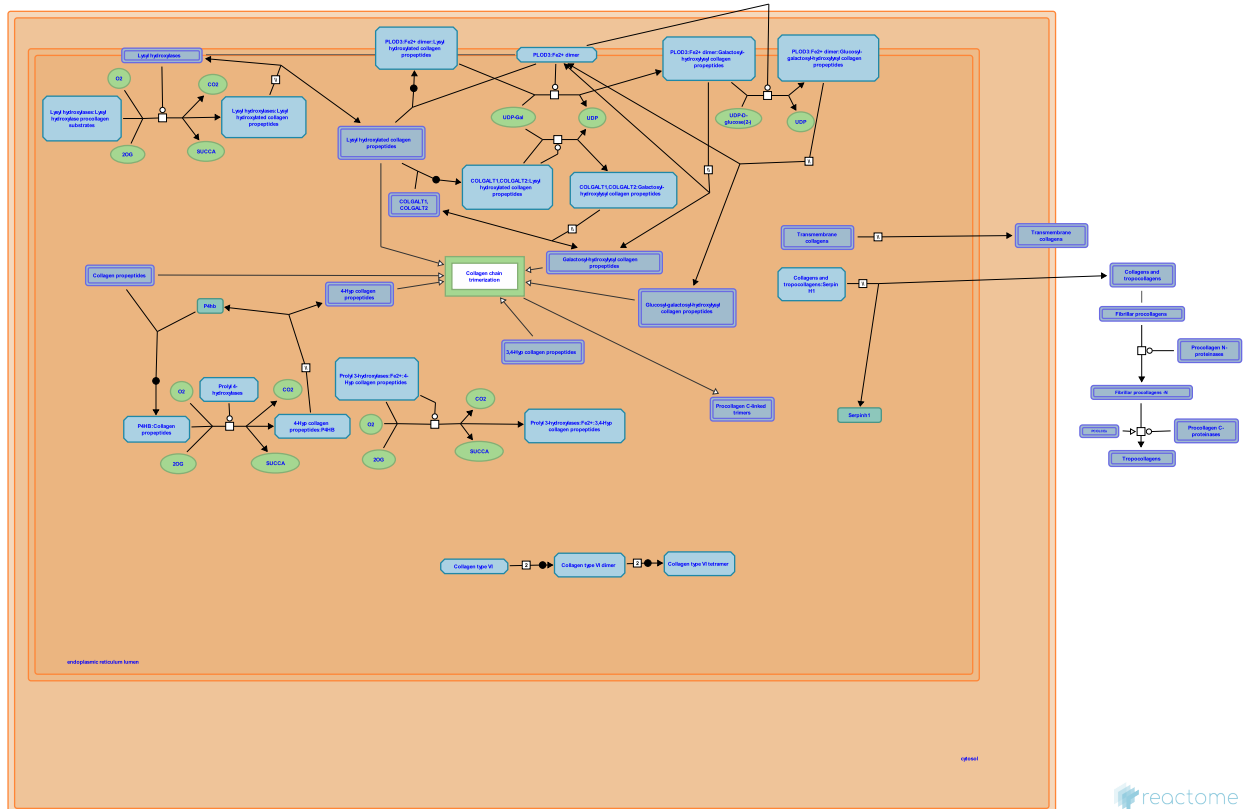


# Collagen biosynthesis and modifying enzymes



European Bioinformatics Institute, New York University Langone Medical Center, Ontario Institute for Cancer Research, Oregon Health and Science University.

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This is just an excerpt of a full-length report for this pathway. To access the complete report, please download it at the [Reactome Textbook](#).

09/05/2024

## Introduction

Reactome is open-source, open access, manually curated and peer-reviewed pathway database. Pathway annotations are authored by expert biologists, in collaboration with Reactome editorial staff and cross-referenced to many bioinformatics databases. A system of evidence tracking ensures that all assertions are backed up by the primary literature. Reactome is used by clinicians, geneticists, genomics researchers, and molecular biologists to interpret the results of high-throughput experimental studies, by bioinformaticians seeking to develop novel algorithms for mining knowledge from genomic studies, and by systems biologists building predictive models of normal and disease variant pathways.

The development of Reactome is supported by grants from the US National Institutes of Health (P41 HG003751), University of Toronto (CFREF Medicine by Design), European Union (EU STRP, EMI-CD), and the European Molecular Biology Laboratory (EBI Industry program).

## Literature references

- Fabregat, A., Sidiropoulos, K., Viteri, G., Forner, O., Marin-Garcia, P., Arnau, V. et al. (2017). Reactome pathway analysis: a high-performance in-memory approach. *BMC bioinformatics*, 18, 142. [↗](#)
- Sidiropoulos, K., Viteri, G., Sevilla, C., Jupe, S., Webber, M., Orlic-Milacic, M. et al. (2017). Reactome enhanced pathway visualization. *Bioinformatics*, 33, 3461-3467. [↗](#)
- Fabregat, A., Jupe, S., Matthews, L., Sidiropoulos, K., Gillespie, M., Garapati, P. et al. (2018). The Reactome Pathway Knowledgebase. *Nucleic Acids Res*, 46, D649-D655. [↗](#)
- Fabregat, A., Korninger, F., Viteri, G., Sidiropoulos, K., Marin-Garcia, P., Ping, P. et al. (2018). Reactome graph database: Efficient access to complex pathway data. *PLoS computational biology*, 14, e1005968. [↗](#)

