

Accessing the Data You Need at the Plant Metabolic Network



kate dreher
biocurator

PMN

The Carnegie Institution for Science
Stanford, CA

Plant metabolism

- Plants provide crucial benefits to the ecosystem and humanity
- A better understanding of plant metabolism may contribute to:
 - More nutritious foods
 - New medicines
 - More pest-resistant plants
 - Higher photosynthetic capacity and yield in agricultural and biofuel crops
 - . . . many more applications
- These efforts require access to high quality plant metabolism data

Plant Metabolic Network goals

- Transform published results into data-rich metabolic pathways
- Create and deploy improved methods for predicting enzyme function and metabolic capacity using plant genome sequences
- Facilitate data analysis
- Support research and education
- Provide public resources : **www.plantcyc.org**
 - **PlantCyc**
 - **AraCyc**
 - **PoplarCyc**
 - **... and 4 NEW databases**

* **CornCyc**

* **GrapeCyc**

* **SoyCyc**

* **CassavaCyc**

PlantCyc

Introduction

The [Plant Metabolic Network](#) (PMN) provides a broad network of plant metabolic pathway databases that contain curated information from the literature and computational analyses about the genes, enzymes, compounds, reactions, and pathways involved in primary and secondary metabolism in plants.

The PMN is funded by the [National Science Foundation](#) (Grant #: [1026003](#) and [0640769](#)), governed by an [Editorial Board](#) composed of internationally renowned scientists, and executed at the [Carnegie Institution for Science](#), Department of Plant Biology.



News

Come meet the PMN in Austin!

- Want to learn about the newest PMN data?
- Eager for a demo on data analysis using the Omics viewer?
- Interested in annotating your favorite enzyme?

Then meet with a PMN curator *one-on-one* at the [Outreach Booth \(215\)](#) during the [ASPB Plant Biology 2012](#) conference.

Additional PMN learning opportunities:

- [Plant Informatics Workshop](#):
Saturday - 7:30 PM
- [PMN poster \(19014\)](#):
Sunday - 6:30 PM

Plant Metabolic Pathway Databases

The PMN currently houses one multi-species reference database called PlantCyc and ten species/taxon-specific databases.

- [PMN Content Statistics](#) - stats about pathways, enzymes, reactions, compounds, and more

Plant Metabolic Network collaborators

□ SRI International – BioCyc project

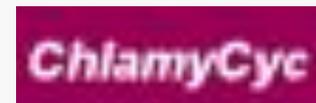
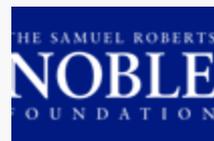
- Provide Pathway Tools Software



- Maintain and update MetaCyc (multi-kingdom) reference metabolic pathway database

□ Other collaborators / contributors include:

- Sol Genomics Network (SGN) / Boyce Thompson Institute
- Gramene
- Maize GDB
- ChlamyCyc
- MedicCyc / Nobel Foundation
- SoyBase
- PlantMetabolomics group
- . . . and more



PMN data content statistics

- Latest PMN release – March 2012

	Pathways	Enzymes *	Reactions	Compounds
PlantCyc 6.0	898	27652	3421	3334

* The term "enzyme" refers to both monomers and complexes found in the databases.

Over 350 species of plants appear in PlantCyc

PMN data content statistics

- Updated versions of AraCyc and PoplarCyc

	Pathways	Enzymes *	Reactions	Compounds
PlantCyc 6.0	898	27652	3421	3334
AraCyc 9.0	502	7100	3320	3210
PoplarCyc 4.0	354	8691	2220	1596

PMN data content statistics

- Plus FOUR new databases arrived!

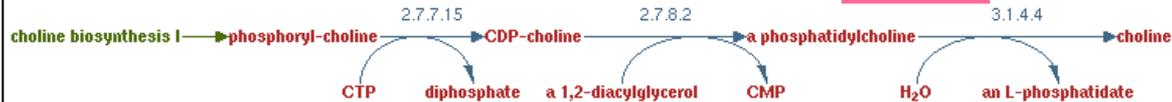
	Pathways	Enzymes *	Reactions	Compounds
PlantCyc 6.0	898	27652	3421	3334
CassavaCyc 1.0	323	7178	2103	1524
CornCyc 1.0	341	10519	2156	1731
GrapeCyc 1.0	330	5338	2101	1540
SoyCyc 2.0	412	13094	2528	1987

Plant Metabolic Network data

- Pathway-based access to data

PlantCyc Pathway: choline biosynthesis III

Enzyme View: [Customize Diagram](#) [More Detail](#) [Less Detail](#) [Cross-Species Comparison](#) [Download Genes](#) [BioPAX format](#)



PMN pa

PlantCyc Enzyme: phosphatidyltransferase

Synonyms: aminoalcoholphosphotransferase

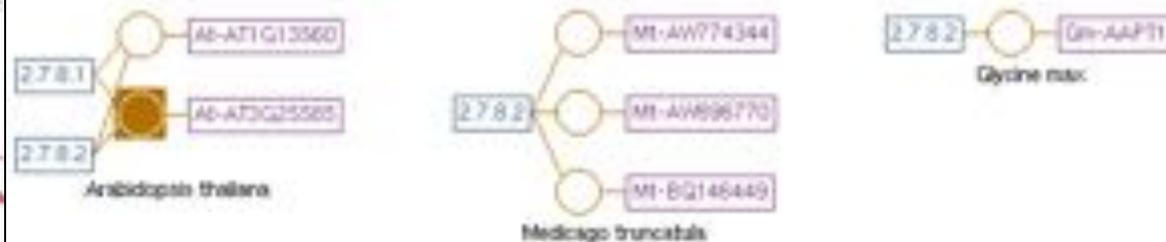
Species: [Arabidopsis thaliana](#)

Gene: [AT3G25585](#)

Sequence Length: 1145 AAs

Unification Links: [Entrez: AAC61769](#), [Phytozome Plant Orthologs: AT3G25585.1](#)

Gene-Reaction Schematic:



MultiFun Terms: [UNCLASSIFIED](#)

Enzymatic reaction of: **cholinephosphotransferase (phosphatidyltransferase)**

[a 1,2-diacylglycerol + CDP-choline <=> a phosphatidylcholine + CMP](#)

The reaction direction shown, that is, $A + B \rightleftharpoons C + D$ versus $C + D \rightleftharpoons A + B$, is in accordance with the Enzyme Commission system.

Reversibility of this reaction is unspecified.

In Pathways: [choline biosynthesis II](#), [phosphatidylcholine biosynthesis I](#), [phosphatidylcholine biosynthesis II](#)

Summary:

The enzyme is bifunctional that utilizes CDP-choline and CDP-ethanolamine in synthesizing phosphatidylcholine and phosphatidylethanolamine, respectively. Its cholinephosphotransferase activity is greater than its ethanolaminephosphotransferase activity.

Inhibitors (Unimech): [CMP](#) [[Goede99](#)], [Ca²⁺](#) [[Goede99](#)]



Upstream pathway

Compound

[Download Genes](#) [BioPAK format](#)



Evidence Codes

thway

Searching at the PMN

- Pathway Tools quick search bar



The screenshot shows the PMN search interface. On the left is the PMN logo with a plant icon and a chemical reaction diagram. On the right is a search bar containing the text "choline". Below the search bar is a dropdown menu with the text "Search Database *PlantCyc* [change](#)". To the right of the search bar is a "Quick Search" button.



