SBML Model Report

Model name: "Pritchard2014 - plant-microbe interaction"

May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following two authors: Leighton Pritchard[1] and Vijayalakshmi Chelliah[2] at July 21st 2014 at 2:07 p. m. and last time modified at December 19th 2014 at 5:07 p. m. Table 1 provides 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	2
species types	0	species	10
events	1	constraints	0
reactions	15	function definitions	1
global parameters	0	unit definitions	3
rules	0	initial assignments	0

Model Notes

Pritchard2014 - plant-microbeinteractionThismodel is an abstraction of a generic interaction between microbes,and a plant host. The reactions are generally intended to berepresentative of processes, not specific molecular mechanisms(except where indicated, eg. for activation of receptors). Themodel is intended to be of a similar level of abstraction as theZig-Zag model

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proposed in Jones and Dangl (2006) [PMID:17108957],but to represent a dynamic system. Jones and Dangl (2006) model is used here to illustrate the advantages of dynamic representations of systems over expository models such as the Zig-Zag model.

This model is described in the article:The zigzag model of plant-microbe interactions: is it time to move on?Pritchard L, Birch PR.Mol. Plant Pathol. 2014 Dec; 15(9): 865-870

Abstract:

This model is hosted on BioModels Database and identified by: BIOMD0000000563.

To cite BioModels Database, please use: BioModels Database: An enhanced, curated and annotated resource for published quantitative kinetic models.

2 Unit Definitions

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

2.1 Unit `volume`

Name volume

Definition dimensionless

2.2 Unit `time`

Name time

Definition dimensionless

2.3 Unit `substance`

Name substance

Definition dimensionless

2.4 Unit `area`

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

Definition m^2

2.5 Unit `length`

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

Definition m

3 Compartments

This model contains two compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`Cell`	Cell		3	1	dimensionless	☑	
`Apoplast`	Apoplast		3	1	dimensionless	☑	

3.1 Compartment `Cell`

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

Name Cell

Notes `This compartment represents the host cell volume.`

3.2 Compartment `Apoplast`

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

Name Apoplast

Notes `This compartment represents {\textquotestraightdblbase}apoplast{\textquotestraightd`

4 Species

This model contains ten species. Section 8 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
PAMP	PAMP	Cell	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
R	R	Cell	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
R_0	R*	Cell	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
E_int	E_int	Cell	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
Callose	Callose	Cell	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
Path	Path	Apoplast	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
Path_bulk	Path_bulk	Apoplast	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
PRR	PRR*	Apoplast	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
PRR_0	PRR	Apoplast	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$
E	E	Apoplast	dimensionless $\cdot$ dimensionless^{-1}	$\boxminus$	$\boxminus$

5 Function definition

This is an overview of one function definition.

5.1 Function definition `Competitive_inhibition__irr`

Name Competitive inhibition (irr)

Arguments substrate, Inhibitor, Km, V, Ki

Mathematical Expression

$$\frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate} + \frac{\mathrm{Km} \cdot \mathrm{Inhibitor}}{\mathrm{Ki}}} \tag{1}$$

6 Event

This is an overview of one event. Each event is initiated whenever its trigger condition switches from `false` to `true`. A delay function postpones the effects of an event to a later time point. At the time of execution, an event can assign values to species, parameters or compartments if these are not set to constant.

6.1 Event `Pathogen_introduced`

Name Pathogen introduced

Notes `Microbes are introduced to the bulk (not locally to the cell) at a specified time p`

Trigger condition

$$\mathrm{time} > 10 \tag{2}$$

Assignment

$$\mathrm{Path\_bulk} = 1 \tag{3}$$

7 Reactions

This model contains 15 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 4: Overview of all reactions

№	Id	Name	Reaction Equation	SBO
1	PAMP_recognition	PAMP recognition	$\text{PRR\_0} + \text{PAMP} \xrightleftharpoons{\text{PRR\_0, PAMP, PRR}} \text{PRR}$	
2	Effector_recognition	Effector recognition	$\text{R} + \text{E\_int} \xrightleftharpoons{\text{R, E\_int, R\_0}} \text{R\_0}$	
3	Effector_removal	Effector removal	$\text{E} \xrightarrow{\text{E}} \emptyset$	
4	PAMP_removal	PAMP removal	$\text{PAMP} \xrightarrow{\text{PAMP}} \emptyset$	
5	Pathogen_arrival	Pathogen arrival	$\text{Path\_bulk} \xrightarrow{\text{Path\_bulk}} \text{Path\_bulk} + \text{Path}$	
6	Pathogen_removal	Pathogen removal	$\text{Path} \xrightarrow{\text{Path}} \emptyset$	
7	PAMP_production	PAMP production	$\text{Path} \xrightarrow{\text{Path}} \text{PAMP} + \text{Path}$	
8	Effector_production	Effector production	$\text{Path} \xrightarrow{\text{Path}} \text{E} + \text{Path}$	
9	E_int_removal	E_int removal	$\text{E\_int} \xrightarrow{\text{E\_int}} \emptyset$	
10	ETI	ETI	$\text{Path} + \text{R\_0} \xrightarrow{\text{Path, R\_0}} \text{R\_0}$	
11	Effector_translocation	Effector translocation	$\text{E} \xrightarrow{\text{Callose, E, Callose}} \text{E\_int}$	

