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<?xml version="1.0"?>
```

```
<!-- FILE : cholesterol_biosynthesis_model.xml
```

```
CREATED : 14th June 2002
```

```
LAST MODIFIED : 22nd July 2002
```

```
AUTHOR : Catherine Lloyd  
The Bioengineering Institute  
The University of Auckland
```

```
MODEL STATUS : This model conforms to the CellML 1.0 Specification released on  
10th August 2001, and the 16/01/2002 CellML Metadata 1.0  
Specification.
```

```
DESCRIPTION : This file contains a CellML description of a generic model of  
cholesterol biosynthesis.
```

```
CHANGES:  
22/07/2002 - CML - Added more metadata.  
-->
```

```
<model name="cholesterol_biosynthesis_model" pathway_editor:rendering_config_file="cholester  
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:bgs="http://www.cel
```

```
<!--  
The following RDF block contains metadata that applies to this document  
as a whole, as indicated by the empty about attribute on the  
<rdf:Description> element.  
-->
```

```
<rdf:Description rdf:about="">
```

```
<!--  
The Model Builder Metadata. The Dublin Core "creator" element is used  
to indicate the person who translated the model into CellML.  
-->
```

```
<dc:creator rdf:parseType="Resource">  
<vCard:N rdf:parseType="Resource">  
<vCard:Family>Lloyd</vCard:Family>  
<vCard:Given>Catherine</vCard:Given>  
<vCard:Other>May</vCard:Other>  
</vCard:N>  
<vCard:EMAIL rdf:parseType="Resource">  
<rdf:value>c.lloyd@auckland.ac.nz</rdf:value>  
<rdf:type rdf:resource="http://imc.org/vCard/3.0#internet" />  
</vCard:EMAIL>  
<vCard:ORG rdf:parseType="Resource">  
<vCard:Orgname>The University of Auckland</vCard:Orgname>  
<vCard:Orgunit>The Bioengineering Institute</vCard:Orgunit>  
</vCard:ORG>  
</dc:creator>
```

```
<!--  
The Creation Date metadata. This is the date on which the model  
was translated into CellML.  
-->
```

```
<dcterms:created rdf:parseType="Resource">  
<dcterms:W3CDTF>2002-06-14</dcterms:W3CDTF>  
</dcterms:created>
```

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<!--
  The Last Modified Date metadata. This is the date on which
  the model was last changed.
-->
<cmeta:modification rdf:parseType="Resource">
  <rdf:value>
    Added more metadata.
  </rdf:value>
  <cmeta:modifier rdf:parseType="Resource">
    <vCard:N rdf:parseType="Resource">
      <vCard:Family>Lloyd</vCard:Family>
      <vCard:Given>Catherine</vCard:Given>
      <vCard:Other>May</vCard:Other>
    </vCard:N>
  </cmeta:modifier>
  <dcterms:modified rdf:parseType="Resource">
    <dcterms:W3CDTF>2002-07-22</dcterms:W3CDTF>
  </dcterms:modified>
</cmeta:modification>

<!-- The Publisher metadata. -->
<dc:publisher>
  The University of Auckland, Bioengineering Institute
</dc:publisher>
</rdf:Description>

<!--
  The following metadata refers to the model itself, as indicated by the
  reference to the ID "cholesterol_biosynthesis_model", which is declared on
  the <model> element.
-->
<rdf:Description rdf:about="#cholesterol_biosynthesis_model">
  <!-- A human readable name for the model. -->
  <dc:title>A Generic Model Of Cholesterol Synthesis</dc:title>

  <!-- A comment regarding the model. -->
  <cmeta:comment rdf:parseType="Resource">
    <rdf:value>
      Below is a CellML description of a general model of cholesterol
      synthesis. It is not based on a specific published mathematical
      model, but instead it is based on a textbook defined pathway. The
      general sequential structure and all the reactant, product and enzyme
      components are included. Michaelis-Menten enzyme kinetics are
      assumed.

      The purpose of this description is to illustrate how CellML can be
      used to model a general metabolic pathway.
    </rdf:value>
    <!-- The creator of the comment. -->
    <dc:creator>
      <vCard:FN>Catherine Lloyd</vCard:FN>
    </dc:creator>
  </cmeta:comment>

  <cmeta:species>Homo sapiens</cmeta:species>

  <!-- Keyword(s) -->
  <bqs:reference rdf:parseType="Resource">
    <dc:subject rdf:parseType="Resource">

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    <bqs:subject_type>keyword</bqs:subject_type>
    <rdf:value>metabolism</rdf:value>
  </dc:subject>
</bqs:reference>

<bqs:Book rdf:parseType="Resource">
  <dc:creator rdf:parseType="Resource">
    <bqs:Person rdf:parseType="Resource">
      <vCard:N rdf:parseType="Resource">
        <vCard:Family>Bronk</vCard:Family>
        <vCard:Given>J</vCard:Given>
        <vCard:Other>Ramsey</vCard:Other>
      </vCard:N>
    </bqs:Person>
  </dc:creator>
  <dc:title>Human Metabolism</dc:title>
  <dcterms:issued rdf:parseType="Resource">
    <dcterms:W3CDTF>1999</dcterms:W3CDTF>
  </dcterms:issued>
  <dc:publisher rdf:parseType="Resource">
    <bqs:Organisation>Addison Wesley Longman Limited</bqs:Organisation>
    <bqs:Property rdf:parseType="Resource">
      <bqs:property_type>location</bqs:property_type>
      <rdf:value>England</rdf:value>
    </bqs:Property>
  </dc:publisher>
</bqs:Book>
</rdf:Description>
</rdf:RDF>

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<!--
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  We start the model definition with a definition of some named
  sets of units for use throughout the model.
-->

```

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```

<units name="micromolar">
  <unit prefix="micro" units="mole" />
  <unit units="litre" exponent="-1" />
</units>

<units name="flux">
  <unit units="micromolar" />
  <unit units="second" exponent="-1" />
</units>

<units name="first_order_rate_constant">
  <unit units="second" exponent="-1" />
</units>

<units name="second_order_rate_constant">
  <unit units="micromolar" exponent="-1" />
  <unit units="second" exponent="-1" />
</units>

<units name="third_order_rate_constant">
  <unit units="micromolar" exponent="-2" />
  <unit units="second" exponent="-1" />
</units>

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<units name="forth_order_rate_constant">
  <unit units="micromolar" exponent="-3" />
  <unit units="second" exponent="-1" />
</units>

<units name="fifth_order_rate_constant">
  <unit units="micromolar" exponent="-4" />
  <unit units="second" exponent="-1" />
</units>

<!--
  The following component is defined for modelling convenience.  It contains
  all the universal variables, in this case, only time.
-->
<component name="global_variables">
  <variable name="time" public_interface="out" units="second" />
</component>

<!--
  The following components describe all the metabolites - both reactants and
  products - involved in cholesterol synthesis.
-->

<component name="Acetyl_CoA" cmeta:id="Acetyl_CoA">
  <variable name="Acetyl_CoA" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Acetyl_CoA_rxn0" public_interface="in" units="flux" />
  <variable name="delta_Acetyl_CoA_rxn1" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
    <apply><diff />
    <bvar>
      <ci>time</ci>
    </bvar>
    <ci>Acetyl_CoA</ci>
  </apply>
  <apply><plus />
    <ci>delta_Acetyl_CoA_rxn0</ci>
    <ci>delta_Acetyl_CoA_rxn1</ci>
  </apply>
</math>
</component>

<component name="CoA_SH" cmeta:id="CoA_SH">
  <variable name="CoA_SH" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_CoA_SH_rxn0" public_interface="in" units="flux" />
  <variable name="delta_CoA_SH_rxn1" public_interface="in" units="flux" />
  <variable name="delta_CoA_SH_rxn2" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
    <apply><diff />
    <bvar>
      <ci>time</ci>
    </bvar>
    <ci>CoA_SH</ci>
  </apply>
  <apply><plus />

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        <ci>delta_CoA_SH_rxn0</ci>
        <ci>delta_CoA_SH_rxn1</ci>
        <ci>delta_CoA_SH_rxn2</ci>
    </apply>
</apply>
</math>
</component>

<component name="Acetoacetyl_CoA" cmeta:id="Acetoacetyl_CoA">
    <variable name="Acetoacetyl_CoA" public_interface="out" initial_value="1.0" units="micromolar" />
    <variable name="delta_Acetoacetyl_CoA_rxn0" public_interface="in" units="flux" />
    <variable name="delta_Acetoacetyl_CoA_rxn1" public_interface="in" units="flux" />
    <variable name="time" public_interface="in" units="second" />
    <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
            <apply><diff />
                <bvar>
                    <ci>time</ci>
                </bvar>
                <ci>Acetoacetyl_CoA</ci>
            </apply>
            <apply><plus />
                <ci>delta_Acetoacetyl_CoA_rxn0</ci>
                <ci>delta_Acetoacetyl_CoA_rxn1</ci>
            </apply>
        </apply>
    </math>
</component>

