

## SBML Model Report

# Model name: “Amara2013 - PCNA ubiquitylation in the activation of PRR pathway”



May 6, 2016

## 1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following four authors: Nick Juty<sup>1</sup>, Vijayalakshmi Chelliah<sup>2</sup>, Flavio Amara<sup>3</sup> and Marco Muzi Falconi<sup>4</sup> at September sixth 2013 at 4:57 p. m. and last time modified at March fifth 2014 at 4:56 p. 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              | 23       |
| events            | 0        | constraints          | 0        |
| reactions         | 25       | function definitions | 0        |
| global parameters | 1        | unit definitions     | 3        |
| rules             | 1        | initial assignments  | 0        |

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## Model Notes

Mechanistic model of the Post-Replication Repair (PRR), the pathway involved in the bypass of DNA lesions induced by sunlight exposure and UV radiation. PRR acts through two different mechanisms, activated by mono- and poly-ubiquitylation of the DNA sliding clamp, called Proliferating Cell Nuclear Antigen (PCNA). This model has been defined according to the stochastic formulation of chemical kinetics [Gillespie DT, J Phys Chem 1977, 81(25):2340-2361], which requires to specify the set of molecular species occurring in the pathway and their respective interactions, formally described as a set of biochemical reactions. The volume considered for this system is 1.666667e-17L; this value can be used to convert the model into the deterministic formulation.

## 2 Unit Definitions

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

### 2.1 Unit `volume`

**Name** `volume`

**Definition** dimensionless

### 2.2 Unit `substance`

**Name** `substance`

**Definition** dimensionless

### 2.3 Unit `per_second`

**Definition**  $\text{s}^{-1}$

### 2.4 Unit `area`

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

**Definition**  $\text{m}^2$

### 2.5 Unit `length`

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

**Definition** `m`

## 2.6 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<br>Dimensions | Size | Unit          | Constant                            | Outside |
|----------------------------|--------------------------|-----|-----------------------|------|---------------|-------------------------------------|---------|
| <code>compartment_1</code> | <code>compartment</code> |     | 3                     | 1    | dimensionless | <input checked="" type="checkbox"/> |         |

### 3.1 Compartment `compartment_1`

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

**Name** `compartment`

## 4 Species

This model contains 23 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 |
|------------|--------------------------|---------------|--|----------|--------------------|
| species_1  | L                        | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_2  | PCNA                     | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_3  | PCNAon                   | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_4  | Rad18:Rad18              | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_5  | Rad18                    | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_6  | Rad6                     | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_7  | Rad6U                    | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_8  | U                        | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_9  | Rad18:Rad18:PCNAon       | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_10 | Rad18:Rad18:PCNAon:Rad6U | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |
| species_11 | Rad18:Rad18:PCNAonU      | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊖   | ⊖                  |

| Id         | Name                       | Compartment   | Derived Unit                                 | Constant | Boundary Condition |
|------------|----------------------------|---------------|--|----------|--------------------|
| species_12 | PCNAonU                    | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_13 | Rad5                       | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_14 | Rad5:PCNAonU               | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_15 | Ubc13U:Mms2                | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_16 | Ubc13U:Mms2:Rad5:PCNAonU   | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_17 | Rad5:PCNAonU:U             | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_18 | Ubc13:Mms2                 | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_19 | PCNAonU:U                  | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_20 | Ubc13U:Mms2:Rad5:PCNAonU:U | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_21 | Rad5:PCNAonU:U:U           | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_22 | PCNAonU:U:U                | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |
| species_23 | PCNAoff                    | compartment_1 | dimensionless<br>dimensionless <sup>-1</sup> | ·<br>⊠   | ⊠                  |

## 5 Parameter

This model contains one global parameter.

Table 4: Properties of each parameter.

| Id          | Name     | SBO | Value | Unit | Constant                 |
|-------------|----------|-----|-------|------|--------------------------|
| parameter_1 | PCNA_sum |     | 0.0   |      | <input type="checkbox"/> |

## 6 Rule

This is an overview of one rule.

### 6.1 Rule `parameter_1`

Rule `parameter_1` is an assignment rule for parameter `parameter_1`:

$$\begin{aligned} \text{parameter\_1} = & [\text{species\_12}] + [\text{species\_19}] + [\text{species\_22}] + [\text{species\_11}] + [\text{species\_14}] \\ & + [\text{species\_17}] + [\text{species\_21}] + [\text{species\_20}] + [\text{species\_16}] \end{aligned} \quad (1)$$

**Derived unit** dimensionless<sup>-1</sup>

## 7 Reactions

This model contains 25 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

| Nº | Id          | Name | Reaction Equation  | SBO |
|----|-------------|------|--|-----|
| 1  | reaction_1  | r01  | $\text{species\_2} + \text{species\_1} \xrightarrow{\text{species\_2, species\_1}} \text{species\_3}$      |     |
| 2  | reaction_2  | r02  | $2 \text{ species\_5} \xrightarrow{\text{species\_5}} \text{species\_4}$                                   |     |
| 3  | reaction_3  | r03  | $\text{species\_4} \xrightarrow{\text{species\_4}} 2 \text{ species\_5}$                                   |     |
| 4  | reaction_4  | r04  | $\text{species\_6} + \text{species\_8} \xrightarrow{\text{species\_6, species\_8}} \text{species\_7}$      |     |
| 5  | reaction_5  | r05  | $\text{species\_3} + \text{species\_4} \xrightarrow{\text{species\_3, species\_4}} \text{species\_9}$      |     |
| 6  | reaction_6  | r06  | $\text{species\_9} \xrightarrow{\text{species\_9}} \text{species\_3} + \text{species\_4}$                  |     |
| 7  | reaction_7  | r07  | $\text{species\_7} + \text{species\_9} \xrightarrow{\text{species\_7, species\_9}} \text{species\_10}$     |     |
| 8  | reaction_8  | r08  | $\text{species\_10} \xrightarrow{\text{species\_10}} \text{species\_7} + \text{species\_9}$                |     |
| 9  | reaction_9  | r09  | $\text{species\_10} \xrightarrow{\text{species\_10}} \text{species\_6} + \text{species\_11}$               |     |
| 10 | reaction_10 | r10  | $\text{species\_11} \xrightarrow{\text{species\_11}} \text{species\_4} + \text{species\_12}$               |     |
| 11 | reaction_11 | r11  | $\text{species\_8} + \text{species\_18} \xrightarrow{\text{species\_8, species\_18}} \text{species\_15}$   |     |
| 12 | reaction_12 | r12  | $\text{species\_12} + \text{species\_13} \xrightarrow{\text{species\_12, species\_13}} \text{species\_14}$ |     |
| 13 | reaction_13 | r13  | $\text{species\_14} \xrightarrow{\text{species\_14}} \text{species\_12} + \text{species\_13}$              |     |
| 14 | reaction_14 | r14  | $\text{species\_14} + \text{species\_15} \xrightarrow{\text{species\_14, species\_15}} \text{species\_16}$ |     |
| 15 | reaction_15 | r15  | $\text{species\_16} \xrightarrow{\text{species\_16}} \text{species\_14} + \text{species\_15}$              |     |