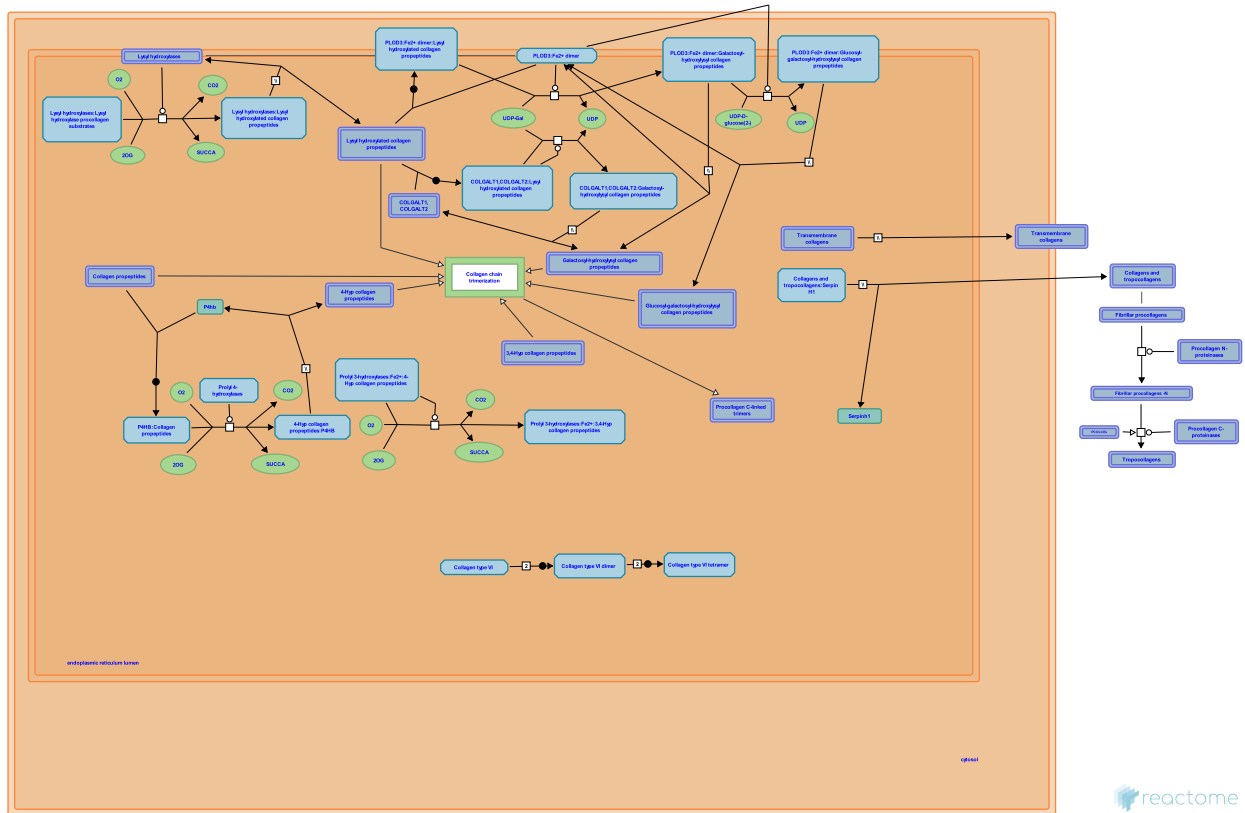
Reactome database release: 88

This document contains 2 pathways and 20 reactions ([see Table of Contents](#))

## Collagen biosynthesis and modifying enzymes ↗

Stable identifier: R-MMU-1650814

Inferred from: Collagen biosynthesis and modifying enzymes (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

## P4HB binds Collagen chains ↗

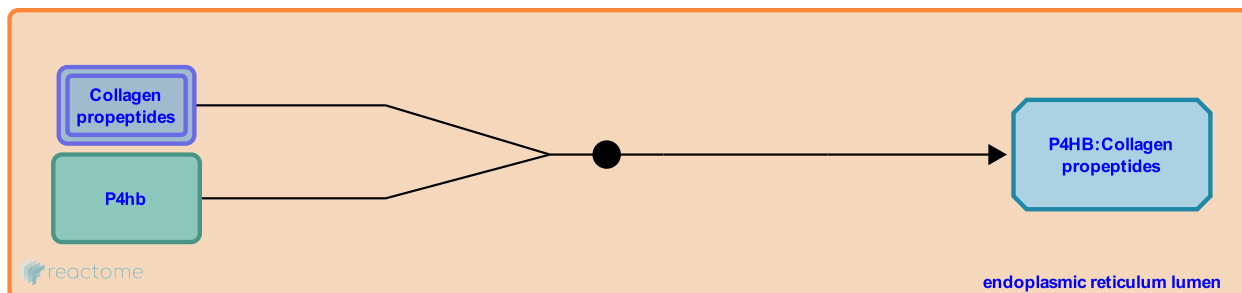
**Location:** [Collagen biosynthesis and modifying enzymes](#)

**Stable identifier:** R-MMU-2002460

**Type:** binding

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** [P4HB binds Collagen chains \(Homo sapiens\)](#)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Followed by:** [Prolyl 4-hydroxylase converts collagen prolines to 4-hydroxyprolines](#)

## Prolyl 4-hydroxylase converts collagen prolines to 4-hydroxyprolines ↗

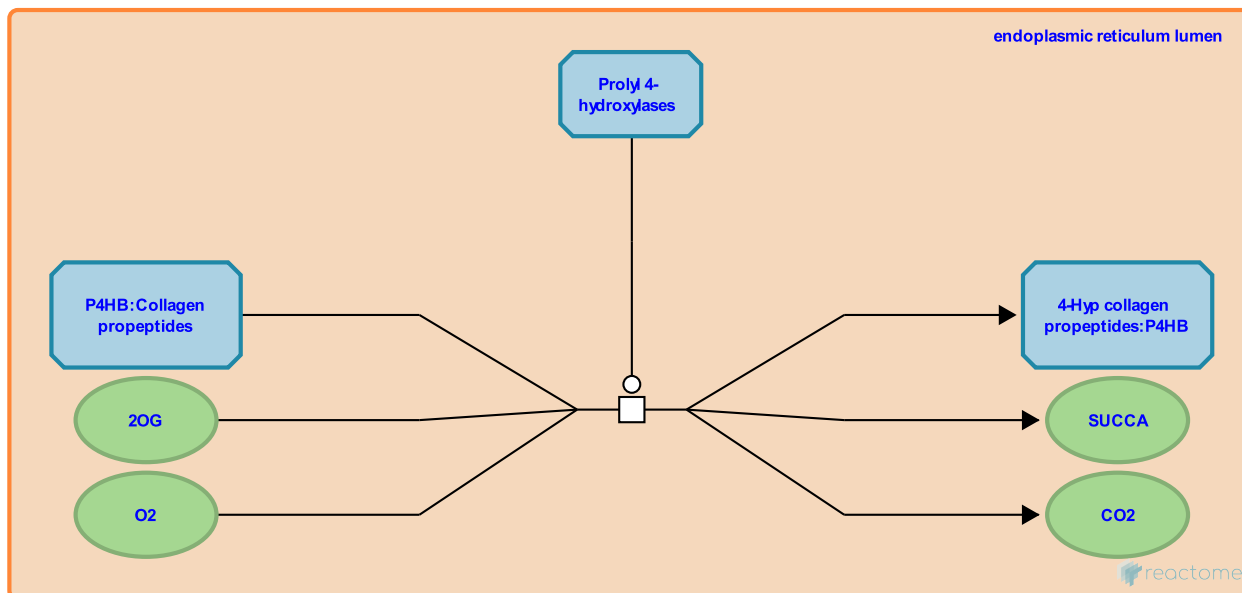
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-1650808

**Type:** transition

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** Prolyl 4-hydroxylase converts collagen prolines to 4-hydroxyprolines (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** P4HB binds Collagen chains

