SBML Model Report

Model name: “Ortega2013 - Interplay between secretases determines biphasic amyloid-beta level”

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: Audald Lloret i Villas[1] and Jonathan Stott[2] at October 23rd 2014 at 11:29 a. m. and last time modified at April eighth 2016 at 5:43 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	1
species types	0	species	6
events	0	constraints	0
reactions	8	function definitions	4
global parameters	15	unit definitions	2
rules	6	initial assignments	0

Model Notes

Ortega2013 - Interplay between secretasesdetermines biphasic amyloid-beta level

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This model is described in the article:Interplay between ?-, ?-, and ?-secretases determines biphasic amyloid-? protein level in the presence of a ?-secretase inhibitor.Ortega F, Stott J, Visser SA, Bendtsen C.J. Biol. Chem. 2013 Jan; 288(2): 785-792

Abstract:

Amyloid-? (A?) is produced by the consecutive cleavage of amyloid precursor protein (APP) first by ?-secretase, generating C99, and then by ?-secretase. APP is also cleaved by ?-secretase. It is hypothesized that reducing the production of A? in the brain may slow the progression of Alzheimer disease. Therefore, different ?-secretase inhibitors have been developed to reduce A? production. Paradoxically, it has been shown that low to moderate inhibitor concentrations cause a rise in A? production in different cell lines, in different animal models, and also in humans. A mechanistic understanding of the A? rise remains elusive. Here, a minimal mathematical model has been developed that quantitatively describes the A? dynamics in cell lines that exhibit the rise as well as in cell lines that do not. The model includes steps of APP processing through both the so-called amyloidogenic pathway and the so-called non-amyloidogenic pathway. It is shown that the cross-talk between these two pathways accounts for the increase in A? production in response to inhibitor, i.e. an increase in C99 will inhibit the non-amyloidogenic pathway, redirecting APP to be cleaved by ?-secretase, leading to an additional increase in C99 that overcomes the loss in ?-secretase activity. With a minor extension, the model also describes plasma A? profiles observed in humans upon dosing with a ?-secretase inhibitor. In conclusion, this mechanistic model rationalizes a series of experimental results that spans from in vitro to in vivo and to humans. This has important implications for the development of drugs targeting A? production in Alzheimer disease.

This model is hosted on BioModels Database and identified by: BIOMD0000000556.

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 three are predefined by SBML and not mentioned in the model.

2.1 Unit `volume`

Name volume

Definition ml

2.2 Unit `substance`

Name substance

Definition mmol

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
`Brain`	Brain		3	1	litre	☑	

3.1 Compartment Brain

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

Name Brain

Notes `Brain`

4 Species

This model contains six species. The boundary condition of six of these species is set to `true` so that these species' amount cannot be changed by any reaction. Section 9 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
`APP`	APP	`Brain`	$\mathrm{mmol} \cdot \mathrm{ml}^{-1}$	☐	☑
`C83`	C83	`Brain`	$\mathrm{mmol} \cdot \mathrm{ml}^{-1}$	☐	☑
`C99`	C99	`Brain`	$\mathrm{mmol} \cdot \mathrm{ml}^{-1}$	☐	☑
`AB`	AB	`Brain`	$\mathrm{mmol} \cdot \mathrm{ml}^{-1}$	☐	☑
`X`	X	`Brain`	$\mathrm{mmol} \cdot \mathrm{ml}^{-1}$	☑	☑
`p3`	p3	`Brain`	$\mathrm{mmol} \cdot \mathrm{ml}^{-1}$	☐	☑

5 Parameters

This model contains 15 global parameters.

Table 4: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
v0	v0		1.000		☑
km1	km1		0.186		☑
vm1	vm1		1.100		☑
km3	km3		28.800		☑
vm3	vm3		14.600		☑
km4	km4		0.915		☑
vm4	vm4		1.710		☑
km5	km5		0.067		☑
vm5	vm5		0.022		☑
km2	km2		1.640		☑
vm2	vm2		0.153		☑
kic	kic		0.173		☑
kiu1	kiu1		145.000		☑
kiu2	kiu2		7.310		☑
den	den		1.000		☐

6 Function definitions

This is an overview of four function definitions.

