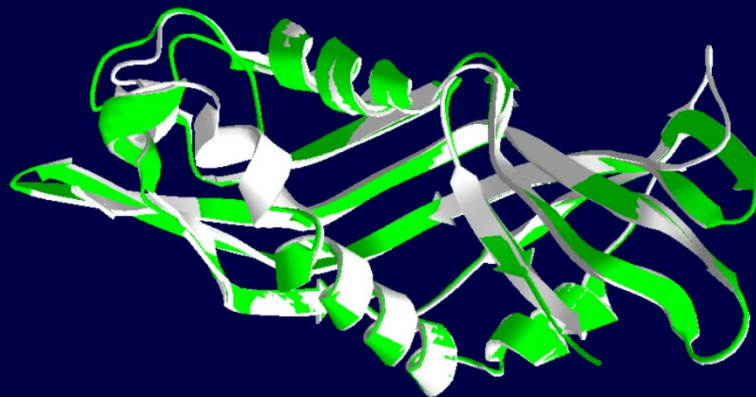
SMP结构域

C2结构域

SYT1
(绿色)



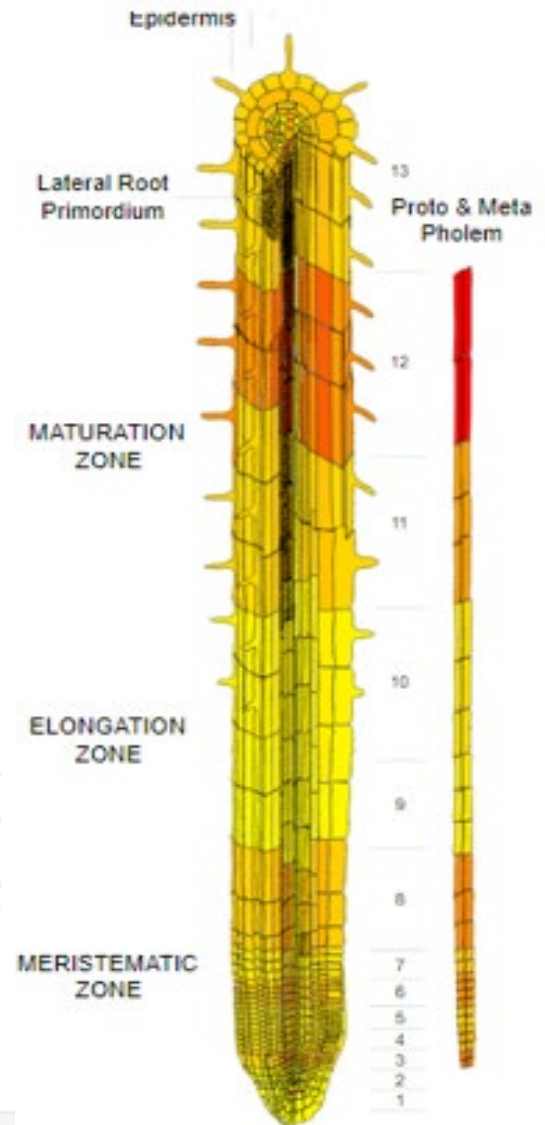
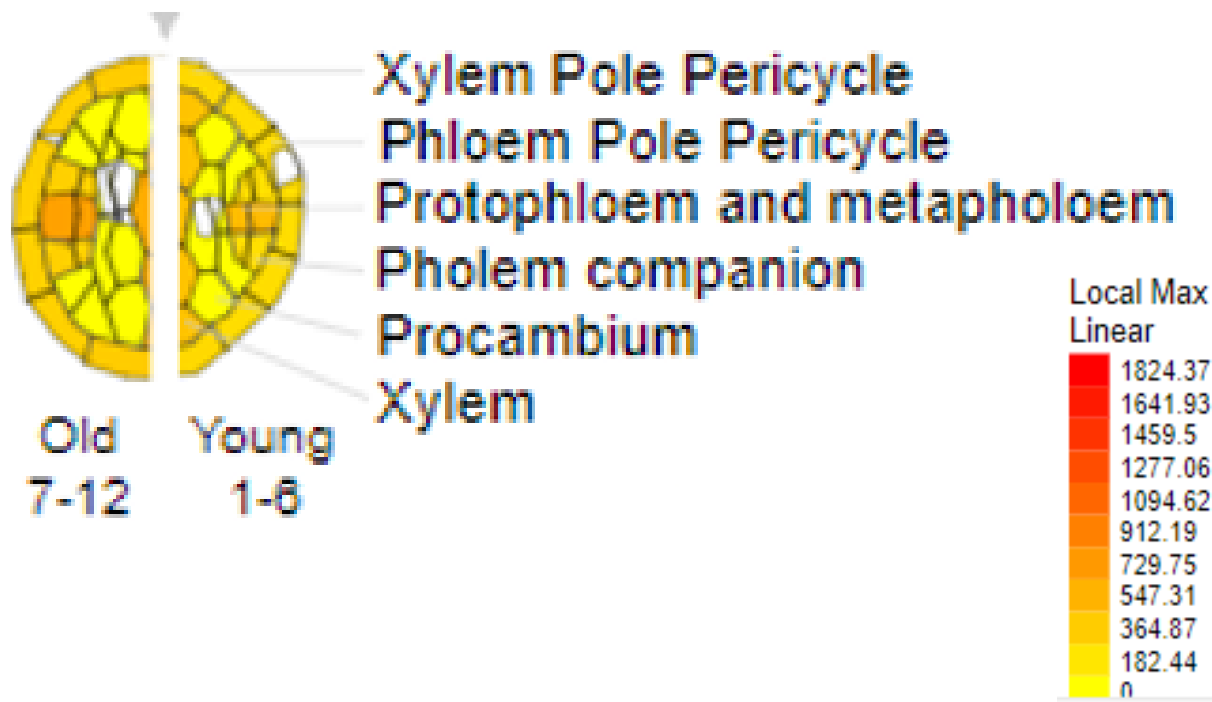
拟合