<component name="Hydroxymethylglutaryl_CoA" cmeta:id="Hydroxymethylglutaryl_CoA">
    <variable name="Hydroxymethylglutaryl_CoA" public_interface="out" initial_value="1.0" units="micromolar" />
    <variable name="delta_Hydroxymethylglutaryl_CoA_rxn1" public_interface="in" units="flux" />
    <variable name="delta_Hydroxymethylglutaryl_CoA_rxn2" public_interface="in" units="flux" />
    <variable name="time" public_interface="in" units="second" />
    <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
            <apply><diff />
                <bvar>
                    <ci>time</ci>
                </bvar>
                <ci>Hydroxymethylglutaryl_CoA</ci>
            </apply>
            <apply><plus />
                <ci>delta_Hydroxymethylglutaryl_CoA_rxn1</ci>
                <ci>delta_Hydroxymethylglutaryl_CoA_rxn2</ci>
            </apply>
        </apply>
    </math>
</component>

<component name="Mevalonate" cmeta:id="Mevalonate">
    <variable name="Mevalonate" public_interface="out" initial_value="1.0" units="micromolar" />
    <variable name="delta_Mevalonate_rxn2" public_interface="in" units="flux" />
    <variable name="delta_Mevalonate_rxn3" public_interface="in" units="flux" />
    <variable name="time" public_interface="in" units="second" />
    <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
            <apply><diff />
                <bvar>

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        <ci>time</ci>
    </bvar>
    <ci>Mevalonate</ci>
</apply>
<apply><plus />
    <ci>delta_Mevalonate_rxn2</ci>
    <ci>delta_Mevalonate_rxn3</ci>
</apply>
</apply>
</math>
</component>

<component name="Phosphomevalonate_5" cmeta:id="Phosphomevalonate_5">
    <variable name="Phosphomevalonate_5" public_interface="out" initial_value="1.0" units="m
    <variable name="delta_Phosphomevalonate_5_rxn3" public_interface="in" units="flux" />
    <variable name="delta_Phosphomevalonate_5_rxn4" public_interface="in" units="flux" />
    <variable name="time" public_interface="in" units="second" />
    <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
            <apply><diff />
                <bvar>
                    <ci>time</ci>
                </bvar>
                <ci>Phosphomevalonate_5</ci>
            </apply>
            <apply><plus />
                <ci>delta_Phosphomevalonate_5_rxn3</ci>
                <ci>delta_Phosphomevalonate_5_rxn4</ci>
            </apply>
        </apply>
    </math>
</component>

<component name="Pyrophosphomevalonate_5" cmeta:id="Pyrophosphomevalonate_5">
    <variable name="Pyrophosphomevalonate_5" public_interface="out" initial_value="1.0" units
    <variable name="delta_Pyrophosphomevalonate_5_rxn4" public_interface="in" units="flux" />
    <variable name="delta_Pyrophosphomevalonate_5_rxn5" public_interface="in" units="flux" />
    <variable name="time" public_interface="in" units="second" />
    <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
            <apply><diff />
                <bvar>
                    <ci>time</ci>
                </bvar>
                <ci>Pyrophosphomevalonate_5</ci>
            </apply>
            <apply><plus />
                <ci>delta_Pyrophosphomevalonate_5_rxn4</ci>
                <ci>delta_Pyrophosphomevalonate_5_rxn5</ci>
            </apply>
        </apply>
    </math>
</component>

<component name="Isopentenyl_pyrophosphate" cmeta:id="Isopentenyl_pyrophosphate">
    <variable name="Isopentenyl_pyrophosphate" public_interface="out" initial_value="1.0" un
    <variable name="delta_Isopentenyl_pyrophosphate_rxn5" public_interface="in" units="flux"
    <variable name="delta_Isopentenyl_pyrophosphate_rxn6" public_interface="in" units="flux"
    <variable name="delta_Isopentenyl_pyrophosphate_rxn7" public_interface="in" units="flux"

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<variable name="delta_Isopentenyl_pyrophosphate_rxn8" public_interface="in" units="flux" />
<variable name="time" public_interface="in" units="second" />
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <apply><eq />
    <apply><diff />
      <bvar>
        <ci>time</ci>
      </bvar>
      <ci>Isopentenyl_pyrophosphate</ci>
    </apply>
    <apply><plus />
      <ci>delta_Isopentenyl_pyrophosphate_rxn5</ci>
      <ci>delta_Isopentenyl_pyrophosphate_rxn6</ci>
      <ci>delta_Isopentenyl_pyrophosphate_rxn7</ci>
      <ci>delta_Isopentenyl_pyrophosphate_rxn8</ci>
    </apply>
  </math>
</component>

<component name="Dimethylallyl_pyrophosphate" cmeta:id="Dimethylallyl_pyrophosphate">
  <variable name="Dimethylallyl_pyrophosphate" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Dimethylallyl_pyrophosphate_rxn6" public_interface="in" units="flux" />
  <variable name="delta_Dimethylallyl_pyrophosphate_rxn7" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>Dimethylallyl_pyrophosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Dimethylallyl_pyrophosphate_rxn6</ci>
        <ci>delta_Dimethylallyl_pyrophosphate_rxn7</ci>
      </apply>
    </math>
  </component>

<component name="NADPH" cmeta:id="NADPH">
  <variable name="NADPH" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_NADPH_rxn2" public_interface="in" units="flux" />
  <variable name="delta_NADPH_rxn9" public_interface="in" units="flux" />
  <variable name="delta_NADPH_rxn10" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>NADPH</ci>
      </apply>
      <apply><plus />
        <ci>delta_NADPH_rxn2</ci>
        <ci>delta_NADPH_rxn9</ci>
        <ci>delta_NADPH_rxn10</ci>
      </apply>
    </math>
  </component>

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    </apply>
  </apply>
</math>
</component>
```

```
<component name="NADP" cmeta:id="NADP">
  <variable name="NADP" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_NADP_rxn2" public_interface="in" units="flux" />
  <variable name="delta_NADP_rxn9" public_interface="in" units="flux" />
  <variable name="delta_NADP_rxn10" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>NADP</ci>
      </apply>
      <apply><plus />
        <ci>delta_NADP_rxn2</ci>
        <ci>delta_NADP_rxn9</ci>
        <ci>delta_NADP_rxn10</ci>
      </apply>
    </math>
</component>
```

```
<component name="H" cmeta:id="H">
  <variable name="H" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_H_rxn2" public_interface="in" units="flux" />
  <variable name="delta_H_rxn9" public_interface="in" units="flux" />
  <variable name="delta_H_rxn10" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>H</ci>
      </apply>
      <apply><plus />
        <ci>delta_H_rxn2</ci>
        <ci>delta_H_rxn9</ci>
        <ci>delta_H_rxn10</ci>
      </apply>
    </math>
</component>
```

```
<component name="ATP" cmeta:id="ATP">
  <variable name="ATP" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_ATP_rxn3" public_interface="in" units="flux" />
  <variable name="delta_ATP_rxn4" public_interface="in" units="flux" />
  <variable name="delta_ATP_rxn5" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
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    <apply><diff />
      <bvar>
        <ci>time</ci>
      </bvar>
      <ci>ATP</ci>
    </apply>
    <apply><plus />
      <ci>delta_ATP_rxn3</ci>
      <ci>delta_ATP_rxn4</ci>
      <ci>delta_ATP_rxn5</ci>
    </apply>
  </apply>
</math>
</component>

<component name="ADP" cmeta:id="ADP">
  <variable name="ADP" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_ADp_rxn3" public_interface="in" units="flux" />
  <variable name="delta_ADp_rxn4" public_interface="in" units="flux" />
  <variable name="delta_ADp_rxn5" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>ADP</ci>
      </apply>
      <apply><plus />
        <ci>delta_ADp_rxn3</ci>
        <ci>delta_ADp_rxn4</ci>
        <ci>delta_ADp_rxn5</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="Pi" cmeta:id="Pi">
  <variable name="Pi" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Pi_rxn5" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>Pi</ci>
      </apply>
      <ci>delta_Pi_rxn5</ci>
    </apply>
  </math>
</component>

<component name="CO2" cmeta:id="CO2">
  <variable name="CO2" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_CO2_rxn5" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />

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```

<math xmlns="http://www.w3.org/1998/Math/MathML">
  <apply><eq />
    <apply><diff />
      <bvar>
        <ci>time</ci>
      </bvar>
      <ci>CO2</ci>
    </apply>
    <ci>delta_CO2_rxn5</ci>
  </apply>
</math>
</component>