The screenshot shows the "Select a Database" dropdown menu. The title is "Select a Database: The selected database". The list of options is:

- Arabidopsis thaliana col
- Glycine max
- Manihot esculenta esculenta
- PlantCyc
- Populus trichocarpa
- Vitis vinifera
- Zea mays mays

Quick search results

The query **choline** matched the following results:

Pathways

Pathway pages contain: description of a pathway, of chromosomal genes, and of regulatory factors.

- [choline biosynthesis I](#)
- [choline biosynthesis II](#)
- [choline biosynthesis III](#)
- [phosphatidylcholine biosynthesis I](#)
- [phosphatidylcholine biosynthesis II](#)
- [phosphatidylcholine biosynthesis III](#)
- [superpathway of phosphatidylcholine biosynthesis](#)
- [superpathway of choline biosynthesis](#)

Genes

Gene pages contain: description of its function, product information, and corresponding protein.

- [choline monoxygenase](#)

Proteins

Protein pages contain: Detailed comments and citations; subunit structure; cofactors, activators, and inhibitors (for enzymes); depiction of regulon (for transcription factors).

- [choline kinase \(pol\)](#)
- [CHOLINE MONOOXYGENASE](#)
- [choline monoxygenase](#)
- [choline monoxygenase](#)
- [choline monoxygenase expressed](#)
- [choline-phosphate transferase \(AT2G32280\)](#)
- [choline-phosphate transferase \(AT4G15130\)](#)
- [choline-phosphate transferase \(LOC_Os02g07720.1\)](#)
- [cholinephosphate transferase](#)

Compounds

Compound pages contain: compound structural information, and links to all reactions and pathways in which the compound participates.

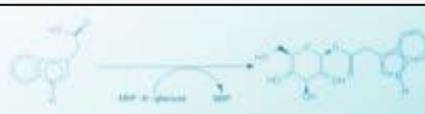
- [16:0-18:1-PC \(1-16\)](#)
- [16:0-18:2-PC \(1-16\)](#)
- [16:0-18:3-PC \(1-16\)](#)
- [18:1-18:1-PC \(1-18\)](#)
- [3-phosphocholine](#)
- [18:1-18:2-PC \(1-18\)](#)
- [18:1-18:3-PC \(1-18\)](#)
- [18:2-18:1-PC \(1-18\)](#)
- [18:2-18:2-PC \(1-18\)](#)
- [3-phosphocholine](#)
- [18:2-18:3-PC \(1-18\)](#)
- [18:3-18:1-PC \(1-18\)](#)
- [18:3-18:2-PC \(1-18\)](#)
- [18:3-18:3-PC \(1-18\)](#)
- [choline](#)
- [O-sinapoylcholine](#)
- [Sn-3-glycerophosphocholine](#)
- [a-1-acyl-2-lyso-glycerophosphocholine](#)
- [a-1-alkyl-2-acetyl-sn-glycero-3-phosphocholine](#)
- [a-1-alkyl-sn-glycero-3-phosphocholine](#)
- [a-1-lyso-2-acyl-sn-glycero-3-phosphocholine](#)
- [a-1-organyl-2-acyl-sn-glycero-3-phosphocholine](#)
- [a-2-lysophosphatidylcholine](#)

Reactions

Reaction pages contain: reaction equation with chemical structures, links to all enzymes that catalyze the reaction, and all pathways in which the reaction participates.

- [1-O-sinapoyl-β-D-glucose + choline = O-sinapoylcholine + β-D-glucose](#)
- [choline + ATP = phosphorylcholine + ADP](#)
- [a-1,2-diacylglycerol + CDP-choline = a-phosphatidylcholine + CMP](#)
- [a-phosphatidylcholine + H₂O = a-1-acyl-2-lyso-glycerophosphocholine + a-carboxylate](#)
- [a-phosphatidylcholine + H₂O = an-L-phosphatidate + choline](#)
- [phosphorylcholine + CTP = CDP-choline + diphosphate](#)

Specific search pages

PMN 

Search Database *PlantCyc* [change](#)

About PMN **Search** Tools Downloads Useful Sites Submit Data Help Feedback

Databases Overview
Compounds

PlantCyc Compound Search

▼ Search for compound by name or ID

Enter a compound name, or a database identifier from this database or from an external database such as ChEBI, LIGAND, PubChem or CAS. This database may not contain mappings to all of these other databases. Partial names will generate a substring search on compound names only (not on database identifiers).
Examples: "tryptophan", "C00034"

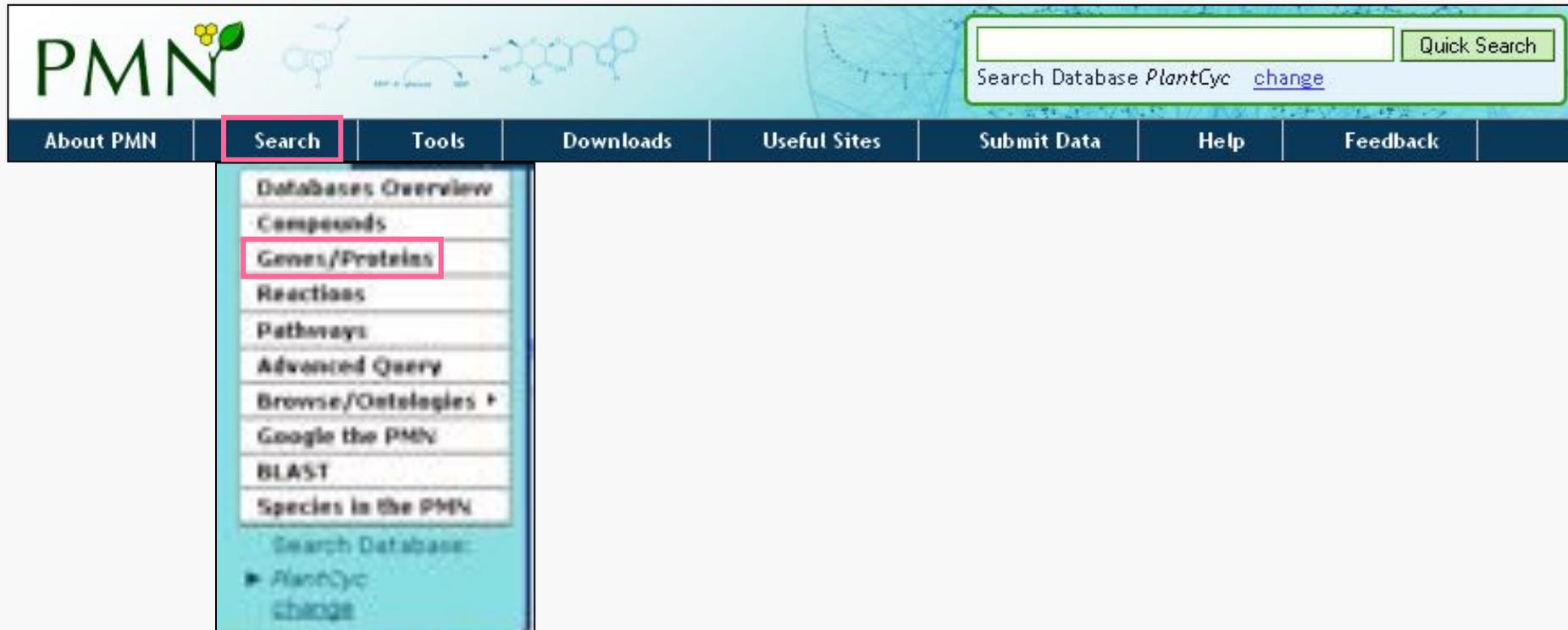
▶ Search/Filter by ontology (inactive)