6.1 Function definition Constant_flux__irreversible

Name Constant flux (irreversible)

Argument v

Mathematical Expression

$$v \tag{1}$$

6.2 Function definition VD

Name VD

Arguments Vm, [X], Kx, S, Km, Den

Mathematical Expression

$$\frac{\frac{\frac{\mathrm{Vm}}{1+\frac{[\mathrm{X}]}{\mathrm{Kx}}}\cdot\mathrm{S}}{\mathrm{Km}}}{\mathrm{Den}} \tag{2}$$

6.3 Function definition V1_3_4_5

Name V1,3,4,5

Arguments Vm, S, Km1, M, Km2

Mathematical Expression

$$\frac{\frac{\mathrm{Vm}\cdot\mathrm{S}}{\mathrm{Km1}}}{1+\frac{\mathrm{S}}{\mathrm{Km1}}+\frac{\mathrm{M}}{\mathrm{Km2}}} \tag{3}$$

6.4 Function definition V2

Name V2

Arguments Vm, S, Km

Mathematical Expression

$$\frac{\frac{\mathrm{Vm}\cdot\mathrm{S}}{\mathrm{Km}}}{1+\frac{\mathrm{S}}{\mathrm{Km}}} \tag{4}$$

7 Rules

This is an overview of six rules.

7.1 Rule den

Rule den is an assignment rule for parameter den:

$$\mathrm{den} = 1+\frac{[\mathrm{C83}]}{\mathrm{km3}}\cdot\frac{1+\frac{[\mathrm{X}]}{\mathrm{kiu1}}}{1+\frac{[\mathrm{X}]}{\mathrm{kic}}}+\frac{[\mathrm{C99}]}{\mathrm{km4}}\cdot\frac{1+\frac{[\mathrm{X}]}{\mathrm{kiu2}}}{1+\frac{[\mathrm{X}]}{\mathrm{kic}}} \tag{5}$$

7.2 Rule APP

Rule APP is a rate rule for species APP:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{APP} = \mathrm{r0}-\mathrm{r1}-\mathrm{r2} \tag{6}$$

Derived unit $\mathrm{mmol}\cdot\mathrm{s}^{-1}$

7.3 Rule C83

Rule C83 is a rate rule for species C83:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{C83} = \mathrm{r1} + \mathrm{r5} - \mathrm{r3\_\_D} \tag{7}$$

Derived unit $\mathrm{mmol} \cdot \mathrm{s}$

7.4 Rule C99

Rule C99 is a rate rule for species C99:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{C99} = \mathrm{r2} - \mathrm{r5} - \mathrm{r4\_\_D} \tag{8}$$

Derived unit $\mathrm{mmol} \cdot \mathrm{s}^{-1}$

7.5 Rule AB

Rule AB is a rate rule for species AB:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{AB} = \mathrm{r4\_\_D} \tag{9}$$

Derived unit $\mathrm{mmol} \cdot \mathrm{s}$

7.6 Rule p3

Rule p3 is a rate rule for species p3:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{p3} = \mathrm{r3\_\_D} \tag{10}$$

Derived unit $\mathrm{mmol} \cdot \mathrm{s}^{-1}$

8 Reactions

This model contains eight 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	r0	r0	$\emptyset \longrightarrow \mathrm{APP}$	
2	r1	r1	$\mathrm{APP} \xrightarrow{\mathrm{C99,\ APP,\ C99}} \mathrm{C83}$	
3	r2	r2	$\mathrm{APP} \xrightarrow{\mathrm{APP}} \mathrm{C99}$	
4	r3__ND	r3 (ND)	$\mathrm{C83} \xrightarrow{\mathrm{C99,\ C83,\ C99}} \mathrm{p3}$	
5	r4__ND	r4 (ND)	$\mathrm{C99} \xrightarrow{\mathrm{C83,\ C99,\ C83}} \mathrm{AB}$	
6	r5	r5	$\mathrm{C99} \xrightarrow{\mathrm{APP,\ C99,\ APP}} \mathrm{C83}$	
7	r3__D	r3 (D)	$\mathrm{C83} \xrightarrow{\mathrm{X,\ X,\ C83}} \mathrm{p3}$	
8	r4__D	r4 (D)	$\mathrm{C99} \xrightarrow{\mathrm{X,\ X,\ C99}} \mathrm{AB}$	

8.1 Reaction r0

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

Name r0

Reaction equation

$$\emptyset \longrightarrow \text{APP} \tag{11}$$

Product

Table 6: Properties of each product.