**Followed by:** P4HB:4-Hyp collagen propeptides dissociates

## P4HB:4-Hyp collagen propeptides dissociates ↗

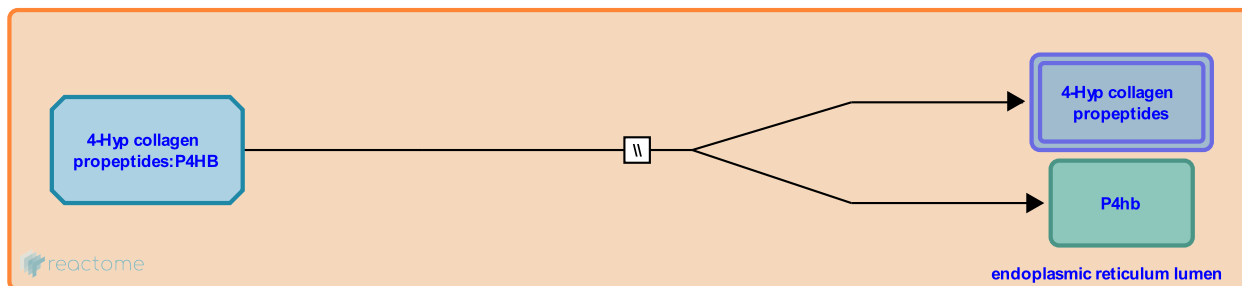
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-8948234

**Type:** omitted

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** P4HB:4-Hyp collagen propeptides dissociates (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](https://www.reactome.org/docs/inferring_events.html) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** Prolyl 4-hydroxylase converts collagen prolines to 4-hydroxyprolines

**Followed by:** Collagen prolyl 3-hydroxylase converts 4-Hyp collagen to 3,4-Hyp collagen

## Collagen prolyl 3-hydroxylase converts 4-Hyp collagen to 3,4-Hyp collagen ↗

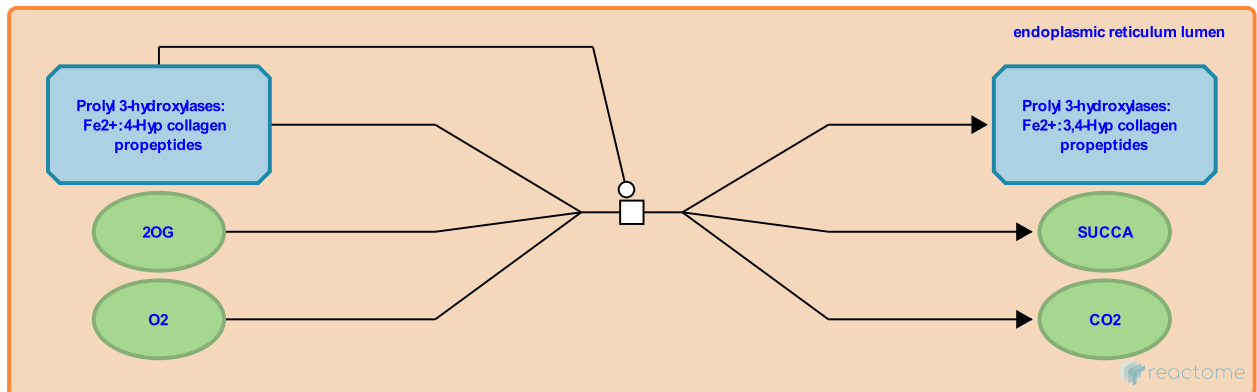
**Location:** [Collagen biosynthesis and modifying enzymes](#)

**Stable identifier:** R-MMU-1980233

**Type:** transition

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** [Collagen prolyl 3-hydroxylase converts 4-Hyp collagen to 3,4-Hyp collagen \(Homo sapiens\)](#)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** [P4HB:4-Hyp collagen propeptides dissociates](#)

## Procollagen lysyl hydroxylases convert collagen lysines to 5-hydroxylysines ↗

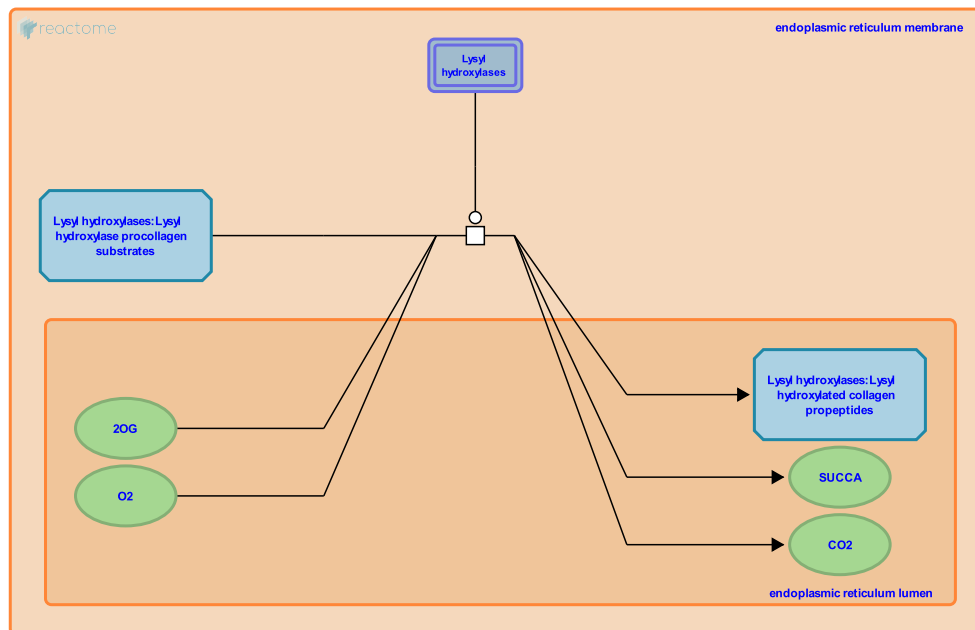
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-1981104

**Type:** transition

**Compartments:** endoplasmic reticulum membrane

**Inferred from:** Procollagen lysyl hydroxylases convert collagen lysines to 5-hydroxylysines (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Followed by:** Lysyl hydroxylated collagen propeptides dissociate from Lysyl hydroxylases