▶ Search/Filter by molecular weight (inactive)

▶ Search/Filter by chemical formula (partial or full) (inactive)

▶ Search by InChI string (inactive)

Specific search pages



PMN   

Search Database *PlantCyc* [change](#)

About PMN **Search** Tools Downloads Useful Sites Submit Data Help Feedback

- Databases Overview
- Compounds
- Genes/Proteins**
- Reactions
- Pathways
- Advanced Query
- Browse/Ontologies ▸
- Google the PMN
- BLAST
- Species in the PMN

Search Database:
▸ *PlantCyc*
[change](#)

Specific search pages

DMN

Quick Search

PlantCyc Gene/Protein/RNA Search

Submit Query Clear Form List of All Genes List of All Polypeptides List of All Protein Complexes List of All RNAs

Search by gene name or database identifier

Enter a gene name or database identifier. Page results contain links. Page results contain links. Page results contain links. Example: "trpA"

Search by product name

Enter a product name or database identifier. Page results contain links. Page results contain links. Page results contain links. Example: "tryptophan synthase", "trpA"

PlantCyc Query Results

You searched for all gene products whose name contains the string "cytokinin oxidase", and that

Your query returned 2 results.

Gene Name ▲ ▼	Product Name ▲ ▼	Organism ▲ ▼	Evidence ▲ ▼
CKX1	cytokinin oxidase	Arabidopsis thaliana	Reaction enhanced in mutant
CKX1	cytokinin oxidase	Zea mays	Assay of partially-purified protein

Search/Filter by product name

Search/Filter by pi

Search/Filter by small molecule

Search/Filter by evidence code

Search/Filter by cell component

Search/Filter by organism

Search/Filter by publication

Inferred by computational analysis (6850)

Inferred by curator (7)

Inferred from experiment (2204)

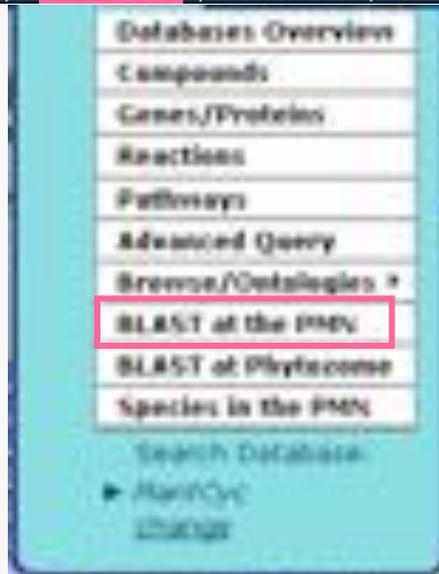
Select one or more evidence codes to filter the result to only include gene products that have the corresponding evidence for their function. Deselecting all evidence codes has the same effect as selecting all evidence codes -- no filtering will be done based on evidence code.

Submit Query Clear Form List of All Genes List of All Proteins List of All RNAs

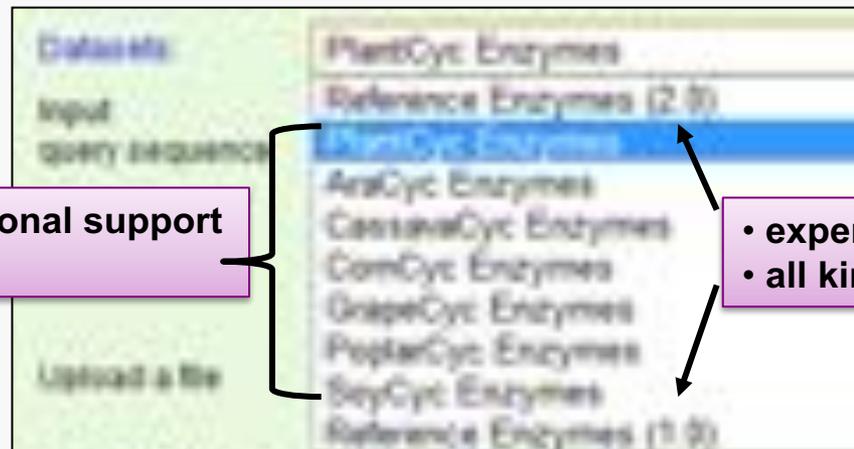
Sequence-based search options



The image shows the top section of the PMN website. On the left is the PMN logo with a green leaf and yellow flower. To its right is a chemical reaction diagram. Further right is a search bar with a 'Quick Search' button. Below the search bar is a navigation menu with the following items: About PMN, Search (highlighted with a red box), Tools, Downloads, Useful Sites, Submit Data, Help, and Feedback.



A dropdown menu is open under the 'Search' button. It contains the following options: Databases Overview, Compounds, Genes/Proteins, Reactions, Pathways, Advanced Query, Browse/Catalogues +, **BLAST at the PMN** (highlighted with a red box), BLAST at Phytozone, and Species in the PMN. At the bottom of the menu, there is a 'Search Database' section with a radio button for 'PlantCyc' and a radio button for 'L2002'.



A dropdown menu for BLAST search results is shown. It has two sections: 'Input query sequence' and 'Upload a file'. Under 'Input query sequence', there is a list of databases: PlantCyc Enzymes, Reference Enzymes (2 (0)), **PlantCyc Enzymes** (highlighted with a blue bar), AraCyc Enzymes, CassavaCyc Enzymes, ComCyc Enzymes, GrapeCyc Enzymes, PoplarCyc Enzymes, SoyCyc Enzymes, and Reference Enzymes (1 (0)).