| Nº | Id          | Name | Reaction Equation   | SBO |
|----|-------------|------|---|-----|
| 16 | reaction_16 | r16  | $\text{species\_16} \xrightarrow{\text{species\_16}} \text{species\_18} + \text{species\_17}$                     |     |
| 17 | reaction_17 | r17  | $\text{species\_17} \xrightarrow{\text{species\_17}} \text{species\_13} + \text{species\_19}$                     |     |
| 18 | reaction_18 | r18  | $\text{species\_13} + \text{species\_19} \xrightarrow{\text{species\_13}, \text{species\_19}} \text{species\_17}$ |     |
| 19 | reaction_19 | r19  | $\text{species\_15} + \text{species\_17} \xrightarrow{\text{species\_15}, \text{species\_17}} \text{species\_20}$ |     |
| 20 | reaction_20 | r20  | $\text{species\_20} \xrightarrow{\text{species\_20}} \text{species\_15} + \text{species\_17}$                     |     |
| 21 | reaction_21 | r21  | $\text{species\_20} \xrightarrow{\text{species\_20}} \text{species\_18} + \text{species\_21}$                     |     |
| 22 | reaction_22 | r22  | $\text{species\_21} \xrightarrow{\text{species\_21}} \text{species\_13} + \text{species\_22}$                     |     |
| 23 | reaction_23 | r23  | $\text{species\_12} \xrightarrow{\text{species\_12}} \text{species\_8} + \text{species\_23}$                      |     |
| 24 | reaction_24 | r24  | $\text{species\_19} \xrightarrow{\text{species\_19}} 2 \text{ species\_8} + \text{species\_23}$                   |     |
| 25 | reaction_25 | r25  | $\text{species\_22} \xrightarrow{\text{species\_22}} 3 \text{ species\_8} + \text{species\_23}$                   |     |

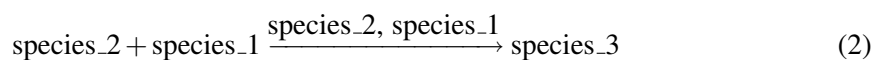


## 7.1 Reaction `reaction_1`

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

**Name** `r01`

### Reaction equation



### Reactants

Table 6: Properties of each reactant.

| Id                     | Name | SBO |
|------------------------|------|-----|
| <code>species_2</code> | PCNA |     |
| <code>species_1</code> | L    |     |

### Modifiers

Table 7: Properties of each modifier.

| Id                     | Name | SBO |
|------------------------|------|-----|
| <code>species_2</code> | PCNA |     |
| <code>species_1</code> | L    |     |

### Product

Table 8: Properties of each product.

| Id                     | Name   | SBO |
|------------------------|--------|-----|
| <code>species_3</code> | PCNAon |     |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_1 = \text{vol}(\text{compartment\_1}) \cdot k_1 \cdot [\text{species\_2}] \cdot [\text{species\_1}] \quad (3)$$

Table 9: Properties of each parameter.

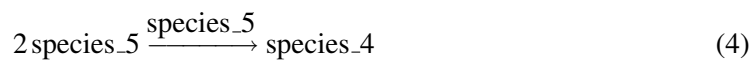
| Id | Name | SBO | Value               | Unit | Constant                            |
|----|------|-----|---------------------|------|-------------------------------------|
| k1 | k1   |     | $1.5 \cdot 10^{-8}$ |      | <input checked="" type="checkbox"/> |

## 7.2 Reaction [reaction\\_2](#)

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

**Name** r02

### Reaction equation



### Reactant

Table 10: Properties of each reactant.

| Id        | Name  | SBO |
|-----------|-------|-----|
| species_5 | Rad18 |     |

### Modifier

Table 11: Properties of each modifier.

| Id        | Name  | SBO |
|-----------|-------|-----|
| species_5 | Rad18 |     |

### Product

Table 12: Properties of each product.

| Id        | Name        | SBO |
|-----------|-------------|-----|
| species_4 | Rad18:Rad18 |     |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_2 = \text{vol}(\text{compartment\_1}) \cdot k1 \cdot [\text{species\_5}]^2 \quad (5)$$

Table 13: Properties of each parameter.

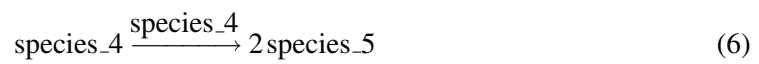
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.01  |      | <input checked="" type="checkbox"/> |

### 7.3 Reaction `reaction_3`

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

**Name** `r03`

#### Reaction equation



#### Reactant

Table 14: Properties of each reactant.

| Id        | Name        | SBO |
|-----------|-------------|-----|
| species_4 | Rad18:Rad18 |     |

#### Modifier

Table 15: Properties of each modifier.

| Id        | Name        | SBO |
|-----------|-------------|-----|
| species_4 | Rad18:Rad18 |     |

#### Product

Table 16: Properties of each product.

| Id        | Name  | SBO |
|-----------|-------|-----|
| species_5 | Rad18 |     |

#### Kinetic Law

**Derived unit** contains undeclared units

$$v_3 = \text{vol}(\text{compartment\_1}) \cdot k1 \cdot [\text{species\_4}] \quad (7)$$

Table 17: Properties of each parameter.

