

SBML Model Report

Model name:
“Tiago2010_FeMetabolism_FeLoaded”



May 6, 2016

1 General Overview

This is a document in SBML Level 2 Version 1 format. This model was created by the following two authors: Vijayalakshmi Chelliah¹ and Tiago Jose da Silva Lopes² at August 19th 2010 at 10:31 a.m. and last time modified at April fourth 2014 at 2:34 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	17
events	0	constraints	0
reactions	29	function definitions	0
global parameters	0	unit definitions	0
rules	0	initial assignments	0

Model Notes

This a model from the article:

Systems analysis of iron metabolism: the network of iron pools and fluxes

Tiago JS Lopes, Tatyana Luganskaja, Maja Vujic-Spasic, Matthias W Hentze, Martina U Muckenthaler, Klaus Schumann and Jens G Reich *BMC Systems Biology*2010, Aug 13;4(1):112.

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[20704761](#),

Abstract:

Background

Every cell of the mammalian organism needs iron in numerous oxido-reductive processes as well as for transport and storage of oxygen. The versatility of ionic iron makes it a toxic entity which can catalyze the production of radicals that damage vital membranous and macromolecular assemblies in the cell. The mammalian organism maintains therefore a complex regulatory network of iron uptake, excretion and intra-body distribution. Intracellular regulation in different cell types is intertwined with a global hormonal signaling structure. Iron deficiency as well as excess of iron are frequent and serious human disorders. They can affect every cell, but also the organism as a whole.

Results

Here, we present a kinematic model of the dynamic system of iron pools and fluxes. It is based on ferrokinetic data and chemical measurements in C57BL6 wild-type mice maintained on iron-deficient, iron-adequate, or iron-loaded diet. The tracer iron levels in major tissues and organs (16 compartment) were followed for 28 days. The evaluation resulted in a whole-body model of fractional clearance rates. The analysis permits calculation of absolute flux rates in the steady-state, of iron distribution into different organs, of tracer-accessible pool sizes and of residence times of iron in the different compartments in response to three states of iron-repletion induced by the dietary regime.

Conclusions

This mathematical model presents a comprehensive physiological picture of mice under three different diets with varying iron contents. The quantitative results reflect systemic properties of iron metabolism: dynamic closedness, hierarchy of time scales, switch-over response and dynamics of iron storage in parenchymal organs. Therefore, we could assess which parameters will change under dietary perturbations and study in quantitative terms when those changes take place.

This model corresponds to the Iron Loaded condition - Mice

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To cite BioModels Database, please use [Le Novre N., Bornstein B., Broicher A., Courtot M., Donizelli M., Dharuri H., Li L., Sauro H., Schilstra M., Shapiro B., Snoep J.L., Hucka M. \(2006\) BioModels Database: A Free, Centralized Database of Curated, Published, Quantitative Kinetic Models of Biochemical and Cellular Systems Nucleic Acids Res., 34: D689-D691.](#)

2 Unit Definitions

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

2.1 Unit substance

Notes Mole is the predefined SBML unit for substance.

Definition mol

2.2 Unit volume

Notes Litre is the predefined SBML unit for volume.

Definition l

2.3 Unit area

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

Definition m²

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 Compartments

This model contains two compartments.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial	Size	Unit	Constant	Outside
			Dimensions				
default	Environment		3	1	litre	<input checked="" type="checkbox"/>	
c1	Organism		3	1	litre	<input checked="" type="checkbox"/>	default

3.1 Compartment default

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

Name Environment

3.2 Compartment `c1`

This is a three dimensional compartment with a constant size of one litre, which is surrounded by default (Environment).