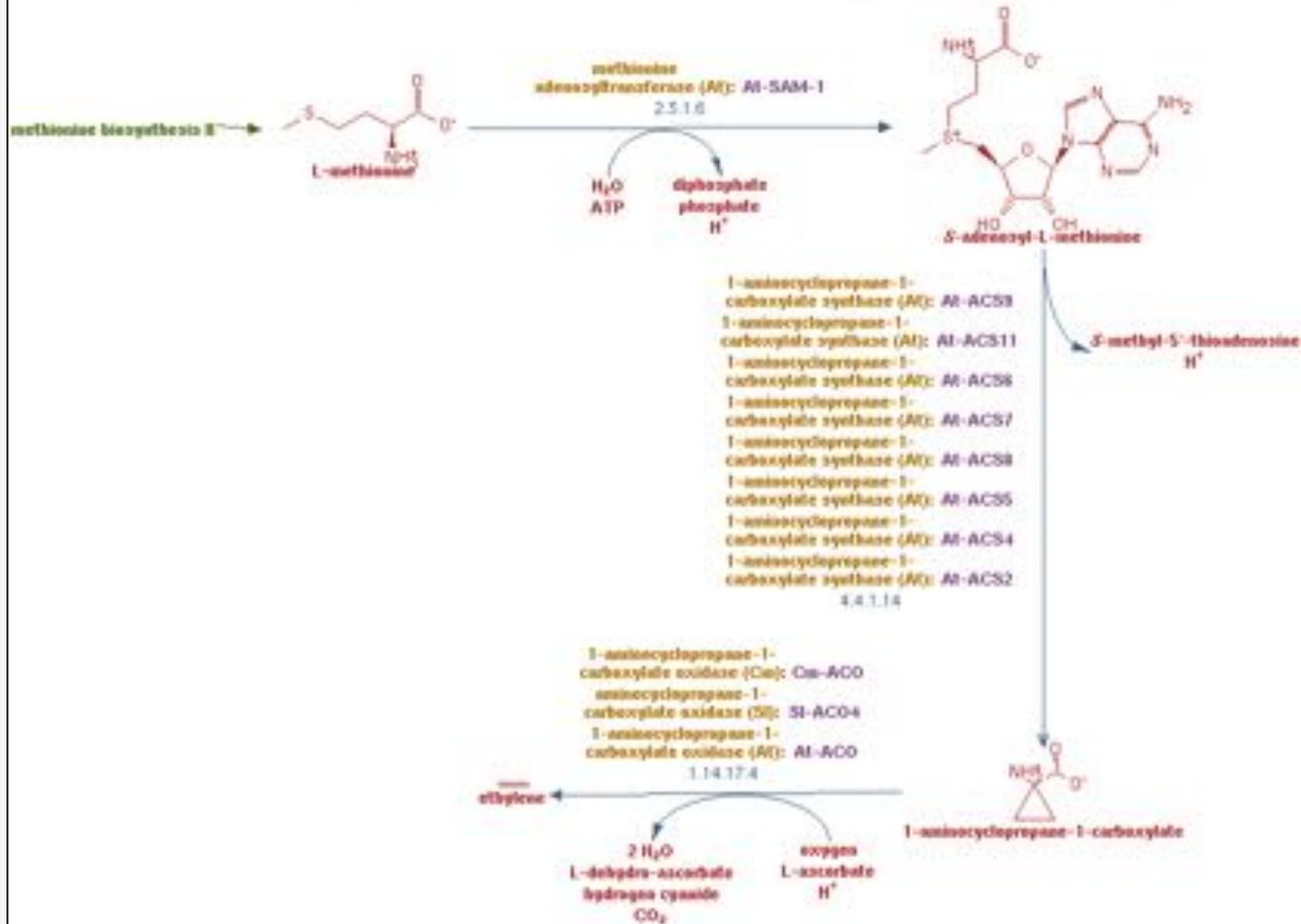
- experimental or computational support
- plants only

- experimental support
- all kingdoms

PlantCyc Pathway: ethylene biosynthesis from methionine



Enzyme View:



Advanced searching in PMN databases

- Advanced search page
 - Allows the construction of very complex queries

PMN
Plant Metabolic Network

Search PlantCyc search

About PMN Search Tools Downloads Useful Sites Submit Data Help Feedback

- Databases Overview
- Compounds
- Genes/Proteins
- Reactions
- Pathways
- Advanced Query
- Browse Ontologies
- BLAST at the PMN
- BLAST at Phytozone
- Species in the PMN

Advanced searching in PMN databases

- 1. Construct query
- 2. Select output fields

2. Select fields to include in the query output:

Column 1 <input checked="" type="radio"/> Sort based on this column	<input type="text" value="add a column"/>
NAME	

Column 1 <input checked="" type="radio"/> Sort based on this column	Column 2 <input checked="" type="checkbox"/> <input type="radio"/> Sort based on this column	Column 3 <input checked="" type="checkbox"/> <input type="radio"/> Sort based on this column	Column 4 <input checked="" type="checkbox"/> <input type="radio"/> Sort based on this column
NAME	Chemical-Formula	Appears-In-Right-Side-Of	Molecular-Weight

- 3. Choose file format and retrieve

3. Select query output format:

HTML Tab Delimited Text (columns are separated by tabs)

4. Submit Query

□ A list of 30-carbon compounds that appear as products in reactions

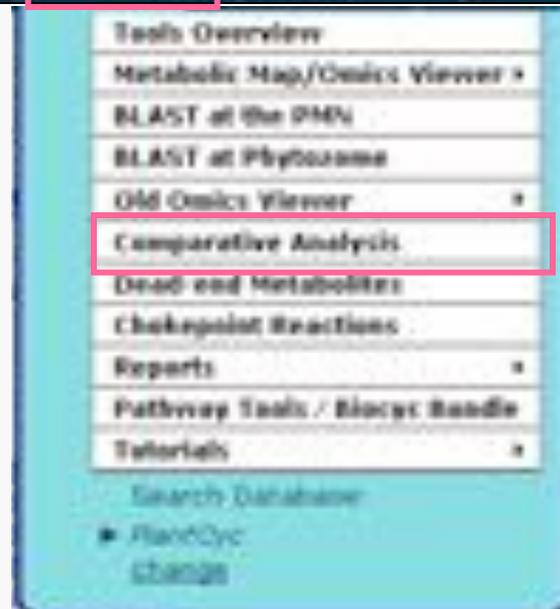
This query resulted in a single table of 53 rows

Column 1 for (x1 ^? NAME)	Column 2 for (x1 ^? CHEMICAL-FORMULA)	Column 3 for (x1 ^? APPEARS-IN-RIGHT-SIDE-OF)	Column 4 for (x1 ^? MOLECULAR-WEIGHT)
α-amyrin	C30H50O1	(S)-2,3-epoxysqualene = α-amyrin	426.724
β-amyrin	C30H50O1	(S)-2,3-epoxysqualene = β-amyrin	426.724
(E)-cinnamoyl-CoA	C30H42N7O17P3S1	trans-cinnamate + coenzyme A = (E)-cinnamoyl-CoA + H₂O	897.68
(S)-2,3-epoxysqualene	C30H50O1	squalene + NADPH + O₂ = (S)-2,3-epoxysqualene + NADP⁺ + H₂O. O₂ + a reduced acceptor + squalene = (S)-2,3-epoxysqualene + H₂O + an acceptor	426.724
24-ethylidenelophanol	C30H50O1	24-methylanalophenol + S-adenosyl-L-methionine = 24-ethylidenelophanol + S-adenosyl-L-homocysteine	426.724
4,4-dimethyl-14α-formyl-5α-cholesta-8,24-dien-3β-ol	C30H48O2	4,4-dimethyl-14α-hydroxymethyl-5α-cholesta-8,24-dien-3β-ol + NADPH + O₂ = 4,4-dimethyl-14α-formyl-5α-cholesta-8,24-dien-3β-ol + NADP⁺ + 2 H₂O	440.708
4,4-dimethyl-14α-hydroxymethyl-5α-cholesta-8,24-dien-3β-ol	C30H50O2	lanosterol + NADPH + O₂ = 4,4-dimethyl-14α-hydroxymethyl-5α-cholesta-8,24-dien-3β-ol + NADP⁺ + H₂O	442.724
4-(1-methyl-2-pyrrolidinyl)-3-oxobutanoyl-CoA	C30H49N8O18P3S1	1-methylpyrrolidine-2-acetyl-CoA + acetyl-CoA = 4-(1-methyl-2-pyrrolidinyl)-3-oxobutanoyl-CoA + coenzyme A	934.741
4-coumaroyl-CoA	C30H42N7O18P3S1	coenzyme A + 4-coumarate + ATP = 4-coumaroyl-CoA + diphosphate + AMP	913.679

Enhanced comparative analysis opportunities



The image shows the top section of the PMN website. On the left is the logo for PMN (Plant Metabolic Network) featuring a stylized plant with a yellow flower and green leaves. To the right of the logo is a search bar with a dropdown menu currently set to 'PlantCyc' and a 'search' button. Below the search bar is a dark blue navigation bar with several menu items: 'About PMN', 'Search', 'Tools', 'Downloads', 'Useful Sites', 'Submit Data', 'Help', and 'Feedback'. The 'Tools' menu item is highlighted with a red box.