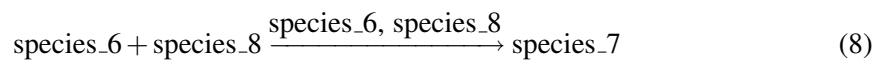
| Id | Name | SBO | Value  | Unit | Constant                            |
|----|------|-----|--------|------|-------------------------------------|
| k1 | k1   |     | 1000.0 |      | <input checked="" type="checkbox"/> |

## 7.4 Reaction `reaction_4`

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

**Name** `r04`

### Reaction equation



### Reactants

Table 18: Properties of each reactant.

| Id        | Name | SBO |
|-----------|------|-----|
| species_6 | Rad6 |     |
| species_8 | U    |     |

### Modifiers

Table 19: Properties of each modifier.

| Id        | Name | SBO |
|-----------|------|-----|
| species_6 | Rad6 |     |
| species_8 | U    |     |

### Product

Table 20: Properties of each product.

| Id        | Name  | SBO |
|-----------|-------|-----|
| species_7 | Rad6U |     |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_4 = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_6] \cdot [\text{species}_8] \quad (9)$$

Table 21: Properties of each parameter.

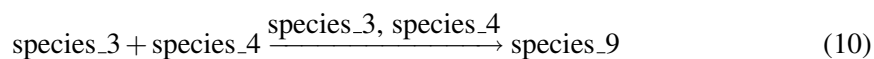
| Id | Name | SBO | Value               | Unit | Constant                            |
|----|------|-----|---------------------|------|-------------------------------------|
| k1 | k1   |     | $2.5 \cdot 10^{-7}$ |      | <input checked="" type="checkbox"/> |

## 7.5 Reaction `reaction_5`

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

**Name** r05

### Reaction equation



### Reactants

Table 22: Properties of each reactant.

| Id        | Name        | SBO |
|-----------|-------------|-----|
| species_3 | PCNAon      |     |
| species_4 | Rad18:Rad18 |     |

### Modifiers

Table 23: Properties of each modifier.

| Id        | Name        | SBO |
|-----------|-------------|-----|
| species_3 | PCNAon      |     |
| species_4 | Rad18:Rad18 |     |

### Product

Table 24: Properties of each product.

| Id        | Name               | SBO |
|-----------|--------------------|-----|
| species_9 | Rad18:Rad18:PCNAon |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_5 = \text{vol}(\text{compartment}_1) \cdot k1 \cdot [\text{species}_3] \cdot [\text{species}_4] \quad (11)$$

Table 25: Properties of each parameter.

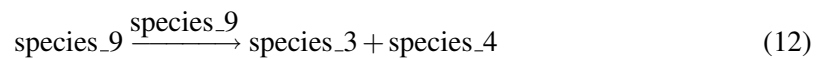
| Id | Name | SBO | Value    | Unit | Constant                            |
|----|------|-----|----------|------|-------------------------------------|
| k1 | k1   |     | 100000.0 |      | <input checked="" type="checkbox"/> |

## 7.6 Reaction `reaction_6`

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

**Name** r06

### Reaction equation



### Reactant

Table 26: Properties of each reactant.

| Id        | Name               | SBO |
|-----------|--------------------|-----|
| species_9 | Rad18:Rad18:PCNAon |     |

### Modifier

Table 27: Properties of each modifier.

| Id        | Name               | SBO |
|-----------|--------------------|-----|
| species_9 | Rad18:Rad18:PCNAon |     |

### Products

Table 28: Properties of each product.

| Id        | Name   | SBO |
|-----------|--------|-----|
| species_3 | PCNAon |     |

| Id        | Name        | SBO |
|-----------|-------------|-----|
| species_4 | Rad18:Rad18 |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_6 = \text{vol}(\text{compartment}_1) \cdot k1 \cdot [\text{species}_9] \quad (13)$$

Table 29: Properties of each parameter.

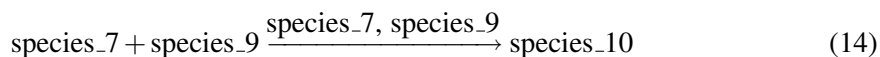
| Id | Name | SBO | Value  | Unit | Constant                            |
|----|------|-----|--------|------|-------------------------------------|
| k1 | k1   |     | 1000.0 |      | <input checked="" type="checkbox"/> |

## 7.7 Reaction [reaction\\_7](#)

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

**Name** r07

### Reaction equation



## Reactants

Table 30: Properties of each reactant.

| Id        | Name               | SBO |
|-----------|--------------------|-----|
| species_7 | Rad6U              |     |
| species_9 | Rad18:Rad18:PCNAon |     |

## Modifiers

Table 31: Properties of each modifier.

| Id        | Name               | SBO |
|-----------|--------------------|-----|
| species_7 | Rad6U              |     |
| species_9 | Rad18:Rad18:PCNAon |     |

## Product

Table 32: Properties of each product.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_10 | Rad18:Rad18:PCNAon:Rad6U |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_7 = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_7] \cdot [\text{species}_9] \quad (15)$$

Table 33: Properties of each parameter.

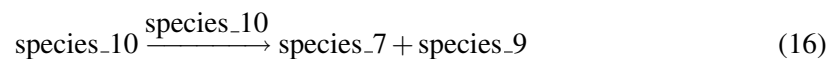
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.035 |      | <input checked="" type="checkbox"/> |

## 7.8 Reaction `reaction_8`

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

**Name** r08

## Reaction equation



## Reactant

Table 34: Properties of each reactant.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_10 | Rad18:Rad18:PCNAon:Rad6U |     |

## Modifier

Table 35: Properties of each modifier.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_10 | Rad18:Rad18:PCNAon:Rad6U |     |



| Id | Name | SBO |
|----|------|-----|
|----|------|-----|

## Products

Table 36: Properties of each product.

| Id        | Name               | SBO |
|-----------|--------------------|-----|
| species_7 | Rad6U              |     |
| species_9 | Rad18:Rad18:PCNAon |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_8 = \text{vol}(\text{compartment}_1) \cdot k1 \cdot [\text{species}_{10}] \quad (17)$$

Table 37: Properties of each parameter.