<component name="Geranyl_pyrophosphate" cmeta:id="Geranyl_pyrophosphate">
  <variable name="Geranyl_pyrophosphate" public_interface="out" initial_value="1.0" units="molar" />
  <variable name="delta_Geranyl_pyrophosphate_rxn7" public_interface="in" units="flux" />
  <variable name="delta_Geranyl_pyrophosphate_rxn8" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>Geranyl_pyrophosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Geranyl_pyrophosphate_rxn7</ci>
        <ci>delta_Geranyl_pyrophosphate_rxn8</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="Farnesyl_pyrophosphate" cmeta:id="Farnesyl_pyrophosphate">
  <variable name="Farnesyl_pyrophosphate" public_interface="out" initial_value="1.0" units="molar" />
  <variable name="delta_Farnesyl_pyrophosphate_rxn8" public_interface="in" units="flux" />
  <variable name="delta_Farnesyl_pyrophosphate_rxn9" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>Farnesyl_pyrophosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Farnesyl_pyrophosphate_rxn8</ci>
        <ci>delta_Farnesyl_pyrophosphate_rxn9</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="PPi" cmeta:id="PPi">
  <variable name="PPi" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_PPi_rxn7" public_interface="in" units="flux" />
  <variable name="delta_PPi_rxn8" public_interface="in" units="flux" />

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<variable name="delta_PP_i_rxn9" public_interface="in" units="flux" />
<variable name="time" public_interface="in" units="second" />
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <apply><eq />
    <apply><diff />
      <bvar>
        <ci>time</ci>
      </bvar>
      <ci>PP_i</ci>
    </apply>
    <apply><plus />
      <ci>delta_PP_i_rxn7</ci>
      <ci>delta_PP_i_rxn8</ci>
      <ci>delta_PP_i_rxn9</ci>
    </apply>
  </apply>
</math>
</component>

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<component name="Squalene" cmeta:id="Squalene">
  <variable name="Squalene" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Squalene_rxn9" public_interface="in" units="flux" />
  <variable name="delta_Squalene_rxn10" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>Squalene</ci>
      </apply>
      <apply><plus />
        <ci>delta_Squalene_rxn9</ci>
        <ci>delta_Squalene_rxn10</ci>
      </apply>
    </apply>
  </math>
</component>

```

```

<component name="Squalene_2_3_epoxide" cmeta:id="Squalene_2_3_epoxide">
  <variable name="Squalene_2_3_epoxide" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Squalene_2_3_epoxide_rxn10" public_interface="in" units="flux" />
  <variable name="delta_Squalene_2_3_epoxide_rxn11" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>Squalene_2_3_epoxide</ci>
      </apply>
      <apply><plus />
        <ci>delta_Squalene_2_3_epoxide_rxn10</ci>
        <ci>delta_Squalene_2_3_epoxide_rxn11</ci>
      </apply>
    </apply>
  </math>
</component>

```

```
</component>
```

```
<component name="O2" cmeta:id="O2">  
  <variable name="O2" public_interface="out" initial_value="1.0" units="micromolar" />  
  <variable name="delta_O2_rxn10" public_interface="in" units="flux" />  
  <variable name="time" public_interface="in" units="second" />  
  <math xmlns="http://www.w3.org/1998/Math/MathML">  
    <apply><eq />  
      <apply><diff />  
        <bvar>  
          <ci>time</ci>  
        </bvar>  
        <ci>O2</ci>  
      </apply>  
      <ci>delta_O2_rxn10</ci>  
    </apply>  
  </math>  
</component>
```

```
<component name="H2O" cmeta:id="H2O">  
  <variable name="H2O" public_interface="out" initial_value="1.0" units="micromolar" />  
  <variable name="delta_H2O_rxn10" public_interface="in" units="flux" />  
  <variable name="time" public_interface="in" units="second" />  
  <math xmlns="http://www.w3.org/1998/Math/MathML">  
    <apply><eq />  
      <apply><diff />  
        <bvar>  
          <ci>time</ci>  
        </bvar>  
        <ci>H2O</ci>  
      </apply>  
      <ci>delta_H2O_rxn10</ci>  
    </apply>  
  </math>  
</component>
```

```
<component name="Lanosterol" cmeta:id="Lanosterol">  
  <variable name="Lanosterol" public_interface="out" initial_value="1.0" units="micromolar" />  
  <variable name="delta_Lanosterol_rxn11" public_interface="in" units="flux" />  
  <variable name="delta_Lanosterol_rxn12" public_interface="in" units="flux" />  
  <variable name="time" public_interface="in" units="second" />  
  <math xmlns="http://www.w3.org/1998/Math/MathML">  
    <apply><eq />  
      <apply><diff />  
        <bvar>  
          <ci>time</ci>  
        </bvar>  
        <ci>Lanosterol</ci>  
      </apply>  
      <apply><plus />  
        <ci>delta_Lanosterol_rxn11</ci>  
        <ci>delta_Lanosterol_rxn12</ci>  
      </apply>  
    </apply>  
  </math>  
</component>
```

```
<component name="Cholesterol" cmeta:id="Cholesterol">  
  <variable name="Cholesterol" public_interface="out" initial_value="1.0" units="micromolar" />
```

```

<variable name="delta_Cholesterol_rxn12" public_interface="in" units="flux" />
<variable name="time" public_interface="in" units="second" />
<math xmlns="http://www.w3.org/1998/Math/MathML">
  <apply><eq />
    <apply><diff />
      <bvar>
        <ci>time</ci>
      </bvar>
      <ci>Cholesterol</ci>
    </apply>
    <ci>delta.Cholesterol_rxn12</ci>
  </apply>
</math>
</component>

<!--
  The following components describe all the enzymes involved in
  cholesterol synthesis.
-->

<component name="Thiolase" cmeta:id="Thiolase">
  <variable name="Thiolase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Cyclase" cmeta:id="Cyclase">
  <variable name="Cyclase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Squalene_monooxygenase" cmeta:id="Squalene_monooxygenase">
  <variable name="Squalene_monooxygenase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Squalene_synthase" cmeta:id="Squalene_synthase">
  <variable name="Squalene_synthase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="HMG_CoA_synthetase" cmeta:id="HMG_CoA_synthetase">
  <variable name="HMG_CoA_synthetase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="HMG_CoA_reductase" cmeta:id="HMG_CoA_reductase">
  <variable name="HMG_CoA_reductase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Mevalonate_kinase" cmeta:id="Mevalonate_kinase">
  <variable name="Mevalonate_kinase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Phosphomevalonate_kinase" cmeta:id="Phosphomevalonate_kinase">
  <variable name="Phosphomevalonate_kinase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Phosphomevalonate_decarboxylase" cmeta:id="Phosphomevalonate_decarboxylase">
  <variable name="Phosphomevalonate_decarboxylase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Prenyl_transferase" cmeta:id="Prenyl_transferase">
  <variable name="Prenyl_transferase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

```

<!--

The following components represent the reaction steps of cholesterol synthesis.

-->

```
<component name="reaction0">
  <variable name="Acetyl_CoA" public_interface="in" units="micromolar" />
  <variable name="Acetoacetyl_CoA" public_interface="in" units="micromolar" />
  <variable name="CoA_SH" public_interface="in" units="micromolar" />
  <variable name="Thiolase" public_interface="in" units="micromolar" />
  <variable name="delta_Acetyl_CoA_rxn0" public_interface="out" units="flux" />
  <variable name="delta_Acetoacetyl_CoA_rxn0" public_interface="out" units="flux" />
  <variable name="delta_CoA_SH_rxn0" public_interface="out" units="flux" />
  <variable name="km0" initial_value="1.0" units="micromolar" />
  <variable name="vmax0" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Acetyl_CoA">
      <role role="reactant" delta_variable="delta_Acetyl_CoA_rxn0" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Acetoacetyl_CoA">
      <role role="product" delta_variable="delta_Acetoacetyl_CoA_rxn0" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="CoA_SH">
      <role role="product" delta_variable="delta_CoA_SH_rxn0" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Thiolase">
      <role role="catalyst" />
    </variable_ref>
    <variable_ref variable="rate">
      <role role="rate">
        <math xmlns="http://www.w3.org/1998/Math/MathML">
          <apply><eq />
            <ci>rate</ci>
            <apply><divide />
              <apply><times />
                <ci>Acetyl_CoA</ci>
                <ci>vmax0</ci>
              </apply>
            <apply><plus />
              <ci>km0</ci>
              <ci>Acetyl_CoA</ci>
            </apply>
          </math>
        </role>
      </variable_ref>
    </reaction>
  </component>

<component name="reaction1">
  <variable name="Acetoacetyl_CoA" public_interface="in" units="micromolar" />
  <variable name="Acetyl_CoA" public_interface="in" units="micromolar" />
  <variable name="Hydroxymethylglutaryl_CoA" public_interface="in" units="micromolar" />
  <variable name="CoA_SH" public_interface="in" units="micromolar" />
  <variable name="HMG_CoA_synthetase" public_interface="in" units="micromolar" />
  <variable name="delta_Acetoacetyl_CoA_rxn1" public_interface="out" units="flux" />
```