№	Id	Name	Reaction Equation	SBO
12	`Callose_production`	Callose production	$\text{PRR} \xrightarrow{\text{PRR}} \text{PRR} + \text{Callose}$	
13	`Callose_removal`	Callose removal	$\text{Callose} \xrightarrow{\text{Callose}} \emptyset$	
14	`PTI`	PTI	$\text{Path} + \text{Callose} \xrightarrow{\text{Path, Callose}} \text{Callose}$	
15	`Callose_suppression`	Callose suppression	$\text{Callose} + \text{E\_int} \xrightarrow{\text{Callose, E\_int}} \text{E\_int}$	

7.1 Reaction `PAMP_recognition`

This is a reversible reaction of two reactants forming one product influenced by three modifiers.

Name PAMP recognition

Notes `PAMP recognition abstracts the interaction between PAMPs(/MAMPs/other molecules), a`

Reaction equation

$$\mathrm{PRR\_0} + \mathrm{PAMP} \xrightleftharpoons{\mathrm{PRR\_0},\ \mathrm{PAMP},\ \mathrm{PRR}} \mathrm{PRR} \tag{4}$$

Reactants

Table 5: Properties of each reactant.

Id	Name	SBO
`PRR_0`	PRR	
`PAMP`	PAMP	

Modifiers

Table 6: Properties of each modifier.

Id	Name	SBO
`PRR_0`	PRR	
`PAMP`	PAMP	
`PRR`	PRR*	

Product

Table 7: Properties of each product.

Id	Name	SBO
`PRR`	PRR*	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \mathrm{k1} \cdot [\mathrm{PRR\_0}] \cdot [\mathrm{PAMP}] - \mathrm{k2} \cdot [\mathrm{PRR}] \tag{5}$$

Table 8: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑
k2	k2		0.1		☑

7.2 Reaction Effector_recognition

This is a reversible reaction of two reactants forming one product influenced by three modifiers.

Name Effector recognition

Notes `Effector recognition abstracts the interaction between internalised effector E_int`

Reaction equation

$$R + E\_int \xrightleftharpoons{R,\ E\_int,\ R\_0} R\_0 \tag{6}$$

Reactants

Table 9: Properties of each reactant.

Id	Name	SBO
R	R	
E_int	E_int	

Modifiers

Table 10: Properties of each modifier.

Id	Name	SBO
R	R	
E_int	E_int	
R_0	R*	

Product

Table 11: Properties of each product.

Id	Name	SBO
R_0	R*	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}(\mathrm{Cell}) \cdot (\mathrm{k1} \cdot [\mathrm{R}] \cdot [\mathrm{E\_int}] - \mathrm{k2} \cdot [\mathrm{R\_0}]) \tag{7}$$

Table 12: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑
k2	k2		0.1		☑

7.3 Reaction Effector_removal

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

Name Effector removal

Notes `This represents the loss of effector from the apoplast, necessary to obtain steady`

Reaction equation

$$\mathrm{E} \xrightarrow{\mathrm{E}} \emptyset \tag{8}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
E	E	

Modifier

Table 14: Properties of each modifier.

Id	Name	SBO
E	E	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol}\left(\mathrm{Apoplast}\right) \cdot \mathrm{k1} \cdot [\mathrm{E}] \tag{9}$$

Table 15: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.4 Reaction PAMP_removal

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

Name PAMP removal

Notes This represents the loss of PAMP from the apoplast, necessary to obtain steady stat

Reaction equation

$$\mathrm{PAMP} \xrightarrow{\mathrm{PAMP}} \emptyset \tag{10}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
PAMP	PAMP	

Modifier

Table 17: Properties of each modifier.