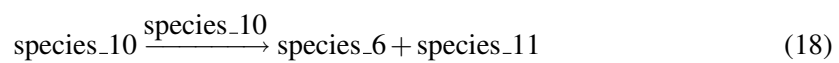
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.01  |      | <input checked="" type="checkbox"/> |

## 7.9 Reaction `reaction_9`

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

**Name** r09

### Reaction equation



## Reactant

Table 38: Properties of each reactant.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_10 | Rad18:Rad18:PCNAon:Rad6U |     |

## Modifier

Table 39: Properties of each modifier.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_10 | Rad18:Rad18:PCNAon:Rad6U |     |

## Products

Table 40: Properties of each product.

| Id         | Name                | SBO |
|------------|---------------------|-----|
| species_6  | Rad6                |     |
| species_11 | Rad18:Rad18:PCNAonU |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_9 = \text{vol}(\text{compartment}_1) \cdot k1 \cdot [\text{species}_10] \quad (19)$$

Table 41: Properties of each parameter.

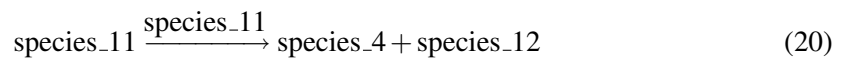
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.01  |      | <input checked="" type="checkbox"/> |

### 7.10 Reaction `reaction_10`

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

**Name** r10

#### Reaction equation



## Reactant

Table 42: Properties of each reactant.

| Id         | Name                | SBO |
|------------|---------------------|-----|
| species_11 | Rad18:Rad18:PCNAonU |     |

## Modifier

Table 43: Properties of each modifier.

| Id         | Name                | SBO |
|------------|---------------------|-----|
| species_11 | Rad18:Rad18:PCNAonU |     |

## Products

Table 44: Properties of each product.

| Id         | Name        | SBO |
|------------|-------------|-----|
| species_4  | Rad18:Rad18 |     |
| species_12 | PCNAonU     |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{10} = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_{11}] \quad (21)$$

Table 45: Properties of each parameter.

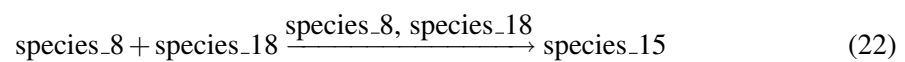
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 1.0   |      | <input checked="" type="checkbox"/> |

### 7.11 Reaction `reaction_11`

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

**Name** r11

#### Reaction equation



## Reactants

Table 46: Properties of each reactant.

| Id         | Name       | SBO |
|------------|------------|-----|
| species_8  | U          |     |
| species_18 | Ubc13:Mms2 |     |

## Modifiers

Table 47: Properties of each modifier.

| Id         | Name       | SBO |
|------------|------------|-----|
| species_8  | U          |     |
| species_18 | Ubc13:Mms2 |     |

## Product

Table 48: Properties of each product.

| Id         | Name        | SBO |
|------------|-------------|-----|
| species_15 | Ubc13U:Mms2 |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{11} = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_8] \cdot [\text{species}_{18}] \quad (23)$$

Table 49: Properties of each parameter.

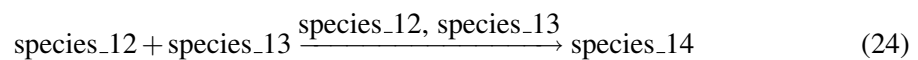
| Id | Name | SBO | Value    | Unit | Constant                            |
|----|------|-----|----------|------|-------------------------------------|
| k1 | k1   |     | 100000.0 |      | <input checked="" type="checkbox"/> |

### 7.12 Reaction `reaction_12`

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

**Name** r12

#### Reaction equation



## Reactants

Table 50: Properties of each reactant.

| Id         | Name    | SBO |
|------------|---------|-----|
| species_12 | PCNAonU |     |
| species_13 | Rad5    |     |

## Modifiers

Table 51: Properties of each modifier.

| Id         | Name    | SBO |
|------------|---------|-----|
| species_12 | PCNAonU |     |
| species_13 | Rad5    |     |

## Product

Table 52: Properties of each product.

| Id         | Name         | SBO |
|------------|--------------|-----|
| species_14 | Rad5:PCNAonU |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{12} = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_12] \cdot [\text{species}_13] \quad (25)$$

Table 53: Properties of each parameter.

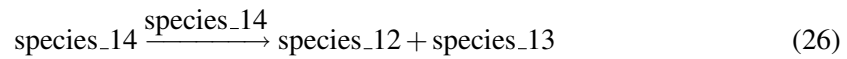
| Id | Name | SBO | Value             | Unit | Constant                            |
|----|------|-----|-------------------|------|-------------------------------------|
| k1 | k1   |     | $5 \cdot 10^{-6}$ |      | <input checked="" type="checkbox"/> |

### 7.13 Reaction `reaction_13`

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

**Name** r13

## Reaction equation



## Reactant

Table 54: Properties of each reactant.

| Id         | Name         | SBO |
|------------|--------------|-----|
| species_14 | Rad5:PCNAonU |     |

## Modifier

Table 55: Properties of each modifier.

| Id         | Name         | SBO |
|------------|--------------|-----|
| species_14 | Rad5:PCNAonU |     |

## Products

Table 56: Properties of each product.

| Id         | Name    | SBO |
|------------|---------|-----|
| species_12 | PCNAonU |     |
| species_13 | Rad5    |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{13} = \text{vol}(\text{compartment\_1}) \cdot k_1 \cdot [\text{species\_14}] \quad (27)$$

Table 57: Properties of each parameter.