## Lysyl hydroxylated collagen propeptides dissociate from Lysyl hydroxylases ↗

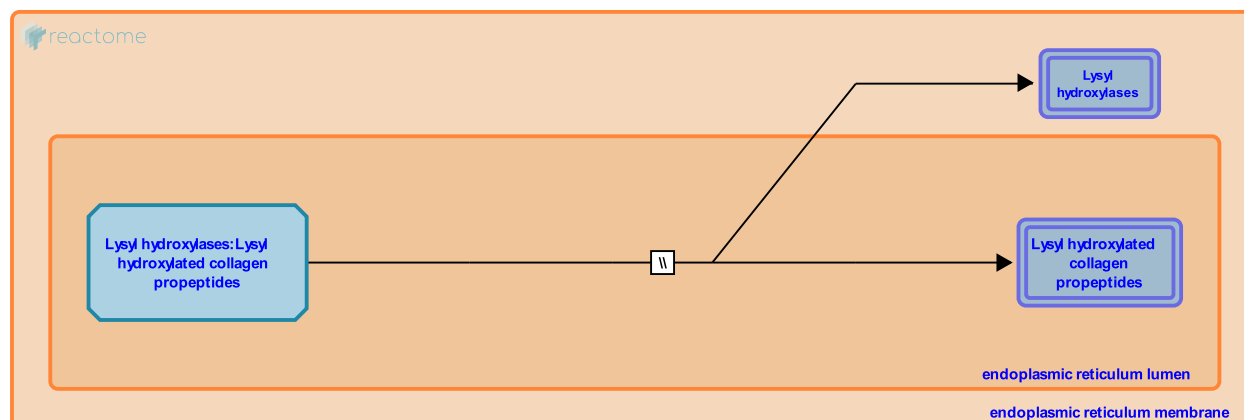
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-8948232

**Type:** omitted

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** Lysyl hydroxylated collagen propeptides dissociate from Lysyl hydroxylases (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** Procollagen lysyl hydroxylases convert collagen lysines to 5-hydroxylysines

**Followed by:** COLGALT1,COLGALT2 bind Lysyl hydroxylated collagen propeptides, PLOD3 binds Lysyl hydroxylated collagen propeptides

## COLGALT1, COLGALT2 bind Lysyl hydroxylated collagen propeptides ↗

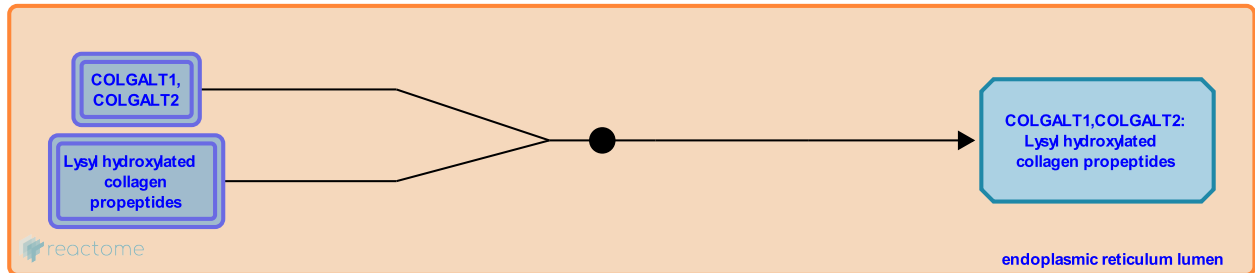
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-8948228

**Type:** binding

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** COLGALT1, COLGALT2 bind Lysyl hydroxylated collagen propeptides (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** Lysyl hydroxylated collagen propeptides dissociate from Lysyl hydroxylases

**Followed by:** Galactosylation of collagen propeptide hydroxylysines by procollagen galactosyltransferases 1, 2.

## PLOD3 binds Lysyl hydroxylated collagen propeptides ↗

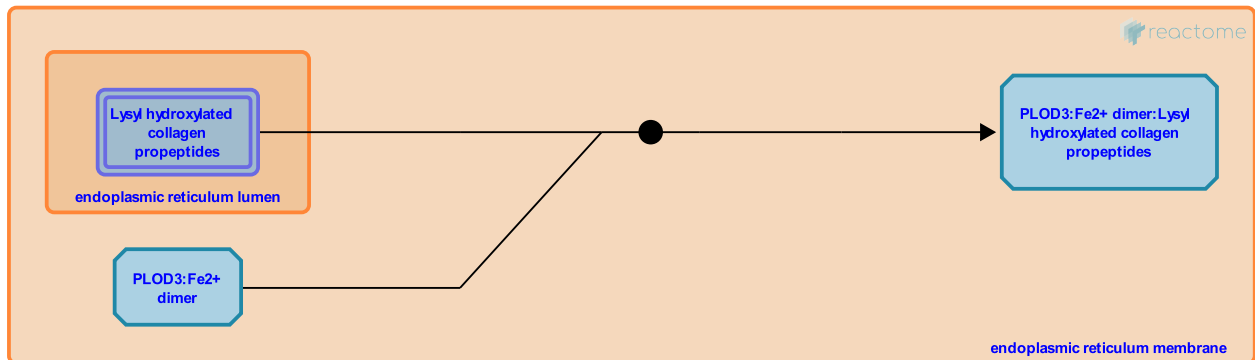
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-8948219

**Type:** binding

**Compartments:** endoplasmic reticulum membrane, endoplasmic reticulum lumen

**Inferred from:** PLOD3 binds Lysyl hydroxylated collagen propeptides (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** Lysyl hydroxylated collagen propeptides dissociate from Lysyl hydroxylases

**Followed by:** Galactosylation of collagen propeptide hydroxylysines by PLOD3

## Galactosylation of collagen propeptide hydroxylysines by procollagen galactosyltransferases 1, 2. ↗

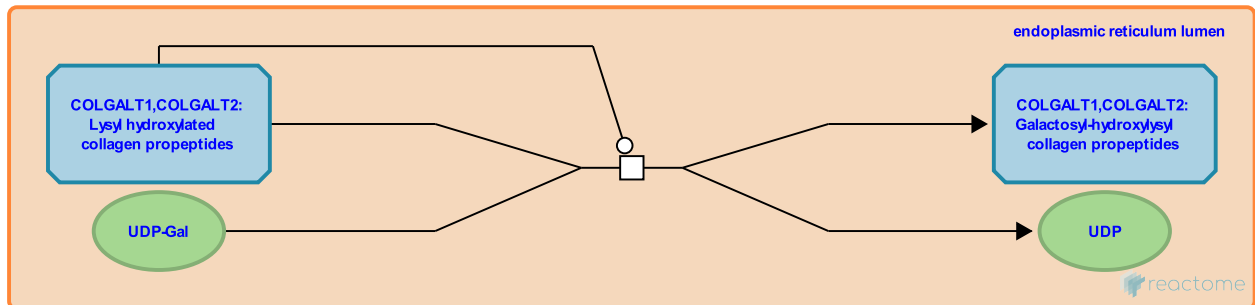
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-1981120

**Type:** transition

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** Galactosylation of collagen propeptide hydroxylysines by procollagen galactosyltransferases 1, 2. (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** COLGALT1, COLGALT2 bind Lysyl hydroxylated collagen propeptides