Name Organism

4 Species

This model contains 17 species. Section 6 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
s1	iron_in_Plasma	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s2	iron_in_Bone Marrow	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s3	iron_in_RBC	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s4	iron_in_Spleen	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s5	iron_in_Liver	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s6	iron_in_Muscle	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s7	iron_in_Duodenum	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s8	iron_in_Integument	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s9	iron_in_Intestine	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s10	iron_ions_Outside	default	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s11	iron_in_Heart	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s12	iron_in_Lungs	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s13	iron_in_Kidneys	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s14	iron_in_Testes	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s15	iron_in_Stomach	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s16	iron_in_Fat	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square
s17	iron_in_Brain	c1	$\text{mol} \cdot \text{l}^{-1}$	\square	\square

5 Reactions

This model contains 29 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

Nº	Id	Name	Reaction Equation	SBO
1	re1		$s1 \longrightarrow s2$	
2	re2		$s2 \longrightarrow s3$	
3	re3		$s3 \longrightarrow s4$	
4	re4		$s4 \longrightarrow s1$	
5	re5		$s2 \longrightarrow s4$	
6	re6		$s1 \longrightarrow s5$	
7	re7		$s5 \longrightarrow s1$	
8	re8		$s1 \longrightarrow s6$	
9	re9		$s6 \longrightarrow s1$	
10	re10		$s1 \longrightarrow s7$	
11	re11		$s1 \longrightarrow s9$	
12	re12		$s1 \longrightarrow s8$	
13	re14		$s9 \longrightarrow s10$	
14	re15		$s8 \longrightarrow s10$	
15	re16		$s1 \longrightarrow s11$	
16	re17		$s11 \longrightarrow s1$	
17	re18		$s1 \longrightarrow s12$	
18	re19		$s12 \longrightarrow s1$	
19	re22		$s1 \longrightarrow s13$	
20	re23		$s13 \longrightarrow s1$	
21	re24		$s1 \longrightarrow s14$	
22	re25		$s14 \longrightarrow s1$	
23	re26		$s1 \longrightarrow s15$	

Nº	Id	Name	Reaction Equation	SBO
24	re28		$s1 \longrightarrow s16$	
25	re29		$s16 \longrightarrow s1$	
26	re30		$s1 \longrightarrow s17$	
27	re31		$s17 \longrightarrow s1$	
28	re32		$s7 \longrightarrow s1$	
29	re33		$s15 \longrightarrow s10$	

5.1 Reaction re1

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 5: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 6: Properties of each product.

Id	Name	SBO
s2	iron_in_Bone Marrow	

Kinetic Law

Derived unit contains undeclared units

$$v_1 = [s1] \cdot k1 \quad (2)$$

Table 7: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	1kp_bon		6.92		<input checked="" type="checkbox"/>

5.2 Reaction re2

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 8: Properties of each reactant.

Id	Name	SBO
s2	iron_in_Bone Marrow	

Product

Table 9: Properties of each product.

Id	Name	SBO
s3	iron_in_RBC	

Kinetic Law

Derived unit contains undeclared units

$$v_2 = [s2] \cdot k1 \quad (4)$$

Table 10: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	27kbon_rbc		0.5		<input checked="" type="checkbox"/>

5.3 Reaction re3

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 11: Properties of each reactant.

Id	Name	SBO
s3	iron_in_RBC	

Product

Table 12: Properties of each product.

Id	Name	SBO
s4	iron_in_Spleen	

Kinetic Law

Derived unit contains undeclared units

$$v_3 = [s3] \cdot k1 \quad (6)$$

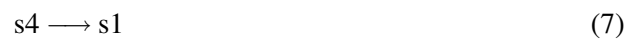
Table 13: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	29krbc_spl		0.032		<input checked="" type="checkbox"/>

5.4 Reaction `re4`

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 14: Properties of each reactant.

Id	Name	SBO
s4	iron_in_Spleen	

Product

Table 15: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_4 = [s_4] \cdot k_1 \quad (8)$$

Table 16: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	23kspl_p		1.91		<input checked="" type="checkbox"/>

5.5 Reaction re5

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 17: Properties of each reactant.

Id	Name	SBO
s2	iron_in_Bone Marrow	

Product

Table 18: Properties of each product.

Id	Name	SBO
s4	iron_in_Spleen	

Kinetic Law

Derived unit contains undeclared units

$$v_5 = [s_2] \cdot k_1 \quad (10)$$

Table 19: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	28kbon_spl		0.046		<input checked="" type="checkbox"/>

5.6 Reaction re6

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 20: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 21: Properties of each product.

Id	Name	SBO
s5	iron_in_Liver	

Kinetic Law

Derived unit contains undeclared units

$$v_6 = [s1] \cdot k1 \quad (12)$$

Table 22: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	4kp_liv		5.25		<input checked="" type="checkbox"/>

5.7 Reaction re7

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 23: Properties of each reactant.