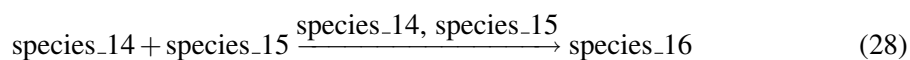
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.005 |      | <input checked="" type="checkbox"/> |

## 7.14 Reaction `reaction_14`

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

**Name** `r14`

### Reaction equation



### Reactants

Table 58: Properties of each reactant.

| Id                      | Name         | SBO |
|-------------------------|--------------|-----|
| <code>species_14</code> | Rad5:PCNAonU |     |
| <code>species_15</code> | Ubc13U:Mms2  |     |

### Modifiers

Table 59: Properties of each modifier.

| Id                      | Name         | SBO |
|-------------------------|--------------|-----|
| <code>species_14</code> | Rad5:PCNAonU |     |
| <code>species_15</code> | Ubc13U:Mms2  |     |

### Product

Table 60: Properties of each product.

| Id                      | Name                     | SBO |
|-------------------------|--------------------------|-----|
| <code>species_16</code> | Ubc13U:Mms2:Rad5:PCNAonU |     |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{14} = \text{vol}(\text{compartment\_1}) \cdot k_1 \cdot [\text{species\_14}] \cdot [\text{species\_15}] \quad (29)$$

Table 61: Properties of each parameter.

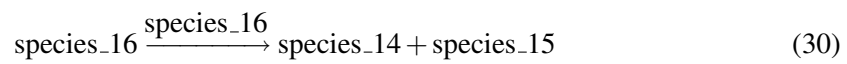
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.078 |      | <input checked="" type="checkbox"/> |

### 7.15 Reaction [reaction\\_15](#)

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

**Name** r15

#### Reaction equation



#### Reactant

Table 62: Properties of each reactant.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_16 | Ubc13U:Mms2:Rad5:PCNAonU |     |

#### Modifier

Table 63: Properties of each modifier.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_16 | Ubc13U:Mms2:Rad5:PCNAonU |     |

#### Products

Table 64: Properties of each product.

| Id         | Name         | SBO |
|------------|--------------|-----|
| species_14 | Rad5:PCNAonU |     |
| species_15 | Ubc13U:Mms2  |     |

#### Kinetic Law

**Derived unit** contains undeclared units



$$v_{15} = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_{16}] \quad (31)$$

Table 65: Properties of each parameter.

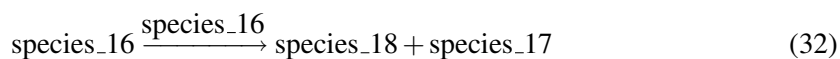
| Id | Name | SBO | Value      | Unit | Constant                            |
|----|------|-----|------------|------|-------------------------------------|
| k1 | k1   |     | $10^{-10}$ |      | <input checked="" type="checkbox"/> |

## 7.16 Reaction [reaction\\_16](#)

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

**Name** r16

### Reaction equation



### Reactant

Table 66: Properties of each reactant.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_16 | Ubc13U:Mms2:Rad5:PCNAonU |     |

### Modifier

Table 67: Properties of each modifier.

| Id         | Name                     | SBO |
|------------|--------------------------|-----|
| species_16 | Ubc13U:Mms2:Rad5:PCNAonU |     |

### Products

Table 68: Properties of each product.

| Id         | Name           | SBO |
|------------|----------------|-----|
| species_18 | Ubc13:Mms2     |     |
| species_17 | Rad5:PCNAonU:U |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{16} = \text{vol}(\text{compartment\_1}) \cdot k1 \cdot [\text{species\_16}] \quad (33)$$

Table 69: Properties of each parameter.

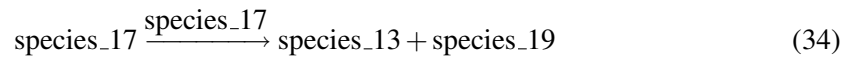
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.05  |      | <input checked="" type="checkbox"/> |

## 7.17 Reaction `reaction_17`

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

**Name** `r17`

### Reaction equation



### Reactant

Table 70: Properties of each reactant.

| Id         | Name           | SBO |
|------------|----------------|-----|
| species_17 | Rad5:PCNAonU:U |     |

### Modifier

Table 71: Properties of each modifier.

| Id         | Name           | SBO |
|------------|----------------|-----|
| species_17 | Rad5:PCNAonU:U |     |

### Products

Table 72: Properties of each product.

| Id         | Name | SBO |
|------------|------|-----|
| species_13 | Rad5 |     |

| Id         | Name      | SBO |
|------------|-----------|-----|
| species_19 | PCNAonU:U |     |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{17} = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_17] \quad (35)$$

Table 73: Properties of each parameter.

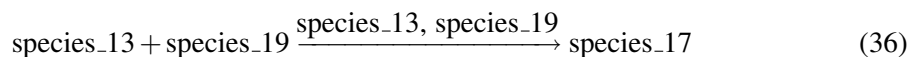
| Id | Name | SBO | Value               | Unit | Constant                            |
|----|------|-----|---------------------|------|-------------------------------------|
| k1 | k1   |     | $7.5 \cdot 10^{-6}$ |      | <input checked="" type="checkbox"/> |

### 7.18 Reaction [reaction\\_18](#)

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

**Name** r18

### Reaction equation



### Reactants

Table 74: Properties of each reactant.

| Id         | Name      | SBO |
|------------|-----------|-----|
| species_13 | Rad5      |     |
| species_19 | PCNAonU:U |     |

### Modifiers

Table 75: Properties of each modifier.

| Id         | Name      | SBO |
|------------|-----------|-----|
| species_13 | Rad5      |     |
| species_19 | PCNAonU:U |     |

## Product

Table 76: Properties of each product.

| Id         | Name           | SBO |
|------------|----------------|-----|
| species_17 | Rad5:PCNAonU:U |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{18} = \text{vol}(\text{compartment}_1) \cdot k1 \cdot [\text{species}_{13}] \cdot [\text{species}_{19}] \quad (37)$$

Table 77: Properties of each parameter.

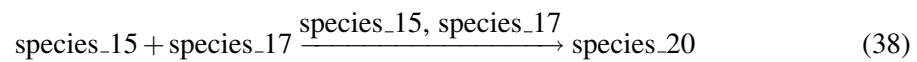
| Id | Name | SBO | Value             | Unit | Constant                            |
|----|------|-----|-------------------|------|-------------------------------------|
| k1 | k1   |     | $5 \cdot 10^{-6}$ |      | <input checked="" type="checkbox"/> |

### 7.19 Reaction [reaction\\_19](#)

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

**Name** r19

## Reaction equation



## Reactants

Table 78: Properties of each reactant.

| Id         | Name           | SBO |
|------------|----------------|-----|
| species_15 | Ubc13U:Mms2    |     |
| species_17 | Rad5:PCNAonU:U |     |

## Modifiers

Table 79: Properties of each modifier.

| Id         | Name           | SBO |
|------------|----------------|-----|
| species_15 | Ubc13U:Mms2    |     |
| species_17 | Rad5:PCNAonU:U |     |

## Product

Table 80: Properties of each product.

| Id         | Name                       | SBO |
|------------|----------------------------|-----|
| species_20 | Ubc13U:Mms2:Rad5:PCNAonU:U |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{19} = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_15] \cdot [\text{species}_17] \quad (39)$$

Table 81: Properties of each parameter.