```

<variable name="delta_Acetyl_CoA_rxn1" public_interface="out" units="flux" />
<variable name="delta_Hydroxymethylglutaryl_CoA_rxn1" public_interface="out" units="flux" />
<variable name="delta_CoA_SH_rxn1" public_interface="out" units="flux" />
<variable name="rate" units="flux" />
<variable name="kml" initial_value="1.0" units="micromolar" />
<variable name="vmax1" initial_value="1.0" units="second_order_rate_constant" />
<reaction reversible="no">
  <variable_ref variable="Acetoacetyl_CoA">
    <role role="reactant" delta_variable="delta_Acetoacetyl_CoA_rxn1" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Acetyl_CoA">
    <role role="reactant" delta_variable="delta_Acetyl_CoA_rxn1" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Hydroxymethylglutaryl_CoA">
    <role role="product" delta_variable="delta_Hydroxymethylglutaryl_CoA_rxn1" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="CoA_SH">
    <role role="product" delta_variable="delta_CoA_SH_rxn1" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="HMG_CoA_synthetase">
    <role role="catalyst" />
  </variable_ref>
  <variable_ref variable="rate">
    <role role="rate">
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
          <ci>rate</ci>
          <apply><divide />
            <apply><times />
              <ci>Acetoacetyl_CoA</ci>
              <ci>Acetyl_CoA</ci>
              <ci>vmax1</ci>
            </apply>
          <apply><plus />
            <ci>kml</ci>
            <ci>Acetoacetyl_CoA</ci>
            <ci>Acetyl_CoA</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction2">
  <variable name="NADPH" public_interface="in" units="micromolar" />
  <variable name="H" public_interface="in" units="micromolar" />
  <variable name="Hydroxymethylglutaryl_CoA" public_interface="in" units="micromolar" />
  <variable name="NADP" public_interface="in" units="micromolar" />
  <variable name="HMG_CoA_reductase" public_interface="in" units="micromolar" />
  <variable name="Mevalonate" public_interface="in" units="micromolar" />
  <variable name="CoA_SH" public_interface="in" units="micromolar" />
  <variable name="delta_NADPH_rxn2" public_interface="out" units="flux" />
  <variable name="delta_H_rxn2" public_interface="out" units="flux" />
  <variable name="delta_Hydroxymethylglutaryl_CoA_rxn2" public_interface="out" units="flux" />
  <variable name="delta_NADP_rxn2" public_interface="out" units="flux" />
  <variable name="delta_Mevalonate_rxn2" public_interface="out" units="flux" />

```

```

<variable name="delta_CoA_SH_rxn2" public_interface="out" units="flux" />
<variable name="km2" initial_value="1.0" units="micromolar" />
<variable name="vmax2" initial_value="1.0" units="fifth_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="no">
  <variable_ref variable="NADPH">
    <role role="reactant" delta_variable="delta_NADPH_rxn2" stoichiometry="2" />
  </variable_ref>
  <variable_ref variable="H">
    <role role="reactant" delta_variable="delta_H_rxn2" stoichiometry="2" />
  </variable_ref>
  <variable_ref variable="Hydroxymethylglutaryl_CoA">
    <role role="reactant" delta_variable="delta_Hydroxymethylglutaryl_CoA_rxn2" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="NADP">
    <role role="product" delta_variable="delta_NADP_rxn2" stoichiometry="2" />
  </variable_ref>
  <variable_ref variable="Mevalonate">
    <role role="product" delta_variable="delta_Mevalonate_rxn2" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="CoA_SH">
    <role role="product" delta_variable="delta_CoA_SH_rxn2" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="HMG_CoA_reductase">
    <role role="catalyst" />
  </variable_ref>
  <variable_ref variable="rate">
    <role role="rate">
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
          <ci>rate</ci>
          <apply><divide />
            <apply><times />
              <apply><power />
                <ci>NADPH</ci>
                <cn cellml:units="dimensionless"> 2.0 </cn>
              </apply>
              <apply><power />
                <ci>H</ci>
                <cn cellml:units="dimensionless"> 2.0 </cn>
              </apply>
              <ci>Hydroxymethylglutaryl_CoA</ci>
              <ci>vmax2</ci>
            </apply>
            <apply><plus />
              <ci>km2</ci>
              <apply><power />
                <ci>NADPH</ci>
                <cn cellml:units="dimensionless"> 2.0 </cn>
              </apply>
              <apply><power />
                <ci>H</ci>
                <cn cellml:units="dimensionless"> 2.0 </cn>
              </apply>
              <ci>Hydroxymethylglutaryl_CoA</ci>
            </apply>
          </apply>
        </math>
    </role>
  </variable_ref>
</reaction>

```

```

    </role>
  </variable_ref>
</reaction>
</component>

```

```

<component name="reaction3">
  <variable name="Mevalonate" public_interface="in" units="micromolar" />
  <variable name="ATP" public_interface="in" units="micromolar" />
  <variable name="ADP" public_interface="in" units="micromolar" />
  <variable name="Phosphomevalonate_5" public_interface="in" units="micromolar" />
  <variable name="Mevalonate_kinase" public_interface="in" units="micromolar" />
  <variable name="delta_Mevalonate_rxn3" public_interface="out" units="flux" />
  <variable name="delta_ATP_rxn3" public_interface="out" units="flux" />
  <variable name="delta_ADP_rxn3" public_interface="out" units="flux" />
  <variable name="delta_Phosphomevalonate_5_rxn3" public_interface="out" units="flux" />
  <variable name="km3" initial_value="1.0" units="micromolar" />
  <variable name="vmax3" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Mevalonate">
      <role role="reactant" delta_variable="delta_Mevalonate_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="ATP">
      <role role="reactant" delta_variable="delta_ATP_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="ADP">
      <role role="product" delta_variable="delta_ADP_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Phosphomevalonate_5">
      <role role="product" delta_variable="delta_Phosphomevalonate_5_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Mevalonate_kinase">
      <role role="catalyst" />
    </variable_ref>
    <variable_ref variable="rate">
      <role role="rate">
        <math xmlns="http://www.w3.org/1998/Math/MathML">
          <apply><eq />
            <ci>rate</ci>
            <apply><divide />
              <apply><times />
                <ci>Mevalonate</ci>
                <ci>ATP</ci>
                <ci>vmax3</ci>
              </apply>
            <apply><plus />
              <ci>km3</ci>
              <ci>Mevalonate</ci>
              <ci>ATP</ci>
            </apply>
          </math>
        </role>
      </variable_ref>
    </reaction>
  </component>

```

```

<component name="reaction4">

```

```

<variable name="Phosphomevalonate_5" public_interface="in" units="micromolar" />
<variable name="Phosphomevalonate_kinase" public_interface="in" units="micromolar" />
<variable name="ATP" public_interface="in" units="micromolar" />
<variable name="ADP" public_interface="in" units="micromolar" />
<variable name="Pyrophosphomevalonate_5" public_interface="in" units="micromolar" />
<variable name="delta_Phosphomevalonate_5_rxn4" public_interface="out" units="flux" />
<variable name="delta_ATP_rxn4" public_interface="out" units="flux" />
<variable name="delta_ADP_rxn4" public_interface="out" units="flux" />
<variable name="delta_Pyrophosphomevalonate_5_rxn4" public_interface="out" units="flux" />
<variable name="km4" initial_value="1.0" units="micromolar" />
<variable name="vmax4" initial_value="1.0" units="second_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="no">
  <variable_ref variable="Phosphomevalonate_5">
    <role role="reactant" delta_variable="delta_Phosphomevalonate_5_rxn4" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="ATP">
    <role role="reactant" delta_variable="delta_ATP_rxn4" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="ADP">
    <role role="product" delta_variable="delta_ADP_rxn4" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Pyrophosphomevalonate_5">
    <role role="product" delta_variable="delta_Pyrophosphomevalonate_5_rxn4" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Phosphomevalonate_kinase">
    <role role="catalyst" direction="forward" />
  </variable_ref>
  <variable_ref variable="rate">
    <role role="rate">
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
          <ci>rate</ci>
          <apply><divide />
            <apply><times />
              <ci>Phosphomevalonate_5</ci>
              <ci>ATP</ci>
              <ci>vmax4</ci>
            </apply>
          <apply><plus />
            <ci>km4</ci>
            <ci>Phosphomevalonate_5</ci>
            <ci>ATP</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction5">
  <variable name="ATP" public_interface="in" units="micromolar" />
  <variable name="Pyrophosphomevalonate_5" public_interface="in" units="micromolar" />
  <variable name="Phosphomevalonate_decarboxylase" public_interface="in" units="micromolar" />
  <variable name="Isopentenyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="ADP" public_interface="in" units="micromolar" />
  <variable name="Pi" public_interface="in" units="micromolar" />

```