Id	Name	SBO
s5	iron_in_Liver	

Product

Table 24: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_7 = [s5] \cdot k1 \quad (14)$$

Table 25: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	15kliv_p		0.1		<input checked="" type="checkbox"/>

5.8 Reaction re8

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 26: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 27: Properties of each product.

Id	Name	SBO
s6	iron_in_Muscle	

Kinetic Law

Derived unit contains undeclared units

$$v_8 = [s1] \cdot k1 \quad (16)$$

Table 28: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	8kp_mus		2.52		<input checked="" type="checkbox"/>

5.9 Reaction re9

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 29: Properties of each reactant.

Id	Name	SBO
s6	iron_in_Muscle	

Product

Table 30: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_9 = [s6] \cdot k1 \quad (18)$$

Table 31: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	l8kmus_p		0.14		<input checked="" type="checkbox"/>

5.10 Reaction re10

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 32: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 33: Properties of each product.

Id	Name	SBO
s7	iron_in_Duodenum	

Kinetic Law

Derived unit contains undeclared units

$$v_{10} = [s1] \cdot k1 \quad (20)$$

Table 34: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	10kp_duo		0.038		<input checked="" type="checkbox"/>

5.11 Reaction `re11`

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 35: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 36: Properties of each product.

Id	Name	SBO
s9	iron_in_Intestine	

Kinetic Law

Derived unit contains undeclared units

$$v_{11} = [s1] \cdot k1 \quad (22)$$

Table 37: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	3kp_int		0.93		<input checked="" type="checkbox"/>

5.12 Reaction `re12`

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 38: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 39: Properties of each product.

Id	Name	SBO
s8	iron_in_Integument	

Kinetic Law

Derived unit contains undeclared units

$$v_{12} = [s1] \cdot k1 \quad (24)$$

Table 40: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	6kp_intg		1.33		<input checked="" type="checkbox"/>

5.13 Reaction re14

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 41: Properties of each reactant.

Id	Name	SBO
s9	iron_in_Intestine	

Product

Table 42: Properties of each product.

Id	Name	SBO
s10	iron_ions_Outside	

Kinetic Law

Derived unit contains undeclared units

$$v_{13} = [s9] \cdot k1 \quad (26)$$

Table 43: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	25kint_out		0.22		<input checked="" type="checkbox"/>

5.14 Reaction re15

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 44: Properties of each reactant.

Id	Name	SBO
s8	iron_in_Integument	

Product

Table 45: Properties of each product.

Id	Name	SBO
s10	iron_ions_Outside	

Kinetic Law

Derived unit contains undeclared units

$$v_{14} = [s8] \cdot k1 \quad (28)$$

Table 46: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	24kintg_out		0.072		<input checked="" type="checkbox"/>

5.15 Reaction re16

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 47: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 48: Properties of each product.

Id	Name	SBO
s11	iron_in_Heart	

Kinetic Law

Derived unit contains undeclared units

$$v_{15} = [s1] \cdot k1 \quad (30)$$

Table 49: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	12kp_hear		0.36		<input checked="" type="checkbox"/>

5.16 Reaction re17

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 50: Properties of each reactant.

Id	Name	SBO
s11	iron_in_Heart	

Product

Table 51: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_{16} = [s11] \cdot k1 \quad (32)$$

Table 52: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	21khea_p		0.17		<input checked="" type="checkbox"/>

5.17 Reaction re18

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 53: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 54: Properties of each product.

Id	Name	SBO
s12	iron_in_Lungs	

Kinetic Law

Derived unit contains undeclared units

$$v_{17} = [s1] \cdot k1 \quad (34)$$

Table 55: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	9kp_lun		0.63		<input checked="" type="checkbox"/>

5.18 Reaction `re19`

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 56: Properties of each reactant.

Id	Name	SBO
s12	iron_in_Lungs	

Product

Table 57: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_{18} = [s12] \cdot k1 \quad (36)$$

Table 58: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	19klung_p		0.086		<input checked="" type="checkbox"/>

5.19 Reaction re22

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 59: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 60: Properties of each product.