**Followed by:** COLGALT1, COLGALT2: Galactosyl-hydroxylysyl collagen propeptides dissociates

## Galactosylation of collagen propeptide hydroxylysines by PLOD3 ↗

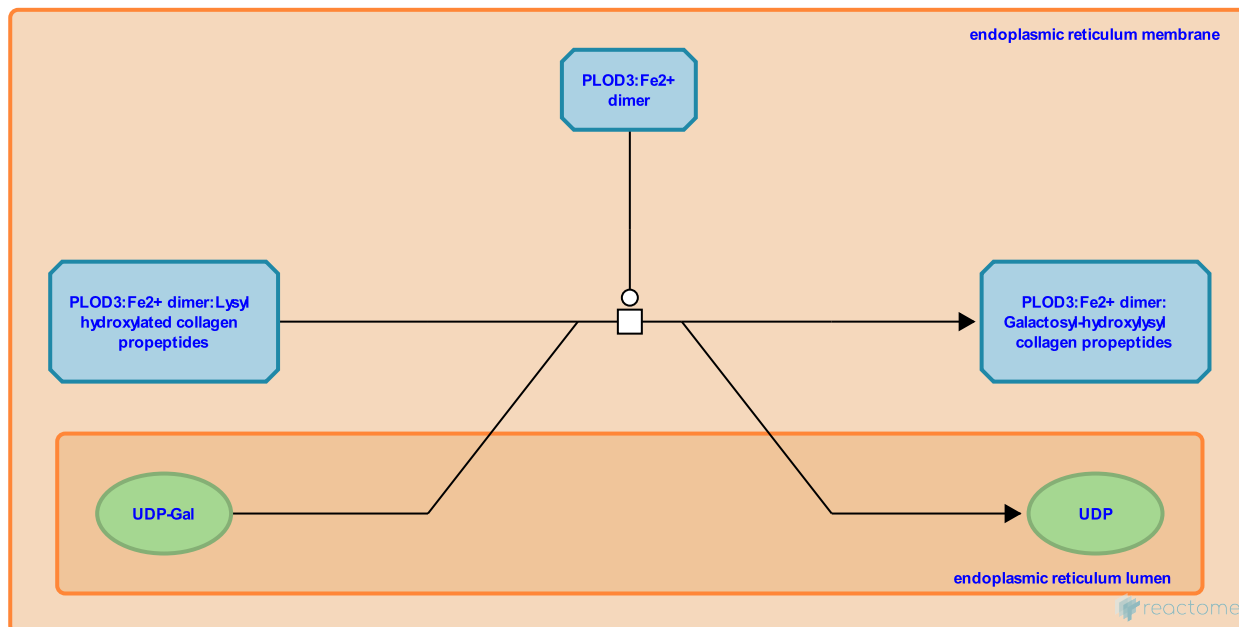
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-1981128

**Type:** transition

**Compartments:** endoplasmic reticulum membrane, endoplasmic reticulum lumen

**Inferred from:** Galactosylation of collagen propeptide hydroxylysines by PLOD3 (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** PLOD3 binds Lysyl hydroxylated collagen propeptides

**Followed by:** Glucosylation of collagen propeptide hydroxylysines, PLOD3:Fe2+ dimer:Galactosyl-hydroxylysyl collagen propeptides dissociates

## COLGALT1,COLGALT2:Galactosyl-hydroxylysyl collagen propeptides dissociates ↗

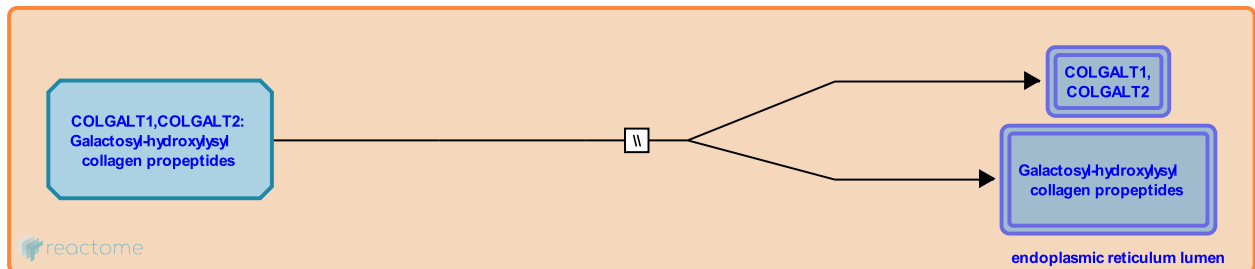
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-8948231

**Type:** omitted

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** COLGALT1,COLGALT2:Galactosyl-hydroxylysyl collagen propeptides dissociates (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** Galactosylation of collagen propeptide hydroxylysines by procollagen galactosyltransferases 1, 2.

## PLOD3:Fe2+ dimer:Galactosyl-hydroxylysyl collagen propeptides dissociates ↗

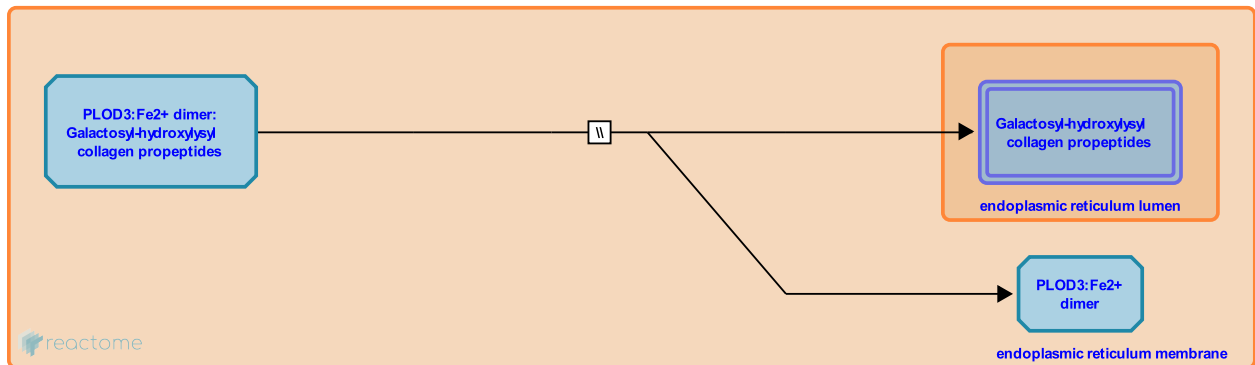
**Location:** [Collagen biosynthesis and modifying enzymes](#)

**Stable identifier:** R-MMU-8948222

**Type:** omitted

**Compartments:** endoplasmic reticulum membrane, endoplasmic reticulum lumen

**Inferred from:** [PLOD3:Fe2+ dimer:Galactosyl-hydroxylysyl collagen propeptides dissociates \(Homo sapiens\)](#)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** [Galactosylation of collagen propeptide hydroxylysines by PLOD3](#)