Id	Name	SBO
APP	APP	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = \text{vol}(\text{Brain}) \cdot \text{Constant\_flux\_\_irreversible}(\text{v0}) \tag{12}$$

$$\text{Constant\_flux\_\_irreversible}(\text{v}) = \text{v} \tag{13}$$

$$\text{Constant\_flux\_\_irreversible}(\text{v}) = \text{v} \tag{14}$$

8.2 Reaction r1

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

Name r1

Reaction equation

$$\text{APP} \xrightarrow{\text{C99, APP, C99}} \text{C83} \tag{15}$$

Reactant

Table 7: Properties of each reactant.

Id	Name	SBO
APP	APP	

Modifiers

Table 8: Properties of each modifier.

Id	Name	SBO
C99	C99	
APP	APP	
C99	C99	

Product

Table 9: Properties of each product.

Id	Name	SBO
C83	C83	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = \mathrm{vol}\left(\mathrm{Brain}\right) \cdot \mathrm{V1\_3\_4\_5}\left(\mathrm{vm1}, [\mathrm{APP}], \mathrm{km1}, [\mathrm{C99}], \mathrm{km5}\right) \tag{16}$$

$$\mathrm{V1\_3\_4\_5}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km1}, \mathrm{M}, \mathrm{Km2}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km1}}}{1 + \frac{\mathrm{S}}{\mathrm{Km1}} + \frac{\mathrm{M}}{\mathrm{Km2}}} \tag{17}$$

$$\mathrm{V1\_3\_4\_5}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km1}, \mathrm{M}, \mathrm{Km2}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km1}}}{1 + \frac{\mathrm{S}}{\mathrm{Km1}} + \frac{\mathrm{M}}{\mathrm{Km2}}} \tag{18}$$

8.3 Reaction `r2`

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

Name r2

Reaction equation

$$\mathrm{APP} \xrightarrow{\mathrm{APP}} \mathrm{C99} \tag{19}$$

Reactant

Table 10: Properties of each reactant.

Id	Name	SBO
APP	APP	

Modifier

Table 11: Properties of each modifier.

Id	Name	SBO
APP	APP	

Product

Table 12: Properties of each product.

Id	Name	SBO
C99	C99	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = \mathrm{vol}\left(\mathrm{Brain}\right) \cdot \mathrm{V2}\left(\mathrm{vm2}, [\mathrm{APP}], \mathrm{km2}\right) \tag{20}$$

$$\mathrm{V2}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km}}}{1 + \frac{\mathrm{S}}{\mathrm{Km}}} \tag{21}$$

$$\mathrm{V2}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km}}}{1 + \frac{\mathrm{S}}{\mathrm{Km}}} \tag{22}$$

8.4 Reaction r3__ND

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

Name r3 (ND)

Reaction equation

$$\mathrm{C83} \xrightarrow{\mathrm{C99},\ \mathrm{C83},\ \mathrm{C99}} \mathrm{p3} \tag{23}$$

Reactant

Table 13: Properties of each reactant.

Id	Name	SBO
C83	C83	

Modifiers

Table 14: Properties of each modifier.

Id	Name	SBO
C99	C99	
C83	C83	
C99	C99	

Product

Table 15: Properties of each product.

Id	Name	SBO
p3	p3	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = \mathrm{vol}\left(\mathrm{Brain}\right) \cdot \mathrm{V1\_3\_4\_5}\left(\mathrm{vm3}, [\mathrm{C83}], \mathrm{km3}, [\mathrm{C99}], \mathrm{km4}\right) \tag{24}$$

$$\mathrm{V1\_3\_4\_5}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km1}, \mathrm{M}, \mathrm{Km2}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km1}}}{1 + \frac{\mathrm{S}}{\mathrm{Km1}} + \frac{\mathrm{M}}{\mathrm{Km2}}} \tag{25}$$

$$\mathrm{V1\_3\_4\_5}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km1}, \mathrm{M}, \mathrm{Km2}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km1}}}{1 + \frac{\mathrm{S}}{\mathrm{Km1}} + \frac{\mathrm{M}}{\mathrm{Km2}}} \tag{26}$$

8.5 Reaction r4__ND

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

Name r4 (ND)

Reaction equation

$$\mathrm{C99} \xrightarrow{\mathrm{C83},\ \mathrm{C99},\ \mathrm{C83}} \mathrm{AB} \tag{27}$$

Reactant

Table 16: Properties of each reactant.