The image shows the 'Tools' dropdown menu from the PMN website. The menu is light blue and contains the following items: 'Tools Overview', 'Metabolic Map/Omics Viewer >', 'BLAST at the PMN', 'BLAST at Phytozome', 'Old Omics Viewer >', 'Comparative Analysis', 'Dead-end Metabolites', 'Checkpoint Reactions', 'Reports >', 'Pathway Tools / Biocyc Bundle', and 'Tutorials >'. The 'Comparative Analysis' item is highlighted with a red box. Below the main menu items, there is a 'Search Database' section with a sub-item 'PlantCyc' and a 'change' link.

Enhanced comparative analysis opportunities

Select which set(s) of comparative-analysis tables you wish to generate:

- Organisms: breakdown by principal life types
- Reactions: breakdown by type of substrate, by EC Number, by number of isozymes, etc.
- Pathways: breakdown by pathway class, information on pathway holes.
- Compounds: small molecules that act as substrates, enzyme activators/inhibitors/cofactors.
- Genes/Proteins: breakdown of genes by product type, ontology, annotations; breakdown of proteins by number of enzymes with activators/inhibitors/cofactors, multifunctional enzymes.
- Orthologs: proteins shared among organisms or unique to an organism.
- Transporters: proteins that facilitate the movement of compounds across cell membranes.
- Transcription Units: number of genes per transcription unit, number of operons per pathway.

Select one or more organism databases:

- Arabidopsis thaliana col
- PlantCyc
- vith visitors
- Glycine max
- Populus trichocarpa
- Zea mays mays
- Escherichia coli

Submit

Clear All

Enhanced comparative analysis opportunities

EC Category	AroCyc (38)	PlantCyc	M. shifera	G. max	E. trichocarpus	Z. mays (39)	H. esculenta (40)
1 -- Oxidoreductases	817 (35%)	714 (34%)	663 (32%)	794 (32%)	674 (31%)	479 (31%)	476 (31%)
2 -- Transferases	741 (32%)	778 (37%)	683 (33%)	637 (31%)	497 (31%)	492 (32%)	488 (32%)
3 -- Hydrolases	498 (17%)	381 (18%)	298 (15%)	355 (15%)	216 (21%)	211 (28%)	211 (28%)
4 -- Lyases	189 (8%)	212 (10%)	109 (5%)	124 (5%)	114 (5%)	124 (8%)	122 (8%)
5 -- Isomerases	84 (4%)	77 (4%)	57 (4%)	72 (4%)	55 (4%)	59 (4%)	56 (4%)
6 -- Ligases	111 (5%)	92 (4%)	88 (5%)	85 (5%)	75 (5%)	74 (5%)	78 (5%)
Total reactions with full or partial EC Numbers	2,350	2,076	1,448	1,848	1,531	1,531	1,531

Table 4: Distribution of Isozymes across SMM Reactions

Isozymes are multiple enzymes that catalyze the same reaction. This table shows the number of SMM Reactions that have the specified number of enzymes. For example, row 1 counts the number of SMM Reactions that are catalyzed by only a single enzyme, row 2 counts the number of SMM Reactions that are catalyzed by two enzymes, the seventh row counts the number of SMM Reactions that are catalyzed by more than 10 enzymes, and so on. To compare the number of reactions across all organisms, expand the row All with multiple isozymes.

Unfortunately, if protein complexes have not been created for a database, then two subunits of a single enzyme may be mistakenly classified as two enzymes. This statistic will be misleading. Protein complex creation is a Pathologic task requiring manual assistance, and has not been done for the vast majority of BioCyc websites. We recommend you give credence to this statistic only for databases that have been manually curated.

Number of Enzymes per Reaction	AroCyc (38)	PlantCyc	M. shifera	G. max	E. trichocarpus	Z. mays (39)	H. esculenta (40)
1	878 (38%)	849 (41%)	285 (15%)	151 (6%)	215 (14%)	187 (12%)	221 (15%)
2	401 (17%)	262 (13%)	247 (13%)	328 (13%)	238 (15%)	176 (11%)	189 (13%)
3	245 (11%)	113 (5%)	154 (8%)	158 (6%)	147 (9%)	118 (8%)	162 (11%)
4	184 (8%)	88 (4%)	101 (5%)	145 (6%)	102 (6%)	70 (5%)	139 (10%)
5	119 (5%)	79 (4%)	59 (3%)	104 (4%)	113 (7%)	66 (4%)	87 (6%)

Enhanced comparative analysis opportunities

EC Category: 4 -- Lyases	AroCyc cell	PlantCyc	V. vinifera	G. max	F. trichocarpa	Z. mays mays	M. esculenta esculenta
4.1.1.1: 2-ketoacid + H⁺ → 2-oxoacid + CO₂		X					
4.1.1.1: D-ribulose 1,5-bisphosphate + O₂ → 2-phosphoglycolate + 1-phosphoglycerate + 2 H⁺	X	X	X	X	X	X	X
4.1.1.1: D-ribulose 1,5-bisphosphate + O₂ → 2-phosphoglycerate + 2-phosphoglycolate	X						
4.1.1.1: L-serine + H⁺ → ethanolamine + CO₂	X	X	X	X	X	X	X
4.1.1.1: UDP-D-glucuronate + H⁺ → UDP-D-glucose + CO₂	X	X	X	X	X	X	X
4.1.1.15: L-glutamate + H⁺ → CO₂ + 4-aminobutrate	X	X	X	X	X	X	X
4.1.1.17: L-ornithine + H⁺ → CO₂ + putrescine		X	X	X	X	X	X
4.1.1.18: L-lysine + H⁺ → CO₂ + cadaverine	X	X					