## Glucosylation of collagen propeptide hydroxylysines ↗

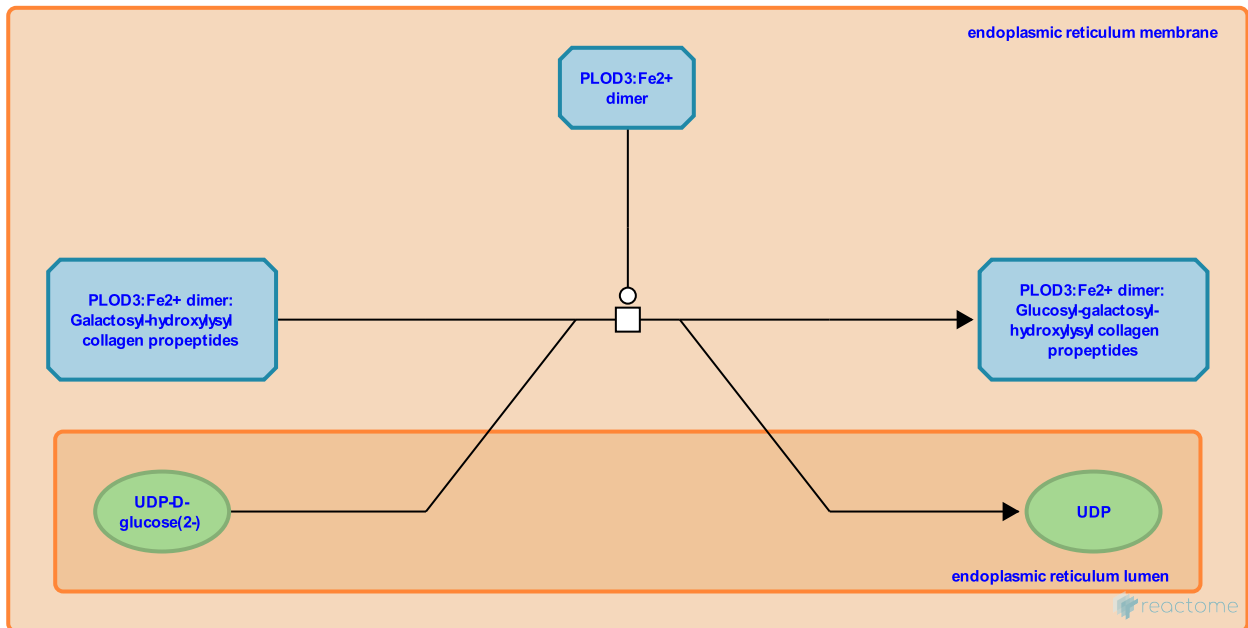
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-1981157

**Type:** transition

**Compartments:** endoplasmic reticulum membrane

**Inferred from:** Glucosylation of collagen propeptide hydroxylysines (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** Galactosylation of collagen propeptide hydroxylysines by PLOD3

**Followed by:** PLOD3:Fe2+ dimer:Glucosyl-galactosyl-hydroxylysyl collagen propeptides dissociates



## PLOD3:Fe2+ dimer:Glucosyl-galactosyl-hydroxylysyl collagen propeptides dissociates ↗

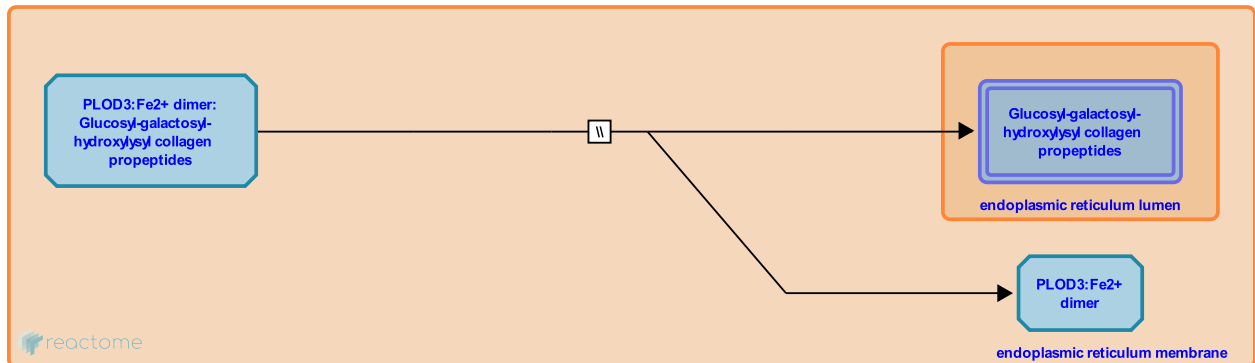
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-8948224

**Type:** omitted

**Compartments:** endoplasmic reticulum membrane, endoplasmic reticulum lumen

**Inferred from:** [PLOD3:Fe2+ dimer:Glucosyl-galactosyl-hydroxylysyl collagen propeptides dissociates \(Homo sapiens\)](#)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

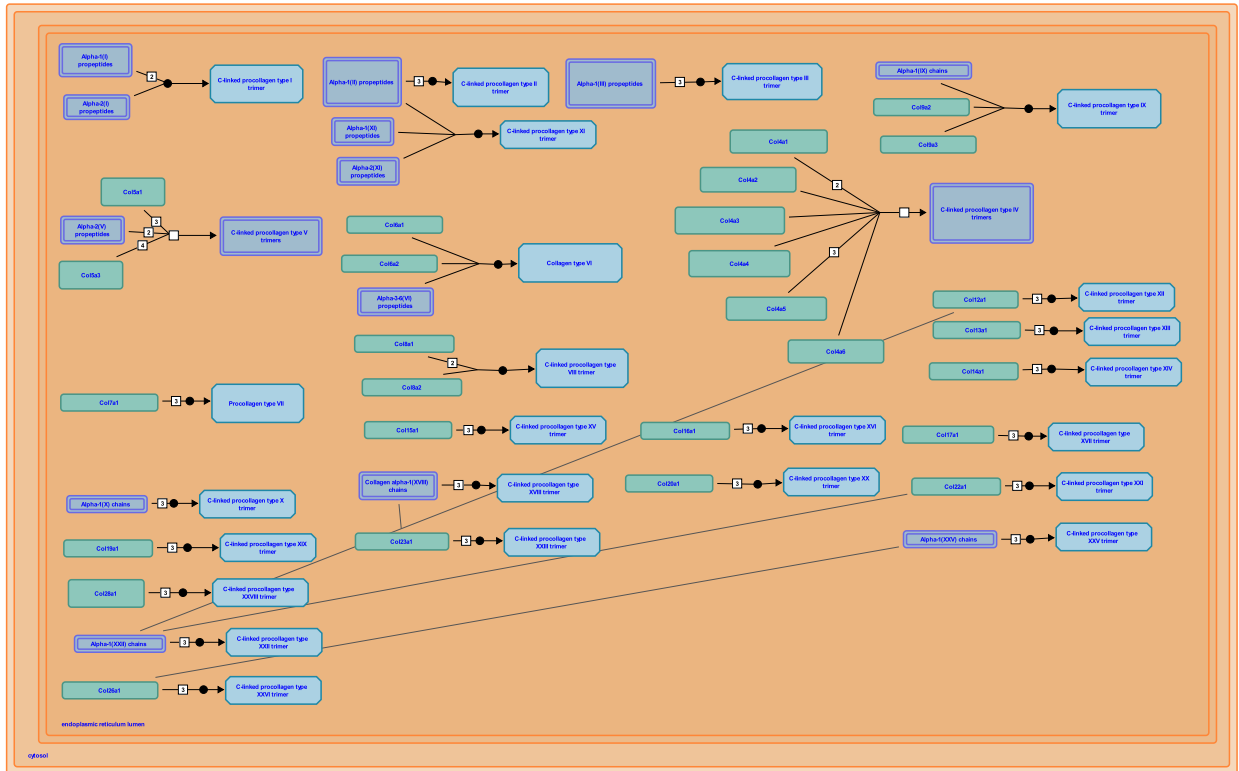
**Preceded by:** [Glucosylation of collagen propeptide hydroxylysines](#)