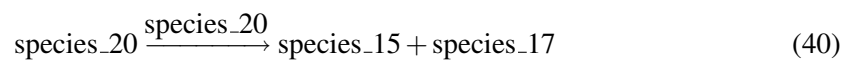
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.078 |      | <input checked="" type="checkbox"/> |

## 7.20 Reaction [reaction\\_20](#)

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

**Name** r20

## Reaction equation



## Reactant

Table 82: Properties of each reactant.

| Id         | Name                       | SBO |
|------------|----------------------------|-----|
| species_20 | Ubc13U:Mms2:Rad5:PCNAonU:U |     |

## Modifier

Table 83: Properties of each modifier.

| Id         | Name                       | SBO |
|------------|----------------------------|-----|
| species_20 | Ubc13U:Mms2:Rad5:PCNAonU:U |     |

## Products

Table 84: Properties of each product.

| Id         | Name           | SBO |
|------------|----------------|-----|
| species_15 | Ubc13U:Mms2    |     |
| species_17 | Rad5:PCNAonU:U |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{20} = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_{20}] \quad (41)$$

Table 85: Properties of each parameter.

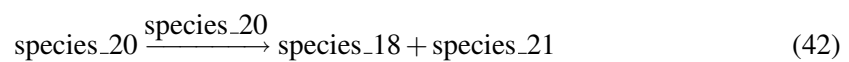
| Id | Name | SBO | Value      | Unit | Constant                            |
|----|------|-----|------------|------|-------------------------------------|
| k1 | k1   |     | $10^{-10}$ |      | <input checked="" type="checkbox"/> |

### 7.21 Reaction [reaction\\_21](#)

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

**Name** r21

#### Reaction equation



#### Reactant

Table 86: Properties of each reactant.

| Id         | Name                       | SBO |
|------------|----------------------------|-----|
| species_20 | Ubc13U:Mms2:Rad5:PCNAonU:U |     |

## Modifier

Table 87: Properties of each modifier.

| Id         | Name                       | SBO |
|------------|----------------------------|-----|
| species_20 | Ubc13U:Mms2:Rad5:PCNAonU:U |     |

## Products

Table 88: Properties of each product.

| Id         | Name             | SBO |
|------------|------------------|-----|
| species_18 | Ubc13:Mms2       |     |
| species_21 | Rad5:PCNAonU:U:U |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{21} = \text{vol}(\text{compartment}_1) \cdot k_1 \cdot [\text{species}_20] \quad (43)$$

Table 89: Properties of each parameter.

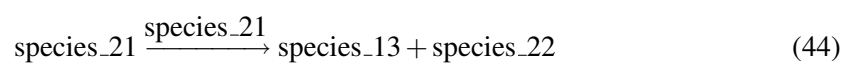
| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.005 |      | <input checked="" type="checkbox"/> |

### 7.22 Reaction `reaction_22`

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

**Name** `r22`

## Reaction equation



## Reactant

Table 90: Properties of each reactant.

| Id         | Name             | SBO |
|------------|------------------|-----|
| species_21 | Rad5:PCNAonU:U:U |     |

## Modifier

Table 91: Properties of each modifier.

| Id         | Name             | SBO |
|------------|------------------|-----|
| species_21 | Rad5:PCNAonU:U:U |     |

## Products

Table 92: Properties of each product.

| Id         | Name        | SBO |
|------------|-------------|-----|
| species_13 | Rad5        |     |
| species_22 | PCNAonU:U:U |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{22} = \text{vol}(\text{compartment\_1}) \cdot k_1 \cdot [\text{species\_21}] \quad (45)$$

Table 93: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.005 |      | <input checked="" type="checkbox"/> |

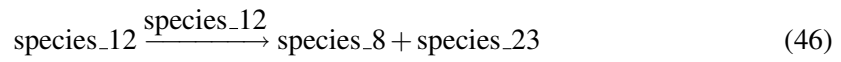
### 7.23 Reaction `reaction_23`

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

**Name** `r23`



## Reaction equation



## Reactant

Table 94: Properties of each reactant.

| Id         | Name    | SBO |
|------------|---------|-----|
| species_12 | PCNAonU |     |

## Modifier

Table 95: Properties of each modifier.

| Id         | Name    | SBO |
|------------|---------|-----|
| species_12 | PCNAonU |     |

## Products

Table 96: Properties of each product.

| Id         | Name    | SBO |
|------------|---------|-----|
| species_8  | U       |     |
| species_23 | PCNAoff |     |

## Kinetic Law

**Derived unit** contains undeclared units

$$v_{23} = \text{vol}(\text{compartment\_1}) \cdot k1 \cdot [\text{species\_12}] \quad (47)$$

Table 97: Properties of each parameter.

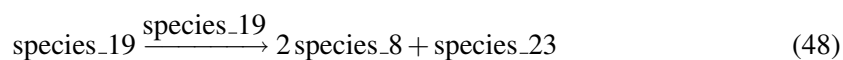
| Id | Name | SBO | Value             | Unit | Constant                            |
|----|------|-----|-------------------|------|-------------------------------------|
| k1 | k1   |     | $3 \cdot 10^{-8}$ |      | <input checked="" type="checkbox"/> |

## 7.24 Reaction `reaction_24`

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

**Name** `r24`

### Reaction equation



### Reactant

Table 98: Properties of each reactant.

| Id                      | Name      | SBO |
|-------------------------|-----------|-----|
| <code>species_19</code> | PCNAonU:U |     |

### Modifier

Table 99: Properties of each modifier.

| Id                      | Name      | SBO |
|-------------------------|-----------|-----|
| <code>species_19</code> | PCNAonU:U |     |

### Products

Table 100: Properties of each product.

| Id                      | Name    | SBO |
|-------------------------|---------|-----|
| <code>species_8</code>  | U       |     |
| <code>species_23</code> | PCNAoff |     |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{24} = \text{vol}(\text{compartment\_1}) \cdot k_1 \cdot [\text{species\_19}] \quad (49)$$

Table 101: Properties of each parameter.