Interpreting Omics results on the Metabolic Map

PMN
Plant Metabolic Network

PlantCyc search

About PMN Search **Tools** Downloads Useful Sites Submit Data Help Feedback

Tools Overview

Metabolic Map/Omics Viewer

BLAST at the PMN

BLAST at Phytozome

Old Omics Viewer

Comparative Analysis

Dead end Metabolites

Checkpoint Reactions

Reports

Pathway Tools / Biocyc Bundle

Tutorials

Search Database

PlantCyc changes

ArabCyc

CassavaCyc

CornCyc

GrapeCyc

PoplarCyc

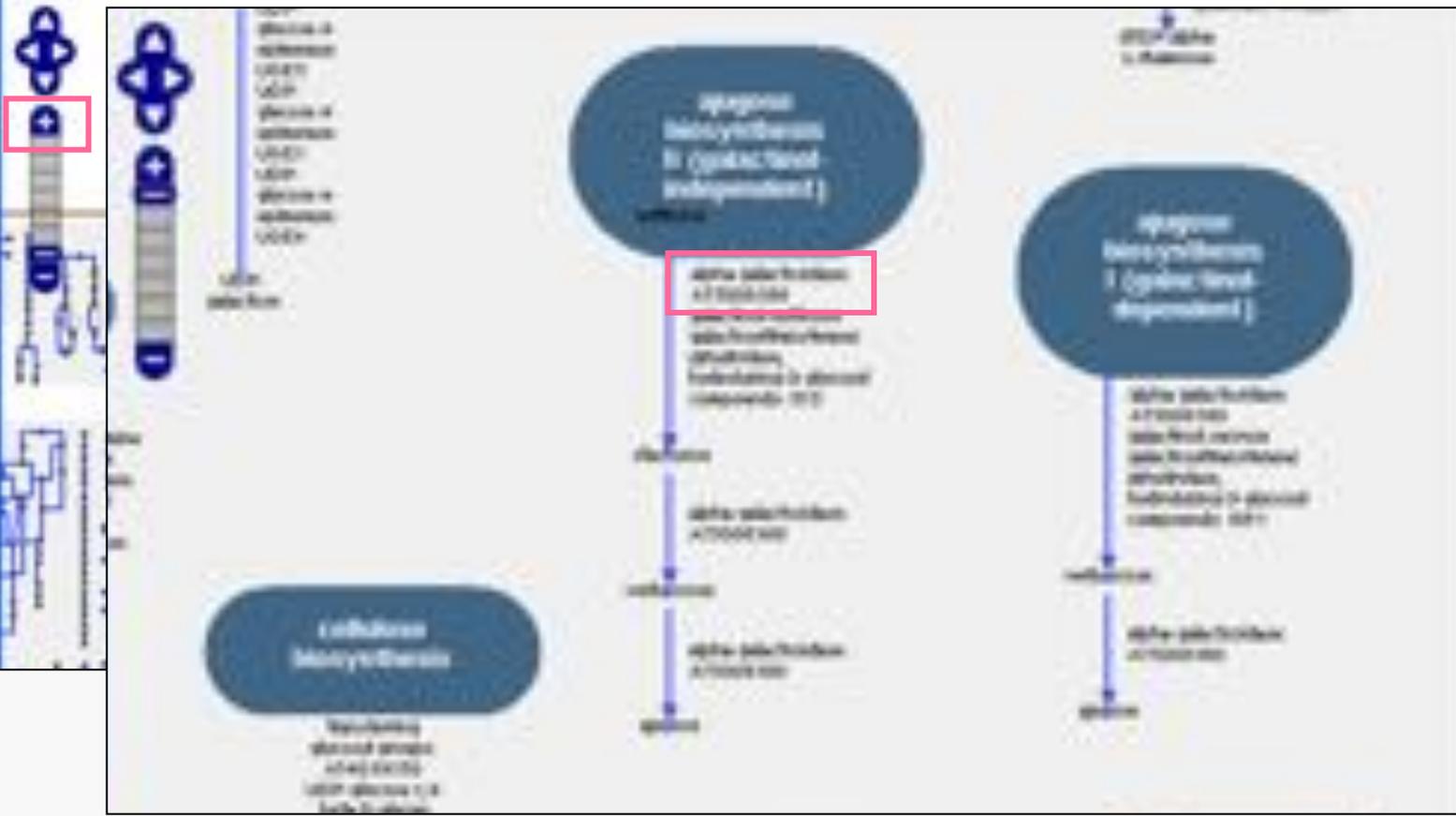
SoyCyc

Tutorial

Omics Viewer Sample Files

Cellular Overview of Arabidopsis thaliana col

For interacting with the whole diagram to finding the left mouse button, click on an object for more info, right click (ctrl-click) for more info for more



Cellular Overview of *Arabidopsis thaliana* col

For interacting with the whole diagram by holding the left mouse button, click on an object for more info, right...

- Display Cellular Overview
- Overlay Experimental Data (Omics Viewer)**
- Highlight Pathway(s) +
- Highlight Reaction(s) +
- Highlight Gene(s) +
- Highlight Enzyme(s) +
- Highlight Compound(s) +
- Highlight/Omics View Based on Names and Frame IDs
- Clear All Highlighting
- Show Legend
- Generate Bookmark for Current Cellular Overview
- Help



Data analysis with the Metabolic Map / Omics Viewer

□ Display exper

■ Data types:

- Genes - t
- Enzymes
- Reaction
- Compound

■ Data inputs:

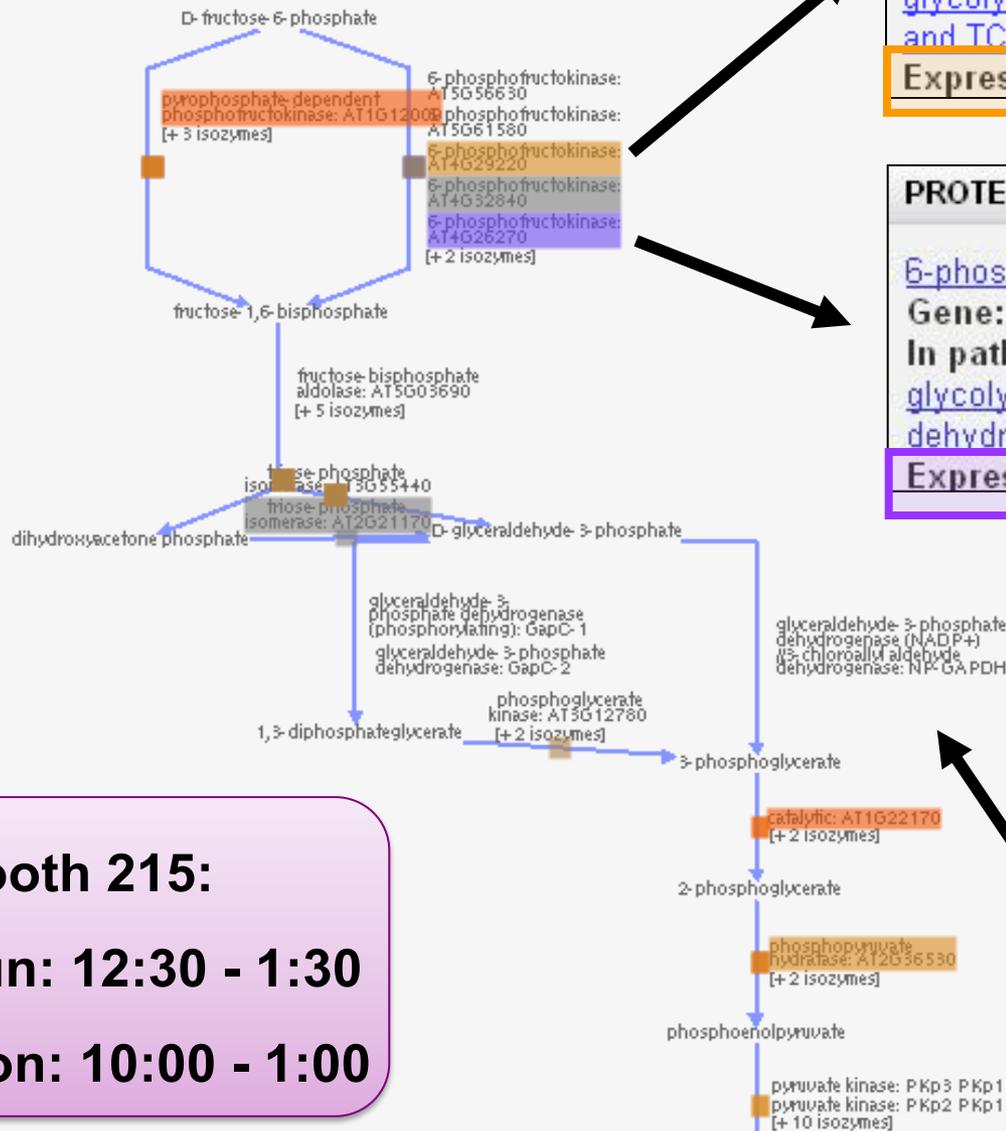
- Single or
- Absolute

```
File Edit View Insert Format Help

# This Arabidopsis expression dataset was taken from the Functional genome
# Low temperature regulatory circuits and gene regulation in higher plants
# http://arabidopsis.org/info/expression/index.html

# Columns of this dataset are:
# Arabidopsis locus id      time_point_1      time_point_2      time_point_3
#
At1g77760      2.15      2.3      3.2      2.15      2.55      1.75
At2g33360      0.7      -0.51      0      -0.73      0.08      -0.72
At3g13210      -1.1      -0.05      1.05      1.15      1.25      0.05
At3g13210      -0.45      -0.35      1.13      1.23      0.67      -0.12
At3g01110      -1.05      -0.15      -1.2      -1.15      -1.15      -0.55
At3g01300      0.07      -0.72      -0.48      -1.4      -1.93      -0.23
At3g02470      0.03      -0.33      0.55      1.25      0.33      1.4
At3g02470      0.55      -0.12      0.62      0.65      -0.05      1.22
At3g02580      0.4      -0.38      0.05      0.33      -2.2      -1.43
At3g02580      2.15      0.7      0.03      -0.4      -2.4      -1.85
At3g02760      -1.15      0.05      0.1      -0.05      -0.57      -0.25
At3g04120      -0.15      -1.35      0.12      -0.3      0.23      1.77
At3g04120      -0.15      -1.5      0.05      -0.32      0.25      1.7
At3g04120      -0.07      -0.65      0.1      -0.75      0.2      1.55
At3g04870      1.05      -1.05      -0.05      -1.1      0.05      -1.33
At3g04940      -0.65      -0.1      -0.85      -1.3      -1.81      -1.3
At3g07420      -0.45      -0.12      -0.7      -0.1      0      -0.1
At3g10850      -0.4      -0.75      -0.45      -0.72      -2.05      -1.57
At3g13790      -0.2      1.5      1.85      1.75      1.77      2.05
At3g13790      1.1      1.75      1.95      1.95      1.85      2.32
At3g14415      0.25      -0.57      -0.55      -1.1      -1.2      -1.22
At3g17240      -0.72      -0.4      -1.05      -0.8      1.3      1.47
```