```

<variable name="CO2" public_interface="in" units="micromolar" />
<variable name="delta_ATP_rxn5" public_interface="out" units="flux" />
<variable name="delta_Pyrophosphomevalonate_5_rxn5" public_interface="out" units="flux" />
<variable name="delta_Isopentenyl_pyrophosphate_rxn5" public_interface="out" units="flux" />
<variable name="delta_ADP_rxn5" public_interface="out" units="flux" />
<variable name="delta_Pi_rxn5" public_interface="out" units="flux" />
<variable name="delta_CO2_rxn5" public_interface="out" units="flux" />
<variable name="km5" initial_value="1.0" units="micromolar" />
<variable name="vmax5" initial_value="1.0" units="second_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="no">
  <variable_ref variable="ATP">
    <role role="reactant" delta_variable="delta_ATP_rxn5" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Pyrophosphomevalonate_5">
    <role role="reactant" delta_variable="delta_Pyrophosphomevalonate_5_rxn5" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Isopentenyl_pyrophosphate">
    <role role="product" delta_variable="delta_Isopentenyl_pyrophosphate_rxn5" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="ADP">
    <role role="product" delta_variable="delta_ADP_rxn5" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Pi">
    <role role="product" delta_variable="delta_Pi_rxn5" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="CO2">
    <role role="product" delta_variable="delta_CO2_rxn5" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Phosphomevalonate_decarboxylase">
    <role role="catalyst" direction="forward" />
  </variable_ref>
  <variable_ref variable="rate">
    <role role="rate">
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
          <ci>rate</ci>
          <apply><divide />
            <apply><times />
              <ci>ATP</ci>
              <ci>Pyrophosphomevalonate_5</ci>
              <ci>vmax5</ci>
            </apply>
          <apply><plus />
            <ci>km5</ci>
            <ci>ATP</ci>
            <ci>Pyrophosphomevalonate_5</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction6">
  <variable name="Isopentenyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="Dimethylallyl_pyrophosphate" public_interface="in" units="micromolar" />

```

```

<variable name="delta_Isopentenyl_pyrophosphate_rxn6" public_interface="out" units="flux" />
<variable name="delta_Dimethylallyl_pyrophosphate_rxn6" public_interface="out" units="flux" />
<variable name="k6" initial_value="1.0" units="first_order_rate_constant" />
<variable name="k6_" initial_value="1.0" units="first_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="yes">
  <variable_ref variable="Isopentenyl_pyrophosphate">
    <role role="reactant" direction="forward" delta_variable="delta_Isopentenyl_pyrophosphate" />
  </variable_ref>
  <variable_ref variable="Dimethylallyl_pyrophosphate">
    <role role="product" direction="forward" delta_variable="delta_Dimethylallyl_pyrophosphate" />
  </variable_ref>
  <variable_ref variable="rate">
    <role role="rate">
      <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply><eq />
          <ci>rate</ci>
          <apply><plus />
            <apply><times />
              <ci>k6</ci>
              <ci>Isopentenyl_pyrophosphate</ci>
            </apply>
          <apply><minus />
            <apply><times />
              <ci>k6_</ci>
              <ci>Dimethylallyl_pyrophosphate</ci>
            </apply>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction7">
  <variable name="Dimethylallyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="Isopentenyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="PPi" public_interface="in" units="micromolar" />
  <variable name="Geranyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="Prenyl_transferase" public_interface="in" units="micromolar" />
  <variable name="delta_Dimethylallyl_pyrophosphate_rxn7" public_interface="out" units="flux" />
  <variable name="delta_Isopentenyl_pyrophosphate_rxn7" public_interface="out" units="flux" />
  <variable name="delta_PPi_rxn7" public_interface="out" units="flux" />
  <variable name="delta_Geranyl_pyrophosphate_rxn7" public_interface="out" units="flux" />
  <variable name="km7" initial_value="1.0" units="micromolar" />
  <variable name="vmax7" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Dimethylallyl_pyrophosphate">
      <role role="reactant" delta_variable="delta_Dimethylallyl_pyrophosphate_rxn7" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Isopentenyl_pyrophosphate">
      <role role="reactant" delta_variable="delta_Isopentenyl_pyrophosphate_rxn7" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="PPi">
      <role role="product" delta_variable="delta_PPi_rxn7" stoichiometry="1" />
    </variable_ref>
  </reaction>
</component>

```

```

<variable_ref variable="Geranyl_pyrophosphate">
  <role role="product" delta_variable="delta_Geranyl_pyrophosphate_rxn7" stoichiometry=
</variable_ref>
<variable_ref variable="Prenyl_transferase">
  <role role="catalyst" direction="forward" />
</variable_ref>
<variable_ref variable="rate">
  <role role="rate">
    <math xmlns="http://www.w3.org/1998/Math/MathML">
      <apply><eq />
        <ci>rate</ci>
        <apply><divide />
          <apply><times />
            <ci>Dimethylallyl_pyrophosphate</ci>
            <ci>Isopentenyl_pyrophosphate</ci>
            <ci>vmax7</ci>
          </apply>
        <apply><plus />
          <ci>km7</ci>
          <ci>Dimethylallyl_pyrophosphate</ci>
          <ci>Isopentenyl_pyrophosphate</ci>
        </apply>
      </math>
    </role>
  </variable_ref>
</reaction>
</component>

```

```

<component name="reaction8">
  <variable name="Isopentenyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="Geranyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="PPi" public_interface="in" units="micromolar" />
  <variable name="Prenyl_transferase" public_interface="in" units="micromolar" />
  <variable name="Farnesyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="delta_Isopentenyl_pyrophosphate_rxn8" public_interface="out" units="flux" />
  <variable name="delta_Geranyl_pyrophosphate_rxn8" public_interface="out" units="flux" />
  <variable name="delta_PPi_rxn8" public_interface="out" units="flux" />
  <variable name="delta_Farnesyl_pyrophosphate_rxn8" public_interface="out" units="flux" />
  <variable name="km8" initial_value="1.0" units="micromolar" />
  <variable name="vmax8" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Isopentenyl_pyrophosphate">
      <role role="reactant" delta_variable="delta_Isopentenyl_pyrophosphate_rxn8" stoichiometry=
    </variable_ref>
    <variable_ref variable="Geranyl_pyrophosphate">
      <role role="reactant" delta_variable="delta_Geranyl_pyrophosphate_rxn8" stoichiometry=
    </variable_ref>
    <variable_ref variable="PPi">
      <role role="product" delta_variable="delta_PPi_rxn8" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Farnesyl_pyrophosphate">
      <role role="product" delta_variable="delta_Farnesyl_pyrophosphate_rxn8" stoichiometry=
    </variable_ref>
    <variable_ref variable="Prenyl_transferase">
      <role role="catalyst" direction="forward" />
    </variable_ref>
  </reaction>

```

```

<variable_ref variable="rate">
  <role role="rate">
    <math xmlns="http://www.w3.org/1998/Math/MathML">
      <apply><eq />
        <ci>rate</ci>
        <apply><divide />
          <apply><times />
            <ci>Isopentenyl_pyrophosphate</ci>
            <ci>Geranyl_pyrophosphate</ci>
            <ci>vmax8</ci>
          </apply>
        <apply><plus />
          <ci>km8</ci>
          <ci>Isopentenyl_pyrophosphate</ci>
          <ci>Geranyl_pyrophosphate</ci>
        </apply>
      </math>
    </role>
  </variable_ref>
</reaction>
</component>

```

```

<component name="reaction9">
  <variable name="NADPH" public_interface="in" units="micromolar" />
  <variable name="Farnesyl_pyrophosphate" public_interface="in" units="micromolar" />
  <variable name="H" public_interface="in" units="micromolar" />
  <variable name="NADP" public_interface="in" units="micromolar" />
  <variable name="PPi" public_interface="in" units="micromolar" />
  <variable name="Squalene" public_interface="in" units="micromolar" />
  <variable name="Squalene_synthase" public_interface="in" units="micromolar" />
  <variable name="delta_NADPH_rxn9" public_interface="out" units="flux" />
  <variable name="delta_Farnesyl_pyrophosphate_rxn9" public_interface="out" units="flux" />
  <variable name="delta_H_rxn9" public_interface="out" units="flux" />
  <variable name="delta_NADP_rxn9" public_interface="out" units="flux" />
  <variable name="delta_PPi_rxn9" public_interface="out" units="flux" />
  <variable name="delta_Squalene_rxn9" public_interface="out" units="flux" />
  <variable name="km9" initial_value="1.0" units="micromolar" />
  <variable name="vmax9" initial_value="1.0" units="third_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="NADPH">
      <role role="reactant" delta_variable="delta_NADPH_rxn9" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Farnesyl_pyrophosphate">
      <role role="reactant" delta_variable="delta_Farnesyl_pyrophosphate_rxn9" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="H">
      <role role="reactant" delta_variable="delta_H_rxn9" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="NADP">
      <role role="product" delta_variable="delta_NADP_rxn9" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="PPi">
      <role role="product" delta_variable="delta_PPi_rxn9" stoichiometry="2" />
    </variable_ref>
    <variable_ref variable="Squalene">
      <role role="product" delta_variable="delta_Squalene_rxn9" stoichiometry="1" />
    </variable_ref>
  </reaction>

```