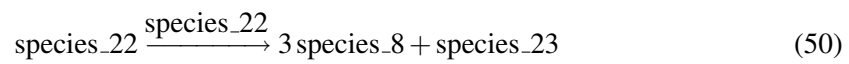
| Id | Name | SBO | Value             | Unit | Constant                            |
|----|------|-----|-------------------|------|-------------------------------------|
| k1 | k1   |     | $8 \cdot 10^{-4}$ |      | <input checked="" type="checkbox"/> |

## 7.25 Reaction [reaction\\_25](#)

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

**Name** r25

### Reaction equation



### Reactant

Table 102: Properties of each reactant.

| Id         | Name        | SBO |
|------------|-------------|-----|
| species_22 | PCNAonU:U:U |     |

### Modifier

Table 103: Properties of each modifier.

| Id         | Name        | SBO |
|------------|-------------|-----|
| species_22 | PCNAonU:U:U |     |

### Products

Table 104: Properties of each product.

| Id         | Name    | SBO |
|------------|---------|-----|
| species_8  | U       |     |
| species_23 | PCNAoff |     |

### Kinetic Law

**Derived unit** contains undeclared units

$$v_{25} = \text{vol}(\text{compartment\_1}) \cdot k1 \cdot [\text{species\_22}] \quad (51)$$

Table 105: Properties of each parameter.

| Id | Name | SBO | Value | Unit | Constant                            |
|----|------|-----|-------|------|-------------------------------------|
| k1 | k1   |     | 0.005 |      | <input checked="" type="checkbox"/> |

## 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 `species_1`

**Name** L

**Initial concentration** 1001 dimensionless · dimensionless<sup>-1</sup>

This species takes part in two reactions (as a reactant in [reaction\\_1](#) and as a modifier in [reaction\\_1](#)).

$$\frac{d}{dt} \text{species\_1} = -v_1 \quad (52)$$

### 8.2 Species `species_2`

**Name** PCNA

**Initial concentration** 7480 dimensionless · dimensionless<sup>-1</sup>

This species takes part in two reactions (as a reactant in [reaction\\_1](#) and as a modifier in [reaction\\_1](#)).

$$\frac{d}{dt} \text{species\_2} = -v_1 \quad (53)$$

### 8.3 Species `species_3`

**Name** PCNAon

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in four reactions (as a reactant in [reaction\\_5](#) and as a product in [reaction\\_1](#), [reaction\\_6](#) and as a modifier in [reaction\\_5](#)).

$$\frac{d}{dt}\text{species\_3} = v_1 + v_6 - v_5 \quad (54)$$

### 8.4 Species `species_4`

**Name** Rad18:Rad18

**SBO:0000286** multimer

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in seven reactions (as a reactant in [reaction\\_3](#), [reaction\\_5](#) and as a product in [reaction\\_2](#), [reaction\\_6](#), [reaction\\_10](#) and as a modifier in [reaction\\_3](#), [reaction\\_5](#)).

$$\frac{d}{dt}\text{species\_4} = v_2 + v_6 + v_{10} - v_3 - v_5 \quad (55)$$

### 8.5 Species `species_5`

**Name** Rad18

**Initial concentration** 206 dimensionless · dimensionless<sup>-1</sup>

This species takes part in three reactions (as a reactant in [reaction\\_2](#) and as a product in [reaction\\_3](#) and as a modifier in [reaction\\_2](#)).

$$\frac{d}{dt}\text{species\_5} = 2 v_3 - 2 v_2 \quad (56)$$

### 8.6 Species `species_6`

**Name** Rad6

**Initial concentration** 194 dimensionless · dimensionless<sup>-1</sup>

This species takes part in three reactions (as a reactant in [reaction\\_4](#) and as a product in [reaction\\_9](#) and as a modifier in [reaction\\_4](#)).

$$\frac{d}{dt}\text{species\_6} = v_9 - v_4 \quad (57)$$

### 8.7 Species `species_7`

**Name** Rad6U

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in four reactions (as a reactant in [reaction\\_7](#) and as a product in [reaction\\_4](#), [reaction\\_8](#) and as a modifier in [reaction\\_7](#)).

$$\frac{d}{dt}\text{species\_7} = v_4 + v_8 - v_7 \quad (58)$$

### 8.8 Species `species_8`

**Name** U

**Initial concentration** 8698 dimensionless · dimensionless<sup>-1</sup>

This species takes part in seven reactions (as a reactant in [reaction\\_4](#), [reaction\\_11](#) and as a product in [reaction\\_23](#), [reaction\\_24](#), [reaction\\_25](#) and as a modifier in [reaction\\_4](#), [reaction\\_11](#)).

$$\frac{d}{dt}\text{species\_8} = v_{23} + 2 v_{24} + 3 v_{25} - v_4 - v_{11} \quad (59)$$

### 8.9 Species `species_9`

**Name** Rad18:Rad18:PCNAon

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in six reactions (as a reactant in [reaction\\_6](#), [reaction\\_7](#) and as a product in [reaction\\_5](#), [reaction\\_8](#) and as a modifier in [reaction\\_6](#), [reaction\\_7](#)).

$$\frac{d}{dt}\text{species\_9} = v_5 + v_8 - v_6 - v_7 \quad (60)$$

### 8.10 Species `species_10`

**Name** Rad18:Rad18:PCNAon:Rad6U

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in five reactions (as a reactant in [reaction\\_8](#), [reaction\\_9](#) and as a product in [reaction\\_7](#) and as a modifier in [reaction\\_8](#), [reaction\\_9](#)).

$$\frac{d}{dt}\text{species\_10} = v_7 - v_8 - v_9 \quad (61)$$

### 8.11 Species `species_11`

**Name** Rad18:Rad18:PCNAonU

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in three reactions (as a reactant in [reaction\\_10](#) and as a product in [reaction\\_9](#) and as a modifier in [reaction\\_10](#)).