## Collagen chain trimerization ↗

**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-8948216

**Inferred from:** Collagen chain trimerization (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

## Dimerization of procollagen type VI ↗

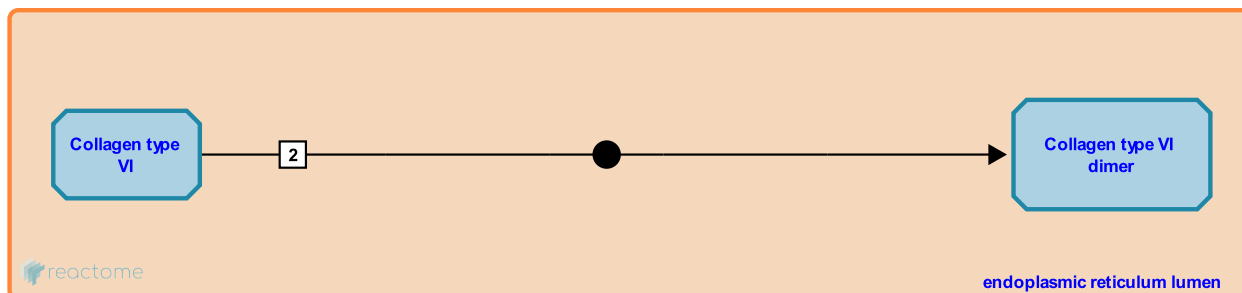
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-1614460

**Type:** binding

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** [Dimerization of procollagen type VI \(Homo sapiens\)](#)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Followed by:** [Tetramerization of procollagen VI](#)

## Tetramerization of procollagen VI ↗

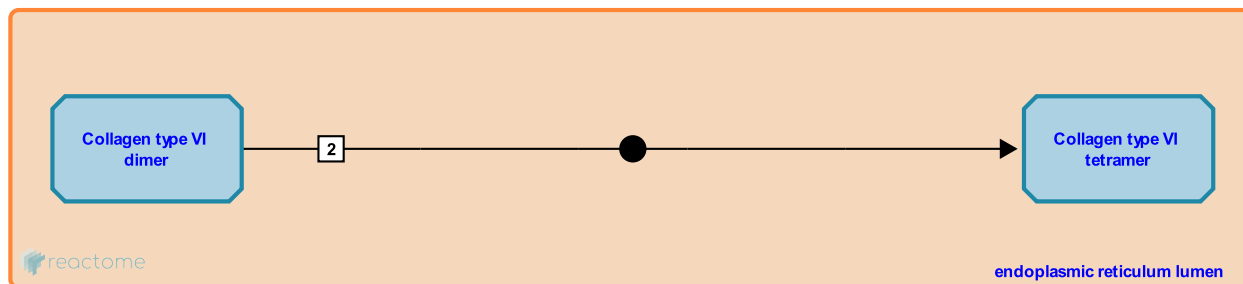
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-1614461

**Type:** binding

**Compartments:** endoplasmic reticulum lumen

**Inferred from:** Tetramerization of procollagen VI (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** Dimerization of procollagen type VI

## Secretion of collagens ↗

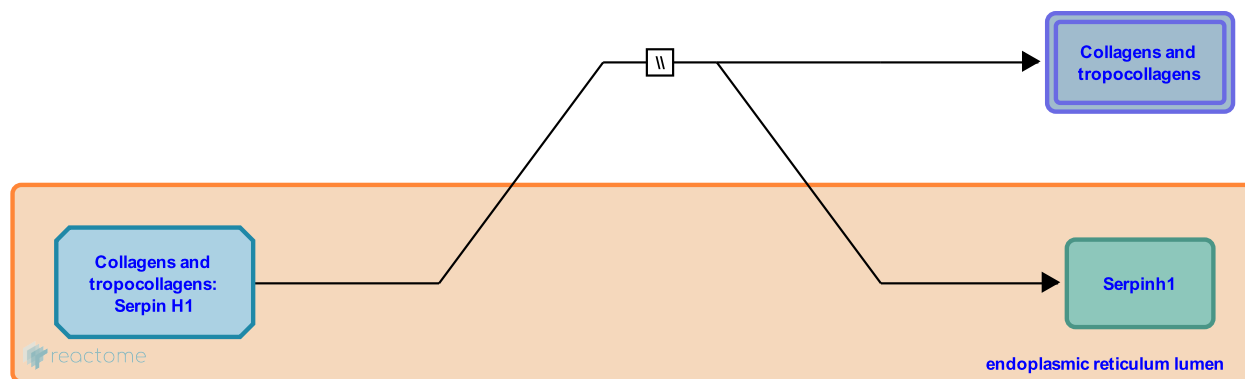
**Location:** Collagen biosynthesis and modifying enzymes

**Stable identifier:** R-MMU-2089971

**Type:** omitted

**Compartments:** extracellular region, endoplasmic reticulum lumen

**Inferred from:** Secretion of collagens (Homo sapiens)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](http://www.pantherdb.org/about.jsp) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