Id	Name	SBO
C99	C99	

Modifiers

Table 17: Properties of each modifier.

Id	Name	SBO
C83	C83	
C99	C99	
C83	C83	

Product

Table 18: Properties of each product.

Id	Name	SBO
AB	AB	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = \mathrm{vol}\left(\mathrm{Brain}\right) \cdot \mathrm{V1\_3\_4\_5}\left(\mathrm{vm4}, [\mathrm{C99}], \mathrm{km4}, [\mathrm{C83}], \mathrm{km3}\right) \tag{28}$$

$$\mathrm{V1\_3\_4\_5}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km1}, \mathrm{M}, \mathrm{Km2}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km1}}}{1 + \frac{\mathrm{S}}{\mathrm{Km1}} + \frac{\mathrm{M}}{\mathrm{Km2}}} \tag{29}$$

$$\mathrm{V1\_3\_4\_5}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km1}, \mathrm{M}, \mathrm{Km2}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km1}}}{1 + \frac{\mathrm{S}}{\mathrm{Km1}} + \frac{\mathrm{M}}{\mathrm{Km2}}} \tag{30}$$

8.6 Reaction r5

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

Name r5

Reaction equation

$$\mathrm{C99} \xrightarrow{\mathrm{APP},\ \mathrm{C99},\ \mathrm{APP}} \mathrm{C83} \tag{31}$$

Reactant

Table 19: Properties of each reactant.

Id	Name	SBO
C99	C99	

Modifiers

Table 20: Properties of each modifier.

Id	Name	SBO
APP	APP	
C99	C99	
APP	APP	

Product

Table 21: Properties of each product.

Id	Name	SBO
C83	C83	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = \mathrm{vol}\left(\mathrm{Brain}\right) \cdot \mathrm{V1\_3\_4\_5}\left(\mathrm{vm5}, [\mathrm{C99}], \mathrm{km5}, [\mathrm{APP}], \mathrm{km1}\right) \tag{32}$$

$$\mathrm{V1\_3\_4\_5}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km1}, \mathrm{M}, \mathrm{Km2}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km1}}}{1 + \frac{\mathrm{S}}{\mathrm{Km1}} + \frac{\mathrm{M}}{\mathrm{Km2}}} \tag{33}$$

$$\mathrm{V1\_3\_4\_5}\left(\mathrm{Vm}, \mathrm{S}, \mathrm{Km1}, \mathrm{M}, \mathrm{Km2}\right) = \frac{\frac{\mathrm{Vm} \cdot \mathrm{S}}{\mathrm{Km1}}}{1 + \frac{\mathrm{S}}{\mathrm{Km1}} + \frac{\mathrm{M}}{\mathrm{Km2}}} \tag{34}$$

8.7 Reaction r3__D

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

Name r3 (D)

Reaction equation

$$\text{C83} \xrightarrow{\text{X, X, C83}} \text{p3} \tag{35}$$

Reactant

Table 22: Properties of each reactant.

Id	Name	SBO
C83	C83	

Modifiers

Table 23: Properties of each modifier.

Id	Name	SBO
X	X	
X	X	
C83	C83	

Product

Table 24: Properties of each product.