Id	Name	SBO
PAMP	PAMP	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{vol}\left(\mathrm{Cell}\right) \cdot \mathrm{k1} \cdot [\mathrm{PAMP}] \tag{11}$$

Table 18: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.5 Reaction Pathogen_arrival

This is an irreversible reaction of one reactant forming two products influenced by one modifier.

Name Pathogen arrival

Notes Pathogen arrival represents movement of microbes from some (distant) 'bulk' to the

Reaction equation

$$\text{Path\_bulk} \xrightarrow{\text{Path\_bulk}} \text{Path\_bulk} + \text{Path} \tag{12}$$

Reactant

Table 19: Properties of each reactant.

Id	Name	SBO
Path_bulk	Path_bulk	

Modifier

Table 20: Properties of each modifier.

Id	Name	SBO
Path_bulk	Path_bulk	

Products

Table 21: Properties of each product.

Id	Name	SBO
Path_bulk	Path_bulk	
Path	Path	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\left(\mathrm{Apoplast}\right) \cdot \mathrm{k1} \cdot [\mathrm{Path\_bulk}] \tag{13}$$

Table 22: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.6 Reaction Pathogen_removal

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

Name Pathogen removal

Notes Pathogen removal represents removal of microbes from the locality of the cell, whe

Reaction equation

$$\mathrm{Path} \xrightarrow{\mathrm{Path}} \emptyset \tag{14}$$

Reactant

Table 23: Properties of each reactant.

Id	Name	SBO
Path	Path	

Modifier

Table 24: Properties of each modifier.

Id	Name	SBO
Path	Path	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{vol}\left(\mathrm{Apoplast}\right) \cdot \mathrm{k1} \cdot [\mathrm{Path}] \tag{15}$$

Table 25: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.7 Reaction PAMP_production

This is an irreversible reaction of one reactant forming two products influenced by one modifier.

Name PAMP production

Notes PAMP is produced proportional to the amount of local microbe (Path) present, in the

Reaction equation

$$\text{Path} \xrightarrow{\text{Path}} \text{PAMP} + \text{Path} \tag{16}$$

Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
Path	Path	

Modifier

Table 27: Properties of each modifier.

Id	Name	SBO
Path	Path	

Products

Table 28: Properties of each product.

Id	Name	SBO
PAMP	PAMP	
Path	Path	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \mathrm{k1} \cdot [\mathrm{Path}] \tag{17}$$

Table 29: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.8 Reaction Effector_production

This is an irreversible reaction of one reactant forming two products influenced by one modifier.

Name Effector production

Notes `Effector E is produced proportional to the amount of local microbe (Path) present.`

Reaction equation

$$\mathrm{Path} \xrightarrow{\mathrm{Path}} \mathrm{E} + \mathrm{Path} \tag{18}$$

Reactant

Table 30: Properties of each reactant.

Id	Name	SBO
Path	Path	

Modifier

Table 31: Properties of each modifier.

Id	Name	SBO
Path	Path	

Products

Table 32: Properties of each product.

Id	Name	SBO
E Path	E Path	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{vol}\left(\mathrm{Apoplast}\right) \cdot \mathrm{k1} \cdot [\mathrm{Path}] \tag{19}$$

Table 33: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.9 Reaction E_int_removal

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

Name E_int removal

Notes `E_int is removed at a constant rate, so steady state can be reached.`

Reaction equation

$$\mathrm{E\_int} \xrightarrow{\mathrm{E\_int}} \emptyset \tag{20}$$

Reactant

Table 34: Properties of each reactant.

Id	Name	SBO
E_int	E_int	

Modifier

Table 35: Properties of each modifier.

Id	Name	SBO
E_int	E_int	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = \mathrm{vol}\left(\mathrm{Cell}\right) \cdot \mathrm{k1} \cdot [\mathrm{E\_int}] \tag{21}$$

Table 36: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.10 Reaction ETI

This is an irreversible reaction of two reactants forming one product influenced by two modifiers.

Name ETI

Notes `The ETI step represents reduction of local microbe concentration due to activation`

Reaction equation

$$\mathrm{Path} + \mathrm{R\_0} \xrightarrow{\mathrm{Path},\ \mathrm{R\_0}} \mathrm{R\_0} \tag{22}$$

Reactants

Table 37: Properties of each reactant.

Id	Name	SBO
Path	Path	
R_0	R*	

Modifiers

Table 38: Properties of each modifier.

Id	Name	SBO
Path	Path	
R_0	R*	

Product

Table 39: Properties of each product.

Id	Name	SBO
R_0	R*	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = \mathrm{k1} \cdot [\mathrm{Path}] \cdot [\mathrm{R\_0}] \tag{23}$$

Table 40: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.11 Reaction Effector_translocation

This is an irreversible reaction of one reactant forming one product influenced by three modifiers.