## Secretion of transmembrane collagens ↗

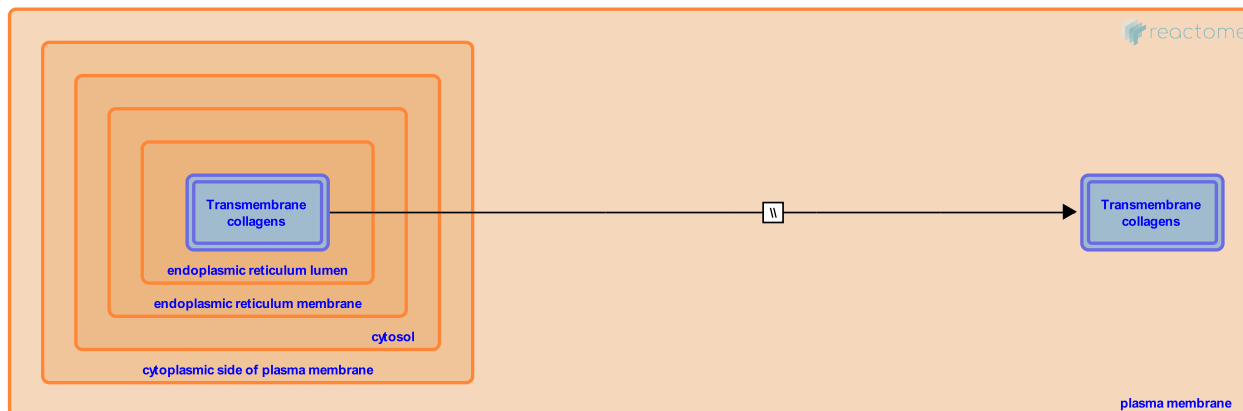
**Location:** [Collagen biosynthesis and modifying enzymes](#)

**Stable identifier:** R-MMU-2152276

**Type:** omitted

**Compartments:** plasma membrane, endoplasmic reticulum lumen

**Inferred from:** [Secretion of transmembrane collagens \(Homo sapiens\)](#)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

## Removal of fibrillar collagen N-propeptides ↗

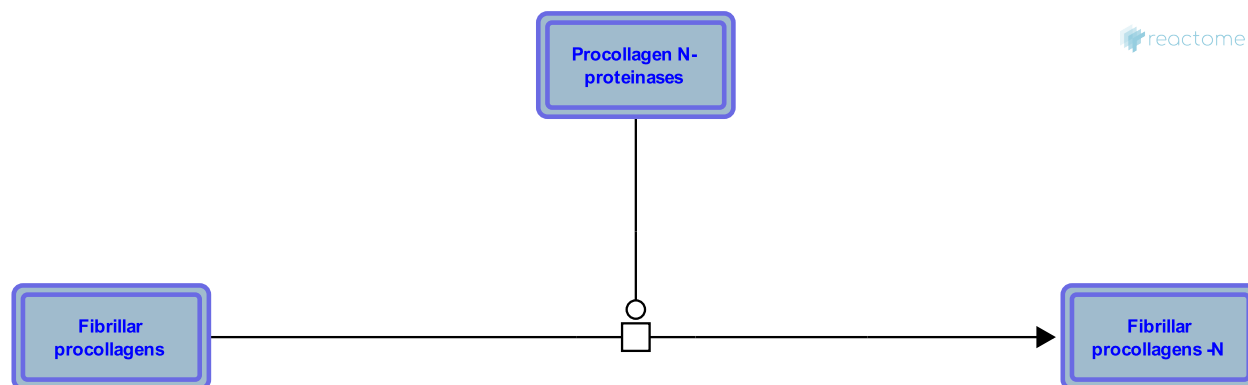
**Location:** [Collagen biosynthesis and modifying enzymes](#)

**Stable identifier:** R-MMU-2002428

**Type:** transition

**Compartments:** extracellular region

**Inferred from:** [Removal of fibrillar collagen N-propeptides \(Homo sapiens\)](#)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Followed by:** [Removal of fibrillar collagen C-propeptides](#)

## Removal of fibrillar collagen C-propeptides ↗

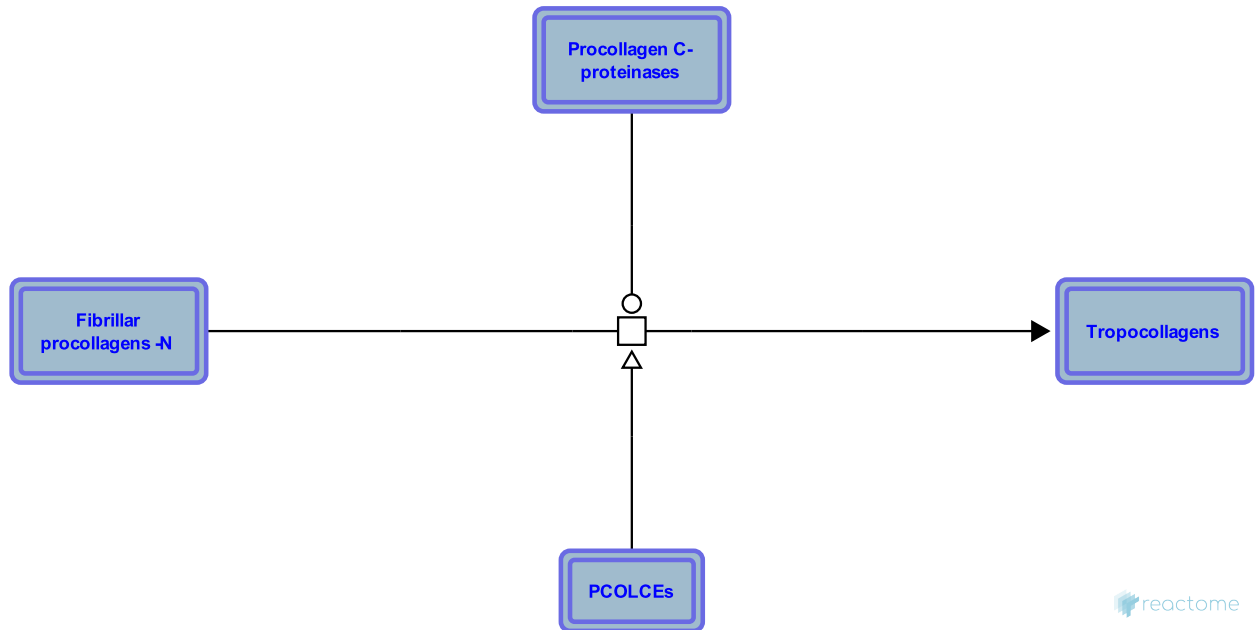
**Location:** [Collagen biosynthesis and modifying enzymes](#)

**Stable identifier:** R-MMU-2002440

**Type:** transition

**Compartments:** extracellular region

**Inferred from:** [Removal of fibrillar collagen C-propeptides \(Homo sapiens\)](#)



This event has been computationally inferred from an event that has been demonstrated in another species.

The inference is based on the homology mapping from PANTHER. Briefly, reactions for which all involved PhysicalEntities (in input, output and catalyst) have a mapped orthologue/paralogue (for complexes at least 75% of components must have a mapping) are inferred to the other species. High level events are also inferred for these events to allow for easier navigation.

[More details and caveats of the event inference in Reactome.](#) For details on PANTHER see also: <http://www.pantherdb.org/about.jsp>

**Preceded by:** [Removal of fibrillar collagen N-propeptides](#)



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