```

</variable_ref>
<variable_ref variable="Squalene_synthase">
  <role role="catalyst" direction="forward" />
</variable_ref>
<variable_ref variable="rate">
  <role role="rate">
    <math xmlns="http://www.w3.org/1998/Math/MathML">
      <apply><eq />
        <ci>rate</ci>
        <apply><divide />
          <apply><times />
            <ci>NADPH</ci>
            <ci>Farnesyl_pyrophosphate</ci>
            <ci>H</ci>
            <ci>vmax9</ci>
          </apply>
          <apply><plus />
            <ci>km9</ci>
            <ci>NADPH</ci>
            <ci>Farnesyl_pyrophosphate</ci>
            <ci>H</ci>
          </apply>
        </apply>
      </math>
    </role>
  </variable_ref>
</reaction>
</component>

<component name="reaction10">
  <variable name="H" public_interface="in" units="micromolar" />
  <variable name="Squalene" public_interface="in" units="micromolar" />
  <variable name="NADPH" public_interface="in" units="micromolar" />
  <variable name="O2" public_interface="in" units="micromolar" />
  <variable name="NADP" public_interface="in" units="micromolar" />
  <variable name="H2O" public_interface="in" units="micromolar" />
  <variable name="Squalene_2_3_epoxide" public_interface="in" units="micromolar" />
  <variable name="Squalene_monooxygenase" public_interface="in" units="micromolar" />
  <variable name="delta_H_rxn10" public_interface="out" units="flux" />
  <variable name="delta_Squalene_rxn10" public_interface="out" units="flux" />
  <variable name="delta_NADPH_rxn10" public_interface="out" units="flux" />
  <variable name="delta_O2_rxn10" public_interface="out" units="flux" />
  <variable name="delta_NADP_rxn10" public_interface="out" units="flux" />
  <variable name="delta_H2O_rxn10" public_interface="out" units="flux" />
  <variable name="delta_Squalene_2_3_epoxide_rxn10" public_interface="out" units="flux" />
  <variable name="km10" initial_value="1.0" units="micromolar" />
  <variable name="vmax10" initial_value="1.0" units="forth_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="H">
      <role role="reactant" delta_variable="delta_H_rxn10" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Squalene">
      <role role="reactant" delta_variable="delta_Squalene_rxn10" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="NADPH">
      <role role="reactant" delta_variable="delta_NADPH_rxn10" stoichiometry="1" />
    </variable_ref>
  </reaction>

```

```

<variable_ref variable="O2">
  <role role="reactant" delta_variable="delta_O2_rxn10" stoichiometry="1" />
</variable_ref>
<variable_ref variable="NADP">
  <role role="product" delta_variable="delta_NADP_rxn10" stoichiometry="1" />
</variable_ref>
<variable_ref variable="H2O">
  <role role="product" delta_variable="delta_H2O_rxn10" stoichiometry="1" />
</variable_ref>
<variable_ref variable="Squalene_2_3_epoxide">
  <role role="product" delta_variable="delta_Squalene_2_3_epoxide_rxn10" stoichiometry="1" />
</variable_ref>
<variable_ref variable="Squalene_monooxygenase">
  <role role="catalyst" direction="forward" />
</variable_ref>
<variable_ref variable="rate">
  <role role="rate">
    <math xmlns="http://www.w3.org/1998/Math/MathML">
      <apply><eq />
        <ci>rate</ci>
        <apply><divide />
          <apply><times />
            <ci>H</ci>
            <ci>Squalene</ci>
            <ci>NADPH</ci>
            <ci>O2</ci>
            <ci>vmax10</ci>
          </apply>
          <apply><plus />
            <ci>km10</ci>
            <ci>H</ci>
            <ci>Squalene</ci>
            <ci>NADPH</ci>
            <ci>O2</ci>
          </apply>
        </apply>
      </math>
    </role>
  </variable_ref>
</reaction>
</component>

<component name="reaction11">
  <variable name="Squalene_2_3_epoxide" public_interface="in" units="micromolar" />
  <variable name="Lanosterol" public_interface="in" units="micromolar" />
  <variable name="Cyclase" public_interface="in" units="micromolar" />
  <variable name="delta_Squalene_2_3_epoxide_rxn11" public_interface="out" units="flux" />
  <variable name="delta_Lanosterol_rxn11" public_interface="out" units="flux" />
  <variable name="km11" initial_value="1.0" units="micromolar" />
  <variable name="vmax11" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Squalene_2_3_epoxide">
      <role role="reactant" delta_variable="delta_Squalene_2_3_epoxide_rxn11" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Lanosterol">
      <role role="product" delta_variable="delta_Lanosterol_rxn11" stoichiometry="1" />
    </variable_ref>
  </reaction>
</component>

```

```

<variable_ref variable="Cyclase">
  <role role="catalyst" />
</variable_ref>
<variable_ref variable="rate">
  <role role="rate">
    <math xmlns="http://www.w3.org/1998/Math/MathML">
      <apply><eq />
        <ci>rate</ci>
        <apply><divide />
          <apply><times />
            <ci>Squalene_2_3_epoxide</ci>
            <ci>vmax11</ci>
          </apply>
        <apply><plus />
          <ci>km11</ci>
          <ci>Squalene_2_3_epoxide</ci>
        </apply>
      </apply>
    </math>
  </role>
</variable_ref>
</reaction>
</component>

```

```

<component name="reaction12">
  <variable name="Lanosterol" public_interface="in" units="micromolar" />
  <variable name="Cholesterol" public_interface="in" units="micromolar" />
  <variable name="delta_Lanosterol_rxn12" public_interface="out" units="flux" />
  <variable name="delta_Cholesterol_rxn12" public_interface="out" units="flux" />
  <variable name="k12" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Lanosterol">
      <role role="reactant" delta_variable="delta_Lanosterol_rxn12" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Cholesterol">
      <role role="product" delta_variable="delta_Cholesterol_rxn12" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="rate">
      <role role="rate">
        <math xmlns="http://www.w3.org/1998/Math/MathML">
          <apply><eq />
            <ci>rate</ci>
            <apply><times />
              <ci>k12</ci>
              <ci>Lanosterol</ci>
            </apply>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

```

```

<connection>
  <map_components component_1="Acetyl_CoA" component_2="reaction0" />
  <map_variables variable_1="Acetyl_CoA" variable_2="Acetyl_CoA" />
  <map_variables variable_1="delta_Acetyl_CoA_rxn0" variable_2="delta_Acetyl_CoA_rxn0" />

```

```

</connection>

<connection>
  <map_components component_1="Acetyl_CoA" component_2="reaction1" />
  <map_variables variable_1="Acetyl_CoA" variable_2="Acetyl_CoA" />
  <map_variables variable_1="delta_Acetyl_CoA_rxn1" variable_2="delta_Acetyl_CoA_rxn1" />
</connection>

<connection>
  <map_components component_1="CoA_SH" component_2="reaction0" />
  <map_variables variable_1="CoA_SH" variable_2="CoA_SH" />
  <map_variables variable_1="delta_CoA_SH_rxn0" variable_2="delta_CoA_SH_rxn0" />
</connection>

<connection>
  <map_components component_1="CoA_SH" component_2="reaction1" />
  <map_variables variable_1="CoA_SH" variable_2="CoA_SH" />
  <map_variables variable_1="delta_CoA_SH_rxn1" variable_2="delta_CoA_SH_rxn1" />
</connection>

<connection>
  <map_components component_1="CoA_SH" component_2="reaction2" />
  <map_variables variable_1="CoA_SH" variable_2="CoA_SH" />
  <map_variables variable_1="delta_CoA_SH_rxn2" variable_2="delta_CoA_SH_rxn2" />
</connection>

<connection>
  <map_components component_1="Acetoacetyl_CoA" component_2="reaction0" />
  <map_variables variable_1="Acetoacetyl_CoA" variable_2="Acetoacetyl_CoA" />
  <map_variables variable_1="delta_Acetoacetyl_CoA_rxn0" variable_2="delta_Acetoacetyl_CoA" />
</connection>

<connection>
  <map_components component_1="Acetoacetyl_CoA" component_2="reaction1" />
  <map_variables variable_1="Acetoacetyl_CoA" variable_2="Acetoacetyl_CoA" />
  <map_variables variable_1="delta_Acetoacetyl_CoA_rxn1" variable_2="delta_Acetoacetyl_CoA" />
</connection>

<connection>
  <map_components component_1="Hydroxymethylglutaryl_CoA" component_2="reaction1" />
  <map_variables variable_1="Hydroxymethylglutaryl_CoA" variable_2="Hydroxymethylglutaryl_CoA" />
  <map_variables variable_1="delta_Hydroxymethylglutaryl_CoA_rxn1" variable_2="delta_Hydroxymethylglutaryl_CoA" />
</connection>