superpathway of cytosolic glycolysis (plants), pyruvate dehydrogenase and TCA cycle



PROTEIN

[6-phosphofructokinase](#)

Gene: AT4G29220

In pathway: [superpathway of cytosolic glycolysis \(plants\), pyruvate dehydrogenase and TCA cycle](#)

Expression data value: 12.4 Step: 1

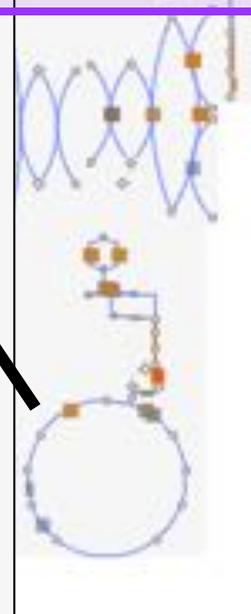
PROTEIN

[6-phosphofructokinase](#)

Gene: AT4G26270

In pathway: [superpathway of cytosolic glycolysis \(plants\), pyruvate dehydrogenase and TCA cycle](#)

Expression data value: 0.004 Step: 1



Booth 215:

Sun: 12:30 - 1:30

Mon: 10:00 - 1:00

Data and software downloads

- Install a local copy of the Pathway Tools software

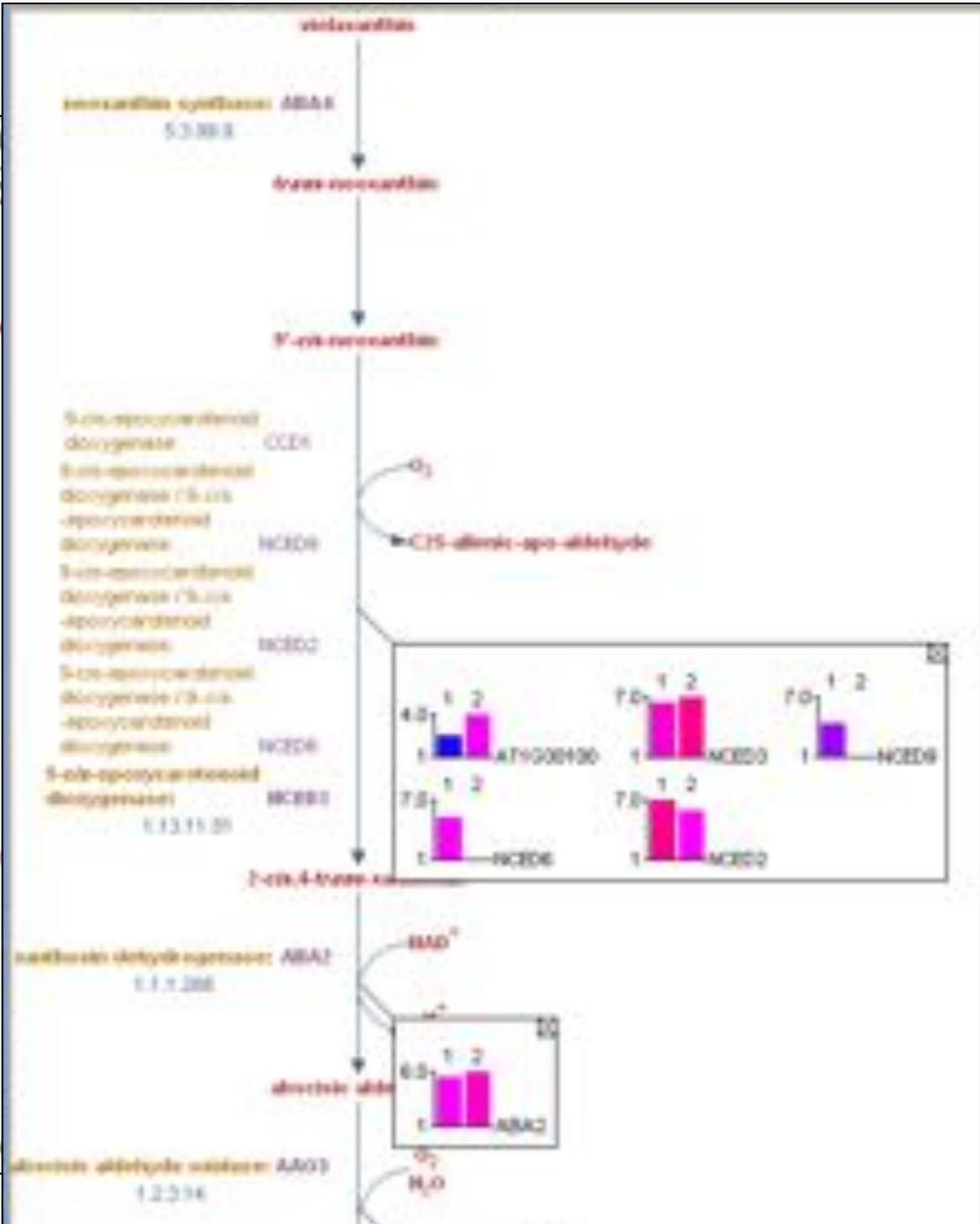
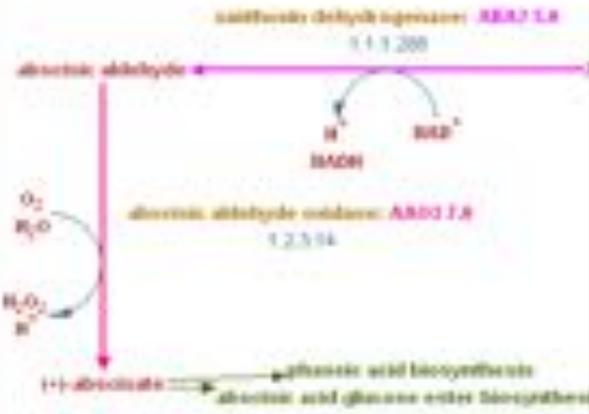
The image shows two overlapping screenshots. The top one is the PMN website, featuring the logo 'PMN Plant Metabolic Network' and a search bar with a 'PlantCyc' dropdown and a 'search' button. The bottom screenshot is a window titled 'Pathway Tools version 12.5' showing the interface for 'Populus trichocarpa'. The interface includes a menu bar (File, Overview, Pathway, Reaction, Protein, RNA, Gene, Compound, Chromosome, Tools, Help), a breadcrumb trail, and a table of genomic data.