Id	Name	SBO
s13	iron_in_Kidneys	

Kinetic Law

Derived unit contains undeclared units

$$v_{19} = [s1] \cdot k1 \quad (38)$$

Table 61: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	2kp_kid		1.62		<input checked="" type="checkbox"/>

5.20 Reaction re23

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 62: Properties of each reactant.

Id	Name	SBO
s13	iron_in_Kidneys	

Product

Table 63: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_{20} = [s13] \cdot k1 \quad (40)$$

Table 64: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	14kkid_p		0.23		<input checked="" type="checkbox"/>

5.21 Reaction re24

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 65: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 66: Properties of each product.

Id	Name	SBO
s14	iron_in_Testes	

Kinetic Law

Derived unit contains undeclared units

$$v_{21} = [s1] \cdot k1 \quad (42)$$

Table 67: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	13kp_tes		0.043		<input checked="" type="checkbox"/>

5.22 Reaction re25

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 68: Properties of each reactant.

Id	Name	SBO
s14	iron_in_Testes	

Product

Table 69: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_{22} = [s14] \cdot k1 \quad (44)$$

Table 70: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	22ktes_p		0.067		<input checked="" type="checkbox"/>

5.23 Reaction re26

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 71: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 72: Properties of each product.

Id	Name	SBO
s15	iron_in_Stomach	

Kinetic Law

Derived unit contains undeclared units

$$v_{23} = [s1] \cdot k1 \quad (46)$$

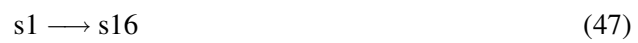
Table 73: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	5kp_sto		0.27		<input checked="" type="checkbox"/>

5.24 Reaction re28

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 74: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 75: Properties of each product.

Id	Name	SBO
s16	iron_in_Fat	

Kinetic Law

Derived unit contains undeclared units

$$v_{24} = [s1] \cdot k1 \quad (48)$$

Table 76: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	7kp_fat		0.066		<input checked="" type="checkbox"/>

5.25 Reaction re29

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 77: Properties of each reactant.

Id	Name	SBO
s16	iron_in_Fat	

Product

Table 78: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_{25} = [s16] \cdot k1 \quad (50)$$

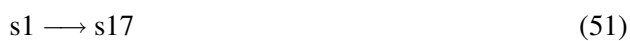
Table 79: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	17kfat_p		0.099		<input checked="" type="checkbox"/>

5.26 Reaction re30

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 80: Properties of each reactant.

Id	Name	SBO
s1	iron_in_Plasma	

Product

Table 81: Properties of each product.

Id	Name	SBO
s17	iron_in_Brain	

Kinetic Law

Derived unit contains undeclared units

$$v_{26} = [s1] \cdot k1 \quad (52)$$

Table 82: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	11kp_bra		0.021		<input checked="" type="checkbox"/>

5.27 Reaction re31

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 83: Properties of each reactant.

Id	Name	SBO
s17	iron_in_Brain	

Product

Table 84: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_{27} = [s17] \cdot k1 \quad (54)$$

Table 85: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	20kbra_p		0.028		<input checked="" type="checkbox"/>

5.28 Reaction re32

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 86: Properties of each reactant.

Id	Name	SBO
s7	iron_in_Duodenum	

Product

Table 87: Properties of each product.

Id	Name	SBO
s1	iron_in_Plasma	

Kinetic Law

Derived unit contains undeclared units

$$v_{28} = k1 \cdot [s7] \quad (56)$$

Table 88: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	26kduo_p		0.24		<input checked="" type="checkbox"/>

5.29 Reaction re33

This is an irreversible reaction of one reactant forming one product.

Reaction equation



Reactant

Table 89: Properties of each reactant.

Id	Name	SBO
s15	iron_in_Stomach	

Product

Table 90: Properties of each product.

Id	Name	SBO
s10	iron_ions_Outside	

Kinetic Law

Derived unit contains undeclared units

$$v_{29} = k1 \cdot [s15] \quad (58)$$

Table 91: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
k1	16ksto_out		0.29		<input checked="" type="checkbox"/>

6 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.