4.1 SYT1表达特征

BAR

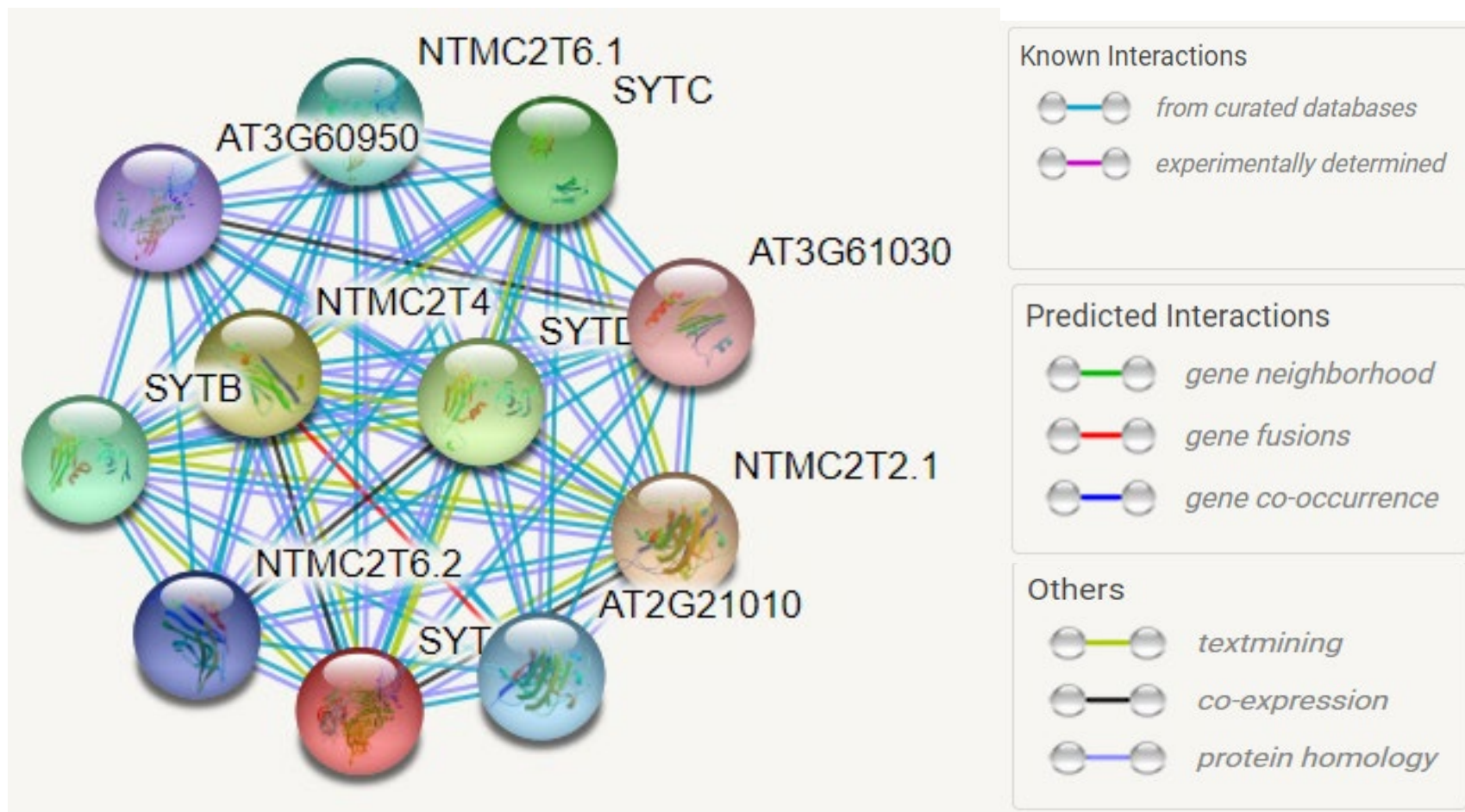
- 在根的成熟区表达量相对较高
- 在维管组织中，韧皮部表达量相对较高，尤其是后生韧皮部