<u>Replicon</u>	<u>Total Genes</u>	<u>Protein Genes</u>	<u>RNA Genes</u>	<u>Pseudogenes</u>	<u>Size (bp)</u>
Chromosome 1	271	271	0	0	
Chromosome 2	237	237	0	0	
Chromosome 3	149	149	0	0	
Chromosome 4	114	114	0	0	
Chromosome 5	156	156	0	0	
Chromosome 6	175	175	0	0	

Arabidopsis thaliana cell

Site Predicted Enzymes

superpathway of geranylgeranyl diphosphate biosynthesis II via MEP
 and/or auxin and violaxanthin biosynthesis



On the horizon . . .

- Develop a better enzyme annotation pipeline
- Predict plant metabolic pathways for additional species with predicted proteomes
 - Almost ready . . . :
 - moss
 - papaya
 - Chlamydomonas
 - Selaginella
- Solicit help from experts for pathway validation
 - Remove mis-predictions
 - Add missed pathways
- Increase coverage of experimentally verified enzymes involved in secondary metabolism from diverse species

Questions, contributions, volunteering to validate?

- ❑ To submit data, report an error, or ask a question . . .
 - Send an e-mail: curator@plantcyc.org
 - Use our feedback form:



- Stop by the Plant Genome Resources Outreach Booth (215) **CHOCOLATE!**
- Visit the PMN poster – P19014
- Schedule an individual meeting with me

Community gratitude

□ We



The screenshot shows a website with a dark blue navigation bar at the top containing links for Search, Tools, Downloads, Useful Sites, Submit Data, Help, and Feedback. On the left, a vertical menu lists various site sections, with 'Contributors' highlighted in a red box. The main content area features a light green box titled 'Item of the Month' which contains a section for 'Recent Community Contributors'. This section expresses gratitude to scientists and lists ten names with their affiliations. Below this list, there is a small graphic of three yellow circles and a final list of contributors.

Item of the Month

Recent Community Contributors

We are grateful to the scientists who submit their data directly to us and to those who answer the questions we send them, including the following contributors from the past few months:

- Rob Ingle
- Axel Tiessen
- Stephen Tobe
- Jacqueline Bede
- Julian Hibberd
- Alisdair R. Fernie
- Carlos S. Andreo
- Geoffrey Fucile
- Alain Rahier
- Shannon M. Bell

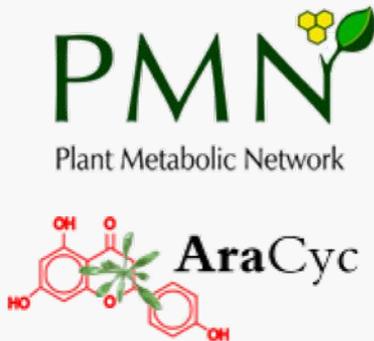
We hope that our [complete list](#) keeps growing with your help and expertise!



- Inad Ajawi - Michigan State University, USA
- Jose Alonso - North Carolina State University, USA
- Richard Amasino - University of Wisconsin, USA
- Ian Baldwin - Max Planck Institute for Chemical Ecology, Germany

Plant metabolic NETWORKING

- Please use our data
- Please use our tools
- Please help us to improve our databases!
- Please contact us if we can be of any help!



curator@plantcyc.org

www.plantcyc.org

PMN Acknowledgements

Curators:

- kate dreher

Post-docs:

- Lee Chae
- Ricardo Nilo Poyanco

Interns

- Varun Dwaraka
- Tam Tran
- Caryn Johansen

Tech Team Members:

- Bob Muller (*Manager*)
- Larry Ploetz (*Sys. Admin*)
- Shanker Singh
- Bill Nelson

Rhee Lab Members:

- Flavia Bossi
- Hye-in Nam

Peifen Zhang (*Director and curator*)

Sue Rhee (*PI*)

Eva Huala (*Co-PI*)



National Science Foundation

CARNEGIE
INSTITUTION FOR
SCIENCE

Collaborators:

SRI

- Peter Karp
- Ron Caspi
- Suzanne Paley
- SRI Tech Team

MaizeGDB

- Mary Schaeffer
- Lisa Harper
- Jack Gardiner
- Taner Sen

- Lukas Mueller (SGN)
- Gramene and MedicCyc

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MaizeGDB

- Mary Schaeffer
- Lisa Harper
- Jack Gardiner
- Taner Sen

PMN Alumni:

- A. S. Karthikeyan (*curator*)
- Christophe Tissier (*curator*)
- Hartmut Foerster (*curator*)
- Damian Priamurskiy (*intern*)
- Ricardo Leitao (*intern*)
- Michael Ahn (*intern*)
- Purva Karia (*intern*)
- Anuradha Pujar (*SGN curator*)

Tech Team Alumni

- Anjo Chi
- Cynthia Lee
- Tom Meyer
- Vanessa Kirkup
- Chris Wilks
- Raymond Chetty

- Lukas Mueller (SGN)
- Gramene and MedicCyc

Peifen Zhang
(Director)

Sue Rhee
(PI)



We're here to help . . .



curator@plantcyc.org

www.plantcyc.org



Booth 215:
Plant Resources Outreach
Sunday, 12:30 – 1:30
Monday, 10:00 – 1:00

Poster P19014 :
Sunday: 6:30 – 7:30 PM

PMN

Quick Search Gene Search

Searching Arabidopsis thaliana col. (LJ2008.02) against database

About PMN Search Tools Downloads Useful Sites Submit Data Help Feedback Cellular Overview

Cellular Overview of *Arabidopsis thaliana* col

For interacting with the whole diagram to finding the left mouse button, click on an object for more info, right-click

By Name or Frame ID

By Substring

From File

Display Cellular Overview

Overlay Experimental Data (Omics Viewer)

Highlight Pathway(s)

Highlight Reaction(s)

Highlight Gene(s)

Highlight Enzyme(s)

Highlight Compound(s)

Highlight/Omics View Based on Names and Frame IDs

Clear All Highlighting

Show Legend

Generate Bookmark for Current Cellular Overview

Help

Highlighting by Gene Name or Frame ID

At1g24360

Highlight Cancel

Generate Bookmark for Cellular Overview

The following bookmark (i.e., a URL or Web link) allows you to redisplay the current diagram with all its active highlighted objects at the current zoom level.

Generated Bookmark:

<http://pmn.plantcsl.org/omview/Web/col/col.html?zoomlevel=0&loc=SBE&loc=29793&orgid=POPLAB&node=CPD:0622%0ACPD:0232%0ACPD:0225%0ACPD:089%0ACPD:0247%0ACPD:0289%0ACPD:4142%0ACPD:>