$$\frac{d}{dt}\text{species\_11} = v_9 - v_{10} \quad (62)$$

### 8.12 Species `species_12`

**Name** PCNAonU

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in six reactions (as a reactant in [reaction\\_12](#), [reaction\\_23](#) and as a product in [reaction\\_10](#), [reaction\\_13](#) and as a modifier in [reaction\\_12](#), [reaction\\_23](#)).

$$\frac{d}{dt}\text{species\_12} = v_{10} + v_{13} - v_{12} - v_{23} \quad (63)$$

### 8.13 Species `species_13`

**Name** Rad5

**Initial concentration** 1520 dimensionless · dimensionless<sup>-1</sup>

This species takes part in seven reactions (as a reactant in [reaction\\_12](#), [reaction\\_18](#) and as a product in [reaction\\_13](#), [reaction\\_17](#), [reaction\\_22](#) and as a modifier in [reaction\\_12](#), [reaction\\_18](#)).

$$\frac{d}{dt}\text{species\_13} = v_{13} + v_{17} + v_{22} - v_{12} - v_{18} \quad (64)$$

### 8.14 Species `species_14`

**Name** Rad5:PCNAonU

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in six reactions (as a reactant in [reaction\\_13](#), [reaction\\_14](#) and as a product in [reaction\\_12](#), [reaction\\_15](#) and as a modifier in [reaction\\_13](#), [reaction\\_14](#)).

$$\frac{d}{dt}\text{species\_14} = v_{12} + v_{15} - v_{13} - v_{14} \quad (65)$$

### 8.15 Species `species_15`

**Name** Ubc13U:Mms2

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in seven reactions (as a reactant in [reaction\\_14](#), [reaction\\_19](#) and as a product in [reaction\\_11](#), [reaction\\_15](#), [reaction\\_20](#) and as a modifier in [reaction\\_14](#), [reaction\\_19](#)).

$$\frac{d}{dt}\text{species\_15} = v_{11} + v_{15} + v_{20} - v_{14} - v_{19} \quad (66)$$

### 8.16 Species `species_16`

**Name** Ubc13U:Mms2:Rad5:PCNAonU

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in five reactions (as a reactant in [reaction\\_15](#), [reaction\\_16](#) and as a product in [reaction\\_14](#) and as a modifier in [reaction\\_15](#), [reaction\\_16](#)).

$$\frac{d}{dt}\text{species\_16} = v_{14} - v_{15} - v_{16} \quad (67)$$

### 8.17 Species `species_17`

**Name** Rad5:PCNAonU:U

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in seven reactions (as a reactant in [reaction\\_17](#), [reaction\\_19](#) and as a product in [reaction\\_16](#), [reaction\\_18](#), [reaction\\_20](#) and as a modifier in [reaction\\_17](#), [reaction\\_19](#)).

$$\frac{d}{dt}\text{species\_17} = v_{16} + v_{18} + v_{20} - v_{17} - v_{19} \quad (68)$$



### 8.18 Species `species_18`

**Name** Ubc13:Mms2

**SBO:0000297** protein complex

**Initial concentration** 193 dimensionless · dimensionless<sup>-1</sup>

This species takes part in four reactions (as a reactant in [reaction\\_11](#) and as a product in [reaction\\_16](#), [reaction\\_21](#) and as a modifier in [reaction\\_11](#)).

$$\frac{d}{dt}\text{species\_18} = v_{16} + v_{21} - v_{11} \quad (69)$$

### 8.19 Species `species_19`

**Name** PCNAonU:U

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in five reactions (as a reactant in [reaction\\_18](#), [reaction\\_24](#) and as a product in [reaction\\_17](#) and as a modifier in [reaction\\_18](#), [reaction\\_24](#)).

$$\frac{d}{dt}\text{species\_19} = v_{17} - v_{18} - v_{24} \quad (70)$$

### 8.20 Species `species_20`

**Name** Ubc13U:Mms2:Rad5:PCNAonU:U

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in five reactions (as a reactant in [reaction\\_20](#), [reaction\\_21](#) and as a product in [reaction\\_19](#) and as a modifier in [reaction\\_20](#), [reaction\\_21](#)).

$$\frac{d}{dt}\text{species\_20} = v_{19} - v_{20} - v_{21} \quad (71)$$

### 8.21 Species `species_21`

**Name** Rad5:PCNAonU:U:U

**SBO:0000297** protein complex

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in three reactions (as a reactant in [reaction\\_22](#) and as a product in [reaction\\_21](#) and as a modifier in [reaction\\_22](#)).

$$\frac{d}{dt}\text{species\_21} = v_{21} - v_{22} \quad (72)$$

## 8.22 Species `species_22`

**Name** PCNAonU:U:U

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in three reactions (as a reactant in `reaction_25` and as a product in `reaction_22` and as a modifier in `reaction_25`).

$$\frac{d}{dt}\text{species\_22} = v_{22} - v_{25} \quad (73)$$

## 8.23 Species `species_23`

**Name** PCNAoff

**Initial concentration** 0 dimensionless · dimensionless<sup>-1</sup>

This species takes part in three reactions (as a product in `reaction_23`, `reaction_24`, `reaction_25`).

$$\frac{d}{dt}\text{species\_23} = v_{23} + v_{24} + v_{25} \quad (74)$$

## A Glossary of Systems Biology Ontology Terms

**SBO:0000286 multimer:** Non-covalent association of identical, or pseudo-identical, entities. By pseudo-identical entities, we mean biochemical elements that differ chemically, although remaining globally identical in structure and/or function. Examples are homologous subunits in an hetero-oligomeric receptor

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

SBML<sup>2</sup>TeX was developed by Andreas Dräger<sup>a</sup>, Hannes Planatscher<sup>a</sup>, Dieudonné M Wouamba<sup>a</sup>, Adrian Schröder<sup>a</sup>, Michael Hucka<sup>b</sup>, Lukas Endler<sup>c</sup>, Martin Golebiewski<sup>d</sup> and Andreas Zell<sup>a</sup>. Please see <http://www.ra.cs.uni-tuebingen.de/software/SBML2LaTeX> for more information.

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