<connection>
  <map_components component_1="Hydroxymethylglutaryl_CoA" component_2="reaction2" />
  <map_variables variable_1="Hydroxymethylglutaryl_CoA" variable_2="Hydroxymethylglutaryl_CoA" />
  <map_variables variable_1="delta_Hydroxymethylglutaryl_CoA_rxn2" variable_2="delta_Hydroxymethylglutaryl_CoA" />
</connection>

<connection>
  <map_components component_1="Mevalonate" component_2="reaction2" />
  <map_variables variable_1="Mevalonate" variable_2="Mevalonate" />
  <map_variables variable_1="delta_Mevalonate_rxn2" variable_2="delta_Mevalonate_rxn2" />
</connection>

<connection>
  <map_components component_1="Mevalonate" component_2="reaction3" />
  <map_variables variable_1="Mevalonate" variable_2="Mevalonate" />

```

```
<map_variables variable_1="delta_Mevalonate_rxn3" variable_2="delta_Mevalonate_rxn3" />
</connection>

<connection>
  <map_components component_1="Phosphomevalonate_5" component_2="reaction3" />
  <map_variables variable_1="Phosphomevalonate_5" variable_2="Phosphomevalonate_5" />
  <map_variables variable_1="delta_Phosphomevalonate_5_rxn3" variable_2="delta_Phosphomevalonate_5_rxn3" />
</connection>

<connection>
  <map_components component_1="Phosphomevalonate_5" component_2="reaction4" />
  <map_variables variable_1="Phosphomevalonate_5" variable_2="Phosphomevalonate_5" />
  <map_variables variable_1="delta_Phosphomevalonate_5_rxn4" variable_2="delta_Phosphomevalonate_5_rxn4" />
</connection>

<connection>
  <map_components component_1="Pyrophosphomevalonate_5" component_2="reaction4" />
  <map_variables variable_1="Pyrophosphomevalonate_5" variable_2="Pyrophosphomevalonate_5" />
  <map_variables variable_1="delta_Pyrophosphomevalonate_5_rxn4" variable_2="delta_Pyrophosphomevalonate_5_rxn4" />
</connection>

<connection>
  <map_components component_1="Pyrophosphomevalonate_5" component_2="reaction5" />
  <map_variables variable_1="Pyrophosphomevalonate_5" variable_2="Pyrophosphomevalonate_5" />
  <map_variables variable_1="delta_Pyrophosphomevalonate_5_rxn5" variable_2="delta_Pyrophosphomevalonate_5_rxn5" />
</connection>

<connection>
  <map_components component_1="Isopentenyl_pyrophosphate" component_2="reaction5" />
  <map_variables variable_1="Isopentenyl_pyrophosphate" variable_2="Isopentenyl_pyrophosphate" />
  <map_variables variable_1="delta_Isopentenyl_pyrophosphate_rxn5" variable_2="delta_Isopentenyl_pyrophosphate_rxn5" />
</connection>

<connection>
  <map_components component_1="Isopentenyl_pyrophosphate" component_2="reaction6" />
  <map_variables variable_1="Isopentenyl_pyrophosphate" variable_2="Isopentenyl_pyrophosphate" />
  <map_variables variable_1="delta_Isopentenyl_pyrophosphate_rxn6" variable_2="delta_Isopentenyl_pyrophosphate_rxn6" />
</connection>

<connection>
  <map_components component_1="Isopentenyl_pyrophosphate" component_2="reaction7" />
  <map_variables variable_1="Isopentenyl_pyrophosphate" variable_2="Isopentenyl_pyrophosphate" />
  <map_variables variable_1="delta_Isopentenyl_pyrophosphate_rxn7" variable_2="delta_Isopentenyl_pyrophosphate_rxn7" />
</connection>

<connection>
  <map_components component_1="Isopentenyl_pyrophosphate" component_2="reaction8" />
  <map_variables variable_1="Isopentenyl_pyrophosphate" variable_2="Isopentenyl_pyrophosphate" />
  <map_variables variable_1="delta_Isopentenyl_pyrophosphate_rxn8" variable_2="delta_Isopentenyl_pyrophosphate_rxn8" />
</connection>

<connection>
  <map_components component_1="Dimethylallyl_pyrophosphate" component_2="reaction6" />
  <map_variables variable_1="Dimethylallyl_pyrophosphate" variable_2="Dimethylallyl_pyrophosphate" />
  <map_variables variable_1="delta_Dimethylallyl_pyrophosphate_rxn6" variable_2="delta_Dimethylallyl_pyrophosphate_rxn6" />
</connection>

<connection>
  <map_components component_1="Dimethylallyl_pyrophosphate" component_2="reaction7" />
```

```
<map_variables variable_1="Dimethylallyl_pyrophosphate" variable_2="Dimethylallyl_pyrophosphate" />
<map_variables variable_1="delta_Dimethylallyl_pyrophosphate_rxn7" variable_2="delta_Dimethylallyl_pyrophosphate_rxn7" />
</connection>

<connection>
  <map_components component_1="NADPH" component_2="reaction2" />
  <map_variables variable_1="NADPH" variable_2="NADPH" />
  <map_variables variable_1="delta_NADPH_rxn2" variable_2="delta_NADPH_rxn2" />
</connection>

<connection>
  <map_components component_1="NADPH" component_2="reaction9" />
  <map_variables variable_1="NADPH" variable_2="NADPH" />
  <map_variables variable_1="delta_NADPH_rxn9" variable_2="delta_NADPH_rxn9" />
</connection>

<connection>
  <map_components component_1="NADPH" component_2="reaction10" />
  <map_variables variable_1="NADPH" variable_2="NADPH" />
  <map_variables variable_1="delta_NADPH_rxn10" variable_2="delta_NADPH_rxn10" />
</connection>

<connection>
  <map_components component_1="NADP" component_2="reaction2" />
  <map_variables variable_1="NADP" variable_2="NADP" />
  <map_variables variable_1="delta_NADP_rxn2" variable_2="delta_NADP_rxn2" />
</connection>

<connection>
  <map_components component_1="NADP" component_2="reaction9" />
  <map_variables variable_1="NADP" variable_2="NADP" />
  <map_variables variable_1="delta_NADP_rxn9" variable_2="delta_NADP_rxn9" />
</connection>

<connection>
  <map_components component_1="NADP" component_2="reaction10" />
  <map_variables variable_1="NADP" variable_2="NADP" />
  <map_variables variable_1="delta_NADP_rxn10" variable_2="delta_NADP_rxn10" />
</connection>

<connection>
  <map_components component_1="H" component_2="reaction2" />
  <map_variables variable_1="H" variable_2="H" />
  <map_variables variable_1="delta_H_rxn2" variable_2="delta_H_rxn2" />
</connection>

<connection>
  <map_components component_1="H" component_2="reaction9" />
  <map_variables variable_1="H" variable_2="H" />
  <map_variables variable_1="delta_H_rxn9" variable_2="delta_H_rxn9" />
</connection>

<connection>
  <map_components component_1="H" component_2="reaction10" />
  <map_variables variable_1="H" variable_2="H" />
  <map_variables variable_1="delta_H_rxn10" variable_2="delta_H_rxn10" />
</connection>

<connection>
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    <map_components component_1="ATP" component_2="reaction3" />
    <map_variables variable_1="ATP" variable_2="ATP" />
    <map_variables variable_1="delta_ATP_rxn3" variable_2="delta_ATP_rxn3" />
</connection>

<connection>
    <map_components component_1="ATP" component_2="reaction4" />
    <map_variables variable_1="ATP" variable_2="ATP" />
    <map_variables variable_1="delta_ATP_rxn4" variable_2="delta_ATP_rxn4" />
</connection>

<connection>
    <map_components component_1="ATP" component_2="reaction5" />
    <map_variables variable_1="ATP" variable_2="ATP" />
    <map_variables variable_1="delta_ATP_rxn5" variable_2="delta_ATP_rxn5" />
</connection>

<connection>
    <map_components component_1="ADP" component_2="reaction3" />
    <map_variables variable_1="ADP" variable_2="ADP" />
    <map_variables variable_1="delta_ADp_rxn3" variable_2="delta_ADp_rxn3" />
</connection>

<connection>
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    <map_variables variable_1="ADP" variable_2="ADP" />
    <map_variables variable_1="delta_ADp_rxn4" variable_2="delta_ADp_rxn4" />
</connection>

<connection>
    <map_components component_1="ADP" component_2="reaction5" />
    <map_variables variable_1="ADP" variable_2="ADP" />
    <map_variables variable_1="delta_ADp_rxn5" variable_2="delta_ADp_rxn5" />
</connection>

<connection>
    <map_components component_1="Pi" component_2="reaction5" />
    <map_variables variable_1="Pi" variable_2="Pi" />
    <map_variables variable_1="delta_Pi_rxn5" variable_2="delta_Pi_rxn5" />
</connection>

<connection>
    <map_components component_1="CO2" component_2="reaction5" />
    <map_variables variable_1="CO2" variable_2="CO2" />
    <map_variables variable_1="delta_CO2_rxn5" variable_2="delta_CO2_rxn5" />
</connection>