4.2 SYT1互作蛋白



STRING

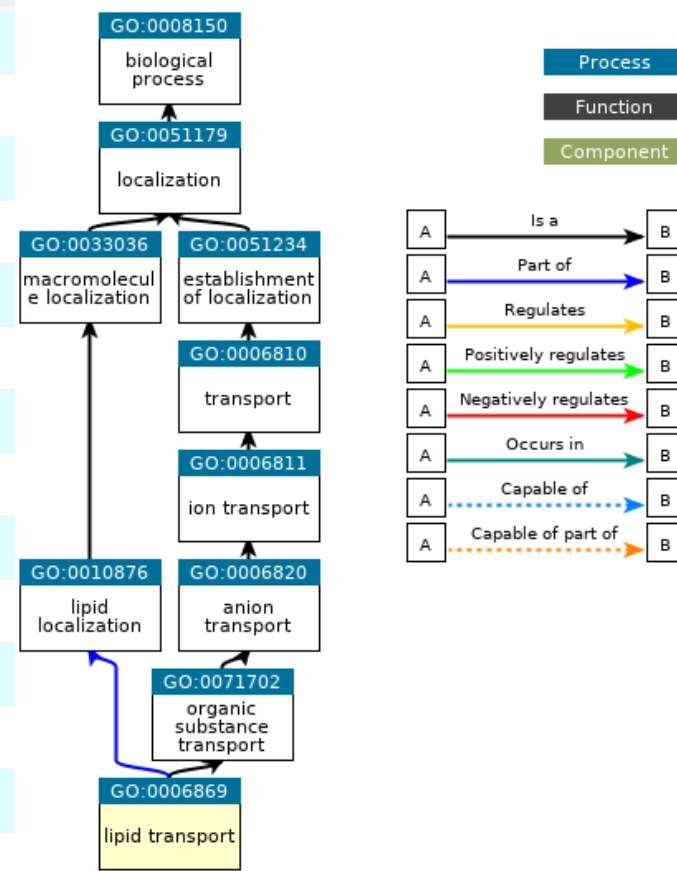


4.3 SYT1功能注释



QuickGO

Gene Product	Symbol	Qualifier	GO Term
UniProtKB:Q9SKR2	SYT1	part_of	GO:0005783 C 🔒 ⊕ endoplasmic reticulum
UniProtKB:Q9SKR2	SYT1	enables	GO:0005515 F 🔒 ⊕ protein binding
UniProtKB:Q9SKR2	SYT1	enables	GO:0008289 F 🔒 ⊕ lipid binding
UniProtKB:Q9SKR2	SYT1	part_of	GO:0005768 C 🔒 ⊕ endosome
UniProtKB:Q9SKR2	SYT1	enables	GO:0008289 F 🔒 ⊕ lipid binding
UniProtKB:Q9SKR2	SYT1	enables	GO:0046872 F 🔒 ⊕ metal ion binding
UniProtKB:Q9SKR2	SYT1	involved_in	GO:0006897 P 🔒 ⊕ endocytosis
UniProtKB:Q9SKR2	SYT1	part_of	GO:0016021 C 🔒 ⊕ integral component of membrane
UniProtKB:Q9SKR2	SYT1	part_of	GO:0016020 C 🔒 ⊕ membrane
UniProtKB:Q9SKR2	SYT1	involved_in	GO:0016032 P 🔒 ⊕ viral process
UniProtKB:Q9SKR2	SYT1	part_of	GO:0005886 C 🔒 ⊕ plasma membrane
UniProtKB:Q9SKR2	SYT1	involved_in	GO:0006869 P 🔒 ⊕ lipid transport
UniProtKB:Q9SKR2	SYT1	part_of	GO:0005886 C 🔒 ⊕ plasma membrane
UniProtKB:Q9SKR2	SYT1	part_of	GO:0010008 C 🔒 ⊕ endosome membrane



