SBML Model Report

Model name: "Band2012_DII-Venus_ReducedModel"

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1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Vijayalakshmi Chelliah[1] and Leah Band[2] at April fifth 2012 at 2:39 p. m. and last time modified at April second 2014 at 0:26 a. m. Table 1 gives an overview of the quantities of all components of this model.

Table 1: Number of components in this model, which are described in the following sections.

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	1
events	0	constraints	0
reactions	3	function definitions	0
global parameters	4	unit definitions	0
rules	0	initial assignments	0

Model Notes

This model is from the article:
Root gravitropism is regulated by a transient lateral auxin gradient controlled by a tipping-point mechanism.

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Band LR, Wells DM, Larrieu A, Sun J, Middleton AM, French AP, Brunoud G, Sato EM, Wilson MH, Pret B, Oliva M, Swarup R, Sairanen I, Parry G, Ljung K, Beeckman T, Garibaldi JM, Estelle M, Owen MR, Vissenberg K, Hodgman TC, Pridmore TP, King JR, Vernoux T, Bennett MJ. Proc Natl Acad Sci U S A.2012 Mar 20;109(12):4668-73 22393022,

Abstract:
Gravity profoundly influences plant growth and development. Plants respond to changes in orientation by using gravitropic responses to modify their growth. Cholodny and Went hypothesized over 80 years ago that plants bend in response to a gravity stimulus by generating a lateral gradient of a growth regulator at an organ's apex, later found to be auxin. Auxin regulates root growth by targeting Aux/IAA repressor proteins for degradation. We used an Aux/IAA-based reporter, domain II (DII)-VENUS, in conjunction with a mathematical model to quantify auxin redistribution following a gravity stimulus. Our multidisciplinary approach revealed that auxin is rapidly redistributed to the lower side of the root within minutes of a 90 gravity stimulus. Unexpectedly, auxin asymmetry was rapidly lost as bending root tips reached an angle of 40 to the horizontal. We hypothesize roots use a „tipping point„ mechanism that operates to reverse the asymmetric auxin flow at the midpoint of root bending. These mechanistic insights illustrate the scientific value of developing quantitative reporters such as DII-VENUS in conjunction with parameterized mathematical models to provide high-resolution kinetics of hormone redistribution.

This model corresponds to the simplified model described in the article. It is assumed that, on the timescale of DII-VENUS degradation, the concentrations of auxin, TIR1/AFB, and their complexes can be approximated by quasi-steady-state expressions. This reduced the full model to a single ODE that describes how the DII-VENUS dynamics depend on the auxin influx and four parameter groupings.

2 Unit Definitions

This is an overview of five unit definitions which are all predefined by SBML and not mentioned in the model.

2.1 Unit `substance`

Notes Mole is the predefined SBML unit for `substance`.

Definition mol

2.2 Unit `volume`

Notes Litre is the predefined SBML unit for `volume`.

Definition l

2.3 Unit `area`

Notes Square metre is the predefined SBML unit for `area` since SBML Level 2 Version 1.

Definition m^2

2.4 Unit `length`

Notes Metre is the predefined SBML unit for `length` since SBML Level 2 Version 1.

Definition m

2.5 Unit `time`

Notes Second is the predefined SBML unit for `time`.

Definition s

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`cell`		0000290	3	1	litre	☑	

3.1 Compartment `cell`

This is a three dimensional compartment with a constant size of one litre.

SBO:0000290 physical compartment

4 Species

This model contains one species. Section 7 provides further details and the derived rates of change of each species.

Table 3: Properties of each species.

Id	Name	Compartment	Derived Unit	Constant	Boundary Condition
VENUS		cell	$\mathrm{mol} \cdot \mathrm{l}^{-1}$	$\boxminus$	$\boxminus$

5 Parameters

This model contains four global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
p1_star			0.056		☑
p2			0.005		☑
lambda_star			0.520		☑
qj_star			0.160		☑

6 Reactions

This model contains three reactions. All reactions are listed in the following table and are subsequently described in detail. If a reaction is affected by a modifier, the identifier of this species is written above the reaction arrow.

Table 5: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	`VENUSproduction`		$\emptyset \longrightarrow \text{VENUS}$	0000393
2	`VENUSdecayduetophotobleaching`		$\text{VENUS} \longrightarrow \emptyset$	0000179
3	`VENUSdecayduetoauxin`		$\text{VENUS} \longrightarrow \emptyset$	0000179

6.1 Reaction `VENUSproduction`

This is an irreversible reaction of no reactant forming one product.

SBO:0000393 production

Reaction equation

$$\emptyset \longrightarrow \text{VENUS} \tag{1}$$

Product

Table 6: Properties of each product.

Id	Name	SBO
`VENUS`		

Kinetic Law

Derived unit not available

$$v_1 = \text{p2} \tag{2}$$

6.2 Reaction `VENUSdecayduetophotobleaching`

This is an irreversible reaction of one reactant forming no product.

SBO:0000179 degradation

Reaction equation

$$\text{VENUS} \longrightarrow \emptyset \tag{3}$$

Reactant

Table 7: Properties of each reactant.

Id	Name	SBO
`VENUS`		

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \text{lambda\_star} \cdot \text{p2} \cdot [\text{VENUS}] \tag{4}$$

6.3 Reaction VENUSdecayduetoauxin

This is an irreversible reaction of one reactant forming no product.

SBO:0000179 degradation

Reaction equation

$$\text{VENUS} \longrightarrow \emptyset \tag{5}$$

Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
VENUS		

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \frac{\text{p2} \cdot [\text{VENUS}]}{\text{p1\_star} \cdot [\text{VENUS}] + \text{qj\_star}} \tag{6}$$

7 Derived Rate Equation

When interpreted as an ordinary differential equation framework, this model implies the following set of equations for the rate of change of the following species.

Identifiers for kinetic laws highlighted in gray cannot be verified to evaluate to units of SBML substance per time. As a result, some SBML interpreters may not be able to verify the consistency of the units on quantities in the model. Please check if

- parameters without an unit definition are involved or
- volume correction is necessary because the hasOnlySubstanceUnits flag may be set to false and spacialDimensions>0 for certain species.

7.1 Species VENUS

SBO:0000297 protein complex

Initial concentration $1 \text{ mol} \cdot \text{l}^{-1}$

This species takes part in three reactions (as a reactant in VENUSdecayduetophotobleaching, VENUSdecayduetoauxin and as a product in VENUSproduction).

$$\frac{\mathrm{d}}{\mathrm{d}t}\text{VENUS} = v_1 - v_2 - v_3 \tag{7}$$

A Glossary of Systems Biology Ontology Terms

SBO:0000179 degradation: Complete disappearance of a physical entity

SBO:0000290 physical compartment: Specific location of space, that can be bounded or not. A physical compartment can have 1, 2 or 3 dimensions

SBO:0000297 protein complex: Macromolecular complex containing one or more polypeptide chains possibly associated with simple chemicals. CHEBI:3608

SBO:0000393 production: Generation of a material or conceptual entity.

SBML2LaTeX was developed by Andreas Dräger[a], Hannes Planatscher[a], Dieudonné M Wouamba[a], Adrian Schröder[a], Michael Hucka[b], Lukas Endler[c], Martin Golebiewski[d] and Andreas Zell[a]. Please see http://www.ra.cs.uni-tuebingen.de/software/SBML2LaTeX for more information.

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