<connection>
    <map_components component_1="Geranyl_pyrophosphate" component_2="reaction7" />
    <map_variables variable_1="Geranyl_pyrophosphate" variable_2="Geranyl_pyrophosphate" />
    <map_variables variable_1="delta_Geranyl_pyrophosphate_rxn7" variable_2="delta_Geranyl_py" />
</connection>

<connection>
    <map_components component_1="Geranyl_pyrophosphate" component_2="reaction8" />
    <map_variables variable_1="Geranyl_pyrophosphate" variable_2="Geranyl_pyrophosphate" />
    <map_variables variable_1="delta_Geranyl_pyrophosphate_rxn8" variable_2="delta_Geranyl_py" />
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<connection>
  <map_components component_1="Farnesyl_pyrophosphate" component_2="reaction8" />
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</connection>

<connection>
  <map_components component_1="Farnesyl_pyrophosphate" component_2="reaction9" />
  <map_variables variable_1="Farnesyl_pyrophosphate" variable_2="Farnesyl_pyrophosphate" />
  <map_variables variable_1="delta_Farnesyl_pyrophosphate_rxn9" variable_2="delta_Farnesyl_
</connection>

<connection>
  <map_components component_1="PPi" component_2="reaction7" />
  <map_variables variable_1="PPi" variable_2="PPi" />
  <map_variables variable_1="delta_PPi_rxn7" variable_2="delta_PPi_rxn7" />
</connection>

<connection>
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  <map_variables variable_1="PPi" variable_2="PPi" />
  <map_variables variable_1="delta_PPi_rxn8" variable_2="delta_PPi_rxn8" />
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<connection>
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  <map_variables variable_1="PPi" variable_2="PPi" />
  <map_variables variable_1="delta_PPi_rxn9" variable_2="delta_PPi_rxn9" />
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<connection>
  <map_components component_1="Squalene" component_2="reaction9" />
  <map_variables variable_1="Squalene" variable_2="Squalene" />
  <map_variables variable_1="delta_Squalene_rxn9" variable_2="delta_Squalene_rxn9" />
</connection>

<connection>
  <map_components component_1="Squalene" component_2="reaction10" />
  <map_variables variable_1="Squalene" variable_2="Squalene" />
  <map_variables variable_1="delta_Squalene_rxn10" variable_2="delta_Squalene_rxn10" />
</connection>

<connection>
  <map_components component_1="Squalene_2_3_epoxide" component_2="reaction10" />
  <map_variables variable_1="Squalene_2_3_epoxide" variable_2="Squalene_2_3_epoxide" />
  <map_variables variable_1="delta_Squalene_2_3_epoxide_rxn10" variable_2="delta_Squalene_
</connection>

<connection>
  <map_components component_1="Squalene_2_3_epoxide" component_2="reaction11" />
  <map_variables variable_1="Squalene_2_3_epoxide" variable_2="Squalene_2_3_epoxide" />
  <map_variables variable_1="delta_Squalene_2_3_epoxide_rxn11" variable_2="delta_Squalene_
</connection>

<connection>
  <map_components component_1="O2" component_2="reaction10" />
  <map_variables variable_1="O2" variable_2="O2" />
  <map_variables variable_1="delta_O2_rxn10" variable_2="delta_O2_rxn10" />
</connection>

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<connection>
  <map_components component_1="H2O" component_2="reaction10" />
  <map_variables variable_1="H2O" variable_2="H2O" />
  <map_variables variable_1="delta_H2O_rxn10" variable_2="delta_H2O_rxn10" />
</connection>

<connection>
  <map_components component_1="Lanosterol" component_2="reaction11" />
  <map_variables variable_1="Lanosterol" variable_2="Lanosterol" />
  <map_variables variable_1="delta_Lanosterol_rxn11" variable_2="delta_Lanosterol_rxn11" />
</connection>

<connection>
  <map_components component_1="Lanosterol" component_2="reaction12" />
  <map_variables variable_1="Lanosterol" variable_2="Lanosterol" />
  <map_variables variable_1="delta_Lanosterol_rxn12" variable_2="delta_Lanosterol_rxn12" />
</connection>

<connection>
  <map_components component_1="Cholesterol" component_2="reaction12" />
  <map_variables variable_1="Cholesterol" variable_2="Cholesterol" />
  <map_variables variable_1="delta_Cholesterol_rxn12" variable_2="delta_Cholesterol_rxn12" />
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<connection>
  <map_components component_1="Acetyl_CoA" component_2="global_variables" />
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</connection>

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  <map_components component_1="CoA_SH" component_2="global_variables" />
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<connection>
  <map_components component_1="Acetoacetyl_CoA" component_2="global_variables" />
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<connection>
  <map_components component_1="Hydroxymethylglutaryl_CoA" component_2="global_variables" />
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<connection>
  <map_components component_1="Mevalonate" component_2="global_variables" />
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<connection>
  <map_components component_1="Phosphomevalonate_5" component_2="global_variables" />
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<connection>
  <map_components component_1="Isopentenyl_pyrophosphate" component_2="global_variables" />
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  <map_components component_1="Dimethylallyl_pyrophosphate" component_2="global_variables" />
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<connection>
  <map_components component_1="NADPH" component_2="global_variables" />
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<connection>
  <map_components component_1="NADP" component_2="global_variables" />
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<connection>
  <map_components component_1="H" component_2="global_variables" />
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<connection>
  <map_components component_1="ATP" component_2="global_variables" />
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<connection>
  <map_components component_1="ADP" component_2="global_variables" />
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</connection>

<connection>
  <map_components component_1="Pi" component_2="global_variables" />
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</connection>

<connection>
  <map_components component_1="CO2" component_2="global_variables" />
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<connection>
  <map_components component_1="Geranyl_pyrophosphate" component_2="global_variables" />
  <map_variables variable_1="time" variable_2="time" />
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<connection>
  <map_components component_1="Farnesyl_pyrophosphate" component_2="global_variables" />
  <map_variables variable_1="time" variable_2="time" />
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<connection>
  <map_components component_1="PPi" component_2="global_variables" />
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</connection>
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</connection>

<connection>
  <map_components component_1="Squalene" component_2="global_variables" />
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<connection>
  <map_components component_1="Squalene_2_3_epoxide" component_2="global_variables" />
  <map_variables variable_1="time" variable_2="time" />
</connection>

<connection>
  <map_components component_1="O2" component_2="global_variables" />
  <map_variables variable_1="time" variable_2="time" />
</connection>

<connection>
  <map_components component_1="H2O" component_2="global_variables" />
  <map_variables variable_1="time" variable_2="time" />
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<connection>
  <map_components component_1="Lanosterol" component_2="global_variables" />
  <map_variables variable_1="time" variable_2="time" />
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<connection>
  <map_components component_1="Cholesterol" component_2="global_variables" />
  <map_variables variable_1="time" variable_2="time" />
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<connection>
  <map_components component_1="Thiolase" component_2="reaction0" />
  <map_variables variable_1="Thiolase" variable_2="Thiolase" />
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<connection>
  <map_components component_1="HMG_CoA_synthetase" component_2="reaction1" />
  <map_variables variable_1="HMG_CoA_synthetase" variable_2="HMG_CoA_synthetase" />
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<connection>
  <map_components component_1="HMG_CoA_reductase" component_2="reaction2" />
  <map_variables variable_1="HMG_CoA_reductase" variable_2="HMG_CoA_reductase" />
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<connection>
  <map_components component_1="Mevalonate_kinase" component_2="reaction3" />
  <map_variables variable_1="Mevalonate_kinase" variable_2="Mevalonate_kinase" />
</connection>

<connection>
  <map_components component_1="Phosphomevalonate_kinase" component_2="reaction4" />
  <map_variables variable_1="Phosphomevalonate_kinase" variable_2="Phosphomevalonate_kinase" />
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<connection>
  <map_components component_1="Phosphomevalonate_decarboxylase" component_2="reaction5" />
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<map_variables variable_1="Phosphomevalonate_decarboxylase" variable_2="Phosphomevalonate" />
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<connection>
  <map_components component_1="Prenyl_transferase" component_2="reaction7" />
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</connection>

<connection>
  <map_components component_1="Prenyl_transferase" component_2="reaction8" />
  <map_variables variable_1="Prenyl_transferase" variable_2="Prenyl_transferase" />
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<connection>
  <map_components component_1="Squalene_synthase" component_2="reaction9" />
  <map_variables variable_1="Squalene_synthase" variable_2="Squalene_synthase" />
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<connection>
  <map_components component_1="Squalene_monooxygenase" component_2="reaction10" />
  <map_variables variable_1="Squalene_monooxygenase" variable_2="Squalene_monooxygenase" />
</connection>

<connection>
  <map_components component_1="Cyclase" component_2="reaction11" />
  <map_variables variable_1="Cyclase" variable_2="Cyclase" />
</connection>

</model>
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