6.1 Species *s1*

Name iron_in_Plasma

Initial amount 100 mol

Charge 0

This species takes part in 23 reactions (as a reactant in [re1](#), [re6](#), [re8](#), [re10](#), [re11](#), [re12](#), [re16](#), [re18](#), [re22](#), [re24](#), [re26](#), [re28](#), [re30](#) and as a product in [re4](#), [re7](#), [re9](#), [re17](#), [re19](#), [re23](#), [re25](#), [re29](#), [re31](#), [re32](#)).

$$\frac{d}{dt}s1 = v_4 + v_7 + v_9 + v_{16} + v_{18} + v_{20} + v_{22} + v_{25} + v_{27} + v_{28} - v_1 - v_6 - v_8 - v_{10} - v_{11} - v_{12} - v_{15} - v_{17} - v_{19} - v_{21} - v_{23} - v_{24} - v_{26} \quad (59)$$

6.2 Species *s2*

Name iron_in_Bone Marrow

Initial amount 0 mol

This species takes part in three reactions (as a reactant in [re2](#), [re5](#) and as a product in [re1](#)).

$$\frac{d}{dt}s2 = v_1 - v_2 - v_5 \quad (60)$$

6.3 Species s3

Name iron_in_RBC

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re3](#) and as a product in [re2](#)).

$$\frac{d}{dt}s3 = v_2 - v_3 \quad (61)$$

6.4 Species s4

Name iron_in_Spleen

Initial amount 0 mol

This species takes part in three reactions (as a reactant in [re4](#) and as a product in [re3](#), [re5](#)).

$$\frac{d}{dt}s4 = v_3 + v_5 - v_4 \quad (62)$$

6.5 Species s5

Name iron_in_Liver

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re7](#) and as a product in [re6](#)).

$$\frac{d}{dt}s5 = v_6 - v_7 \quad (63)$$

6.6 Species s6

Name iron_in_Muscle

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re9](#) and as a product in [re8](#)).

$$\frac{d}{dt}s6 = v_8 - v_9 \quad (64)$$

6.7 Species s7

Name iron_in_Duodenum

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re32](#) and as a product in [re10](#)).

$$\frac{d}{dt}s7 = v_{10} - v_{28} \quad (65)$$

6.8 Species s8

Name iron_in_Integument

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re15](#) and as a product in [re12](#)).

$$\frac{d}{dt}s8 = v_{12} - v_{14} \quad (66)$$

6.9 Species s9

Name iron_in_Intestine

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re14](#) and as a product in [re11](#)).

$$\frac{d}{dt}s9 = v_{11} - v_{13} \quad (67)$$

6.10 Species s10

Name iron_ions_Outside

Initial amount 0 mol

This species takes part in three reactions (as a product in [re14](#), [re15](#), [re33](#)).

$$\frac{d}{dt}s10 = v_{13} + v_{14} + v_{29} \quad (68)$$

6.11 Species s11

Name iron_in_Heart

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re17](#) and as a product in [re16](#)).

$$\frac{d}{dt}s11 = v_{15} - v_{16} \quad (69)$$

6.12 Species s12

Name iron_in_Lungs

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re19](#) and as a product in [re18](#)).

$$\frac{d}{dt}s12 = v_{17} - v_{18} \quad (70)$$

6.13 Species s13

Name iron_in_Kidneys

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re23](#) and as a product in [re22](#)).

$$\frac{d}{dt}s13 = v_{19} - v_{20} \quad (71)$$

6.14 Species s14

Name iron_in_Testes

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re25](#) and as a product in [re24](#)).

$$\frac{d}{dt}s14 = v_{21} - v_{22} \quad (72)$$

6.15 Species s15

Name iron_in_Stomach

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re33](#) and as a product in [re26](#)).

$$\frac{d}{dt}s15 = v_{23} - v_{29} \quad (73)$$

6.16 Species s16

Name iron_in_Fat

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re29](#) and as a product in [re28](#)).

$$\frac{d}{dt}s16 = v_{24} - v_{25} \quad (74)$$

6.17 Species s17

Name iron_in_Brain

Initial amount 0 mol

This species takes part in two reactions (as a reactant in [re31](#) and as a product in [re30](#)).

$$\frac{d}{dt}s17 = v_{26} - v_{27} \quad (75)$$

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