Name Effector translocation

Notes This step represents the translocation of effector E from the apoplast compartment

Reaction equation

$$\mathrm{E} \xrightarrow{\text{Callose, E, Callose}} \mathrm{E\_int} \tag{24}$$

Reactant

Table 41: Properties of each reactant.

Id	Name	SBO
E	E	

Modifiers

Table 42: Properties of each modifier.

Id	Name	SBO
Callose	Callose	
E	E	
Callose	Callose	

Product

Table 43: Properties of each product.

Id	Name	SBO
E_int	E_int	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = \mathrm{Competitive\_inhibition\_\_irr}\left([\mathrm{E}], [\mathrm{Callose}], \mathrm{Km}, \mathrm{V}, \mathrm{Ki}\right) \tag{25}$$

$$\mathrm{Competitive\_inhibition\_\_irr}\left(\mathrm{substrate}, \mathrm{Inhibitor}, \mathrm{Km}, \mathrm{V}, \mathrm{Ki}\right) = \frac{\mathrm{V} \cdot \mathrm{substrate}}{\mathrm{Km} + \mathrm{substrate} + \frac{\mathrm{Km} \cdot \mathrm{Inhibitor}}{\mathrm{Ki}}} \tag{26}$$

Table 44: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Km	Km		0.1		☑
V	V		0.1		☑
Ki	Ki		0.1		☑

7.12 Reaction `Callose_production`

This is an irreversible reaction of one reactant forming two products influenced by one modifier.

Name Callose production

Notes `The mechanism by which Callose is produced is not defined. Callose is produced at a`

Reaction equation

$$\mathrm{PRR} \xrightarrow{\mathrm{PRR}} \mathrm{PRR} + \mathrm{Callose} \tag{27}$$

Reactant

Table 45: Properties of each reactant.

Id	Name	SBO
PRR	PRR*	

Modifier

Table 46: Properties of each modifier.

Id	Name	SBO
PRR	PRR*	

Products

Table 47: Properties of each product.

Id	Name	SBO
PRR	PRR*	
Callose	Callose	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = \mathrm{k1} \cdot [\mathrm{PRR}] \tag{28}$$

Table 48: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.13 Reaction Callose_removal

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

Name Callose removal

Notes Callose is removed at a constant rate, so that a steady state can be reached.

Reaction equation

$$\text{Callose} \xrightarrow{\text{Callose}} \emptyset \tag{29}$$

Reactant

Table 49: Properties of each reactant.

Id	Name	SBO
Callose	Callose	

Modifier

Table 50: Properties of each modifier.

Id	Name	SBO
Callose	Callose	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = \text{vol}\left(\text{Cell}\right) \cdot \text{k1} \cdot [\text{Callose}] \tag{30}$$

Table 51: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.14 Reaction `PTI`

This is an irreversible reaction of two reactants forming one product influenced by two modifiers.

Name PTI

Notes `The PTI step represents reduction of local microbe concentration due to the activat`

Reaction equation

$$\text{Path} + \text{Callose} \xrightarrow{\text{Path, Callose}} \text{Callose} \tag{31}$$

Reactants

Table 52: Properties of each reactant.

Id	Name	SBO
`Path`	Path	
`Callose`	Callose	

Modifiers

Table 53: Properties of each modifier.

Id	Name	SBO
`Path`	Path	
`Callose`	Callose	

Product

Table 54: Properties of each product.

Id	Name	SBO
`Callose`	Callose	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = \text{k1} \cdot [\text{Path}] \cdot [\text{Callose}] \tag{32}$$

Table 55: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

7.15 Reaction Callose_suppression

This is an irreversible reaction of two reactants forming one product influenced by two modifiers.

Name Callose suppression

Notes Callose suppression is represented by greater loss of Callose when there is interna

Reaction equation

$$\text{Callose} + \text{E\_int} \xrightarrow{\text{Callose, E\_int}} \text{E\_int} \tag{33}$$

Reactants

Table 56: Properties of each reactant.

Id	Name	SBO
Callose	Callose	
E_int	E_int	

Modifiers

Table 57: Properties of each modifier.

Id	Name	SBO
Callose	Callose	
E_int	E_int	

Product

Table 58: Properties of each product.