QuickGO - <https://www.ebi.ac.uk/QuickGO>

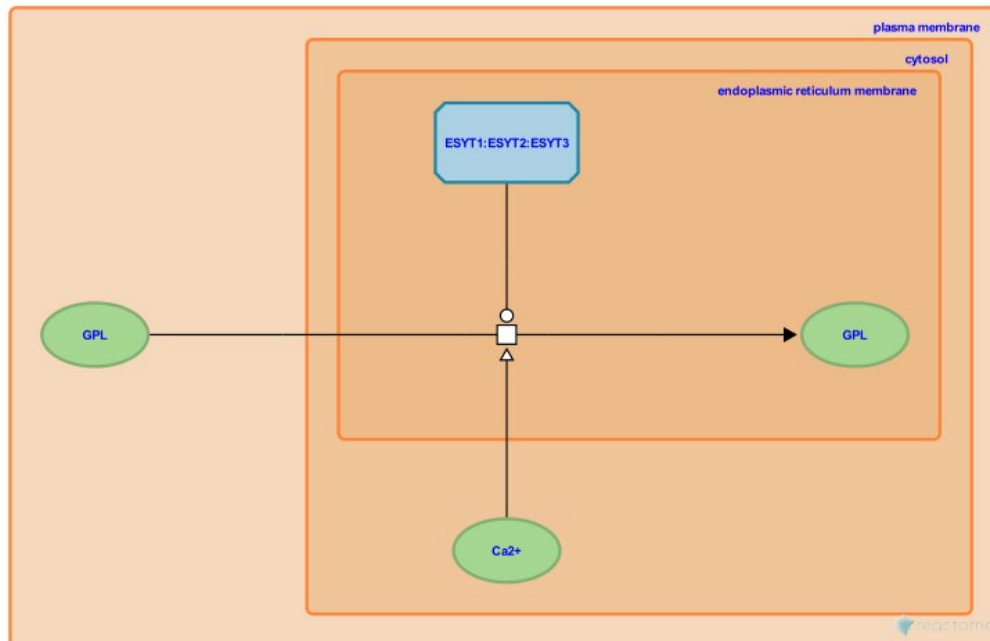
4.4 动物SYTs参与通路



KEGG
REACTOME

Entry	K19902	KO
Name	SYT2	
Definition	synaptotagmin-2	
Disease	H00770 Congenital myasthenic syndrome	
Brite	KEGG Orthology (KO) [BR:ko00001] 09180 Brite Hierarchies 09182 Protein families: genetic information processing 04131 Membrane trafficking K19902 SYT2; synaptotagmin-2 Membrane trafficking [BR:ko04131] Exocytosis Calcium ion-dependent exocytosis Synaptotagmins K19902 SYT2; synaptotagmin-2	

[BRITE hierarchy](#)



- **ESYT1:ESYT2:ESYT3 transport GPL from plasma membrane to ER membrane**
- **They form complexes on the ER membrane, are dependent on PI(4,5)P2 in plasma membranes and regulated by cytosolic Ca²⁺.**
- **An increase in Ca²⁺ levels contributes to ER-PM tethering.**

- 拟南芥SYT1位于ER-PM膜接触位点，具有SMP-C2-C2结构域，在动物和植物中具有同源蛋白以及保守结构域，但是序列一级结构差异较大。
- 在拟南芥中，SYT1在根的成熟区表达量相对较高，SYTs蛋白存在相互作用，可能参与内吞、脂质转运、抗病毒、抗逆等过程，具体的代谢途径暂未报道。
- 动物SYTs蛋白以复合体形式参与膜运输与脂质代谢，该过程依赖于Ca²⁺调控。
- 如果后续湿实验可以筛选出表型，将可以从细胞器互作、脂质、Ca²⁺的角度入手研究SYT1对于管状分子形成的作用。很多方法和思路需要借鉴同源蛋白在动物中的研究。

小组成员



北京大学
PEKING UNIVERSITY



张一彬

张羽飞 王鹤翔

王玥琛



北京大學
PEKING UNIVERSITY

感谢聆听！