Id	Name	SBO
p3	p3	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = \text{vol}\left(\text{Brain}\right) \cdot \text{VD}\left(\text{vm3}, [\text{X}], \text{kic}, [\text{C83}], \text{km3}, \text{den}\right) \tag{36}$$

$$\text{VD}\left(\text{Vm}, [\text{X}], \text{Kx}, \text{S}, \text{Km}, \text{Den}\right) = \frac{\frac{\frac{\text{Vm}}{1+\frac{[\text{X}]}{\text{Kx}}} \cdot \text{S}}{\text{Km}}}{\text{Den}} \tag{37}$$

$$\mathrm{VD}\left(\mathrm{Vm},[\mathrm{X}],\mathrm{Kx},\mathrm{S},\mathrm{Km},\mathrm{Den}\right)=\frac{\frac{\frac{\mathrm{Vm}}{1+\frac{[\mathrm{X}]}{\mathrm{Kx}}}\cdot\mathrm{S}}{\mathrm{Km}}}{\mathrm{Den}} \tag{38}$$

8.8 Reaction r4__D

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

Name r4 (D)

Reaction equation

$$\mathrm{C99} \xrightarrow{\mathrm{X},\ \mathrm{X},\ \mathrm{C99}} \mathrm{AB} \tag{39}$$

Reactant

Table 25: Properties of each reactant.

Id	Name	SBO
C99	C99	

Modifiers

Table 26: Properties of each modifier.

Id	Name	SBO
X	X	
X	X	
C99	C99	

Product

Table 27: Properties of each product.

Id	Name	SBO
AB	AB	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = \mathrm{vol}\left(\mathrm{Brain}\right)\cdot\mathrm{VD}\left(\mathrm{vm4},[\mathrm{X}],\mathrm{kic},[\mathrm{C99}],\mathrm{km4},\mathrm{den}\right) \tag{40}$$

$$\mathrm{VD}\left(\mathrm{Vm},[\mathrm{X}],\mathrm{Kx},\mathrm{S},\mathrm{Km},\mathrm{Den}\right)=\frac{\frac{\frac{\mathrm{Vm}}{1+\frac{[\mathrm{X}]}{\mathrm{Kx}}}\cdot\mathrm{S}}{\mathrm{Km}}}{\mathrm{Den}} \tag{41}$$

$$\mathrm{VD}\left(\mathrm{Vm},[\mathrm{X}],\mathrm{Kx},\mathrm{S},\mathrm{Km},\mathrm{Den}\right)=\frac{\frac{\frac{\mathrm{Vm}}{1+\frac{[\mathrm{X}]}{\mathrm{Kx}}}\cdot\mathrm{S}}{\mathrm{Km}}}{\mathrm{Den}} \tag{42}$$

9 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.

9.1 Species APP

Name APP

Notes `Amyloid protein precursor`

Initial concentration $0\ \mathrm{mmol}\cdot\mathrm{ml}^{-1}$

Involved in rule APP

This species takes part in seven reactions (as a reactant in r1, r2 and as a product in r0 and as a modifier in r1, r2, r5, r5). Not these but one rule determines the species' quantity because this species is on the boundary of the reaction system.

9.2 Species C83

Name C83

Notes `C83 proteolytic product`

Initial concentration $0\ \mathrm{mmol}\cdot\mathrm{ml}^{-1}$

Involved in rule C83

This species takes part in eight reactions (as a reactant in r3__ND, r3__D and as a product in r1, r5 and as a modifier in r3__ND, r4__ND, r4__ND, r3__D). Not these but one rule determines the species' quantity because this species is on the boundary of the reaction system.

9.3 Species C99

Name C99

Notes C99 proteolytic product

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

Involved in rule C99

This species takes part in eleven reactions (as a reactant in r4__ND, r5, r4__D and as a product in r2 and as a modifier in r1, r1, r3__ND, r3__ND, r4__ND, r5, r4__D). Not these but one rule determines the species' quantity because this species is on the boundary of the reaction system.

9.4 Species AB

Name AB

Notes Amyloid-beta

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

Involved in rule AB

This species takes part in two reactions (as a product in r4__ND, r4__D). Not these but one rule determines the species' quantity because this species is on the boundary of the reaction system.

9.5 Species X

Name X

Notes gamma-secretase inhibitor drug

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

This species takes part in four reactions (as a modifier in r3__D, r3__D, r4__D, r4__D), which do not influence its rate of change because this constant species is on the boundary of the reaction system:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{X} = 0 \tag{43}$$

9.6 Species p3

Name p3

Notes Amyloid-beta p3 fragment

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

Involved in rule p3

This species takes part in two reactions (as a product in r3__ND, r3__D). Not these but one rule determines the species' quantity because this species is on the boundary of the reaction system.

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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