Id	Name	SBO
E_int	E_int	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = \mathrm{vol}\left(\mathrm{Cell}\right) \cdot \mathrm{k1} \cdot [\mathrm{Callose}] \cdot [\mathrm{E\_int}] \tag{34}$$

Table 59: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	k1		0.1		☑

8 Derived Rate Equations

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

8.1 Species PAMP

Name PAMP

Notes PAMP is an abstraction of pathogen-associated molecular patterns, which are produce

Initial concentration 0 dimensionless $\cdot$ dimensionless^{-1}

This species takes part in five reactions (as a reactant in PAMP_recognition, PAMP_removal and as a product in PAMP_production and as a modifier in PAMP_recognition, PAMP_removal).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PAMP} = v_7 - v_1 - v_4 \tag{35}$$

8.2 Species R

Name R

Notes R represents the host's Resistance protein, in its unbound state. On binding to an

There is a constant pool of R protein in this model.

Initial concentration $1 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

This species takes part in two reactions (as a reactant in Effector_recognition and as a modifier in Effector_recognition).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R} = -v_2 \tag{36}$$

8.3 Species R_0

Name R*

Notes R* represents the host's Resistance protein, activated by binding to E_int. In the

Initial concentration $0 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

This species takes part in five reactions (as a reactant in ETI and as a product in Effector_recognition, ETI and as a modifier in Effector_recognition, ETI).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{R\_0} = v_2 + v_{10} - v_{10} \tag{37}$$

8.4 Species E_int

Name E_int

Notes E_int acts to reduce the effect of PTI by enhancing the rate of loss of Callose. Th

Initial concentration $0 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

This species takes part in eight reactions (as a reactant in Effector_recognition, E_int_removal, Callose_suppression and as a product in Effector_translocation, Callose_suppression and as a modifier in Effector_recognition, E_int_removal, Callose_suppression).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E\_int} = v_{11} + v_{15} - v_2 - v_9 - v_{15} \tag{38}$$

8.5 Species Callose

Name Callose

Notes This species is a generic {\textquotestraightdblbase}Callose{\textquotestraightdblb

Callose is also a proxy for PTI, in that it enhances the rate of loss of the species

Initial concentration $0 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

This species takes part in ten reactions (as a reactant in Callose_removal, PTI, Callose_suppression and as a product in Callose_production, PTI and as a modifier in Effector_translocation, Effector_translocation, Callose_removal, PTI, Callose_suppression).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Callose} = v_{12} + v_{14} - v_{13} - v_{14} - v_{15} \tag{39}$$

8.6 Species Path

Name Path

Notes Path is a representation of microbes local to the cell. These derive from the large

Initial concentration $0 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

This species takes part in 13 reactions (as a reactant in Pathogen_removal, PAMP_production, Effector_production, ETI, PTI and as a product in Pathogen_arrival, PAMP_production, Effector_production and as a modifier in Pathogen_removal, PAMP_production, Effector-_production, ETI, PTI).

$$\frac{d}{dt}\text{Path} = v_5 + v_7 + v_8 - v_6 - v_7 - v_8 - v_{10} - v_{14} \tag{40}$$

8.7 Species Path_bulk

Name Path_bulk

Notes Path_bulk represents a remote population of microbes, from which the local microbes

Initial concentration $0 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

Involved in event Pathogen_introduced

This species takes part in three reactions (as a reactant in Pathogen_arrival and as a product in Pathogen_arrival and as a modifier in Pathogen_arrival).

$$\frac{d}{dt}\text{Path\_bulk} = v_5 - v_5 \tag{41}$$

Furthermore, one event influences this species' rate of change.

8.8 Species PRR

Name PRR*

Notes PRR* represents the host's Pathogen Recognition Receptor, activated by binding to a

Initial concentration $0 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

This species takes part in five reactions (as a reactant in Callose_production and as a product in PAMP_recognition, Callose_production and as a modifier in PAMP_recognition, Callose_production).

$$\frac{d}{dt}\text{PRR} = v_1 + v_{12} - v_{12} \tag{42}$$

8.9 Species PRR_0

Name PRR

Notes PRR represents the host's Pathogen Recognition Receptor, in its unbound state. On

There is a constant pool of PRR in this model.

Initial concentration $1 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

This species takes part in two reactions (as a reactant in PAMP_recognition and as a modifier in PAMP_recognition).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{PRR\_0} = -v_1 \tag{43}$$

8.10 Species E

Name E

Notes This species is an abstract Effector: a molecular species that is produced by the

Initial concentration $0 \text{ dimensionless} \cdot \text{dimensionless}^{-1}$

This species takes part in five reactions (as a reactant in Effector_removal, Effector_translocation and as a product in Effector_production and as a modifier in Effector_removal, Effector_translocation).

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{E} = v_8 - v_3 - v_{11} \tag{44}$$

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