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

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

```
CREATED : 27th January 2003
```

```
LAST MODIFIED : 27th January 2003
```

```
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  
glycolysis with encapsulation of the side chain reactions.
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CHANGES:
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```
<model name="glycolysis_model_with_encapsulation" pathway_editor:rendering_config_file="Glyco  
<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="">
```

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<!--
```

```
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>
```

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<!--
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```
The Creation Date metadata. This is the date on which the model  
was translated into CellML.
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```
<dcterms:created rdf:parseType="Resource">
```

```
<dcterms:W3CDTF>2003-01-27</dcterms:W3CDTF>
```

```
</dcterms:created>
```

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<!--
  The Last Modified Date metadata. This is the date on which
  the model was last changed.
-->

<!-- 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 "glycolysis_model_with_encapsulation", which is
  declared on the <model> element.
-->
<rdf:Description rdf:about="#glycolysis_model_with_encapsulation">
  <!-- A human readable name for the model. -->
  <dc:title>
    A Generic Model Of Glycolysis with encapsulation of the side chain
    reactions
  </dc:title>

  <!-- A comment regarding the model. -->
  <cmeta:comment rdf:parseType="Resource">
    <rdf:value>
      Below is a CellML description of a general model of the metabolic
      pathway glycolysis with encapsulation of the side chain reactions.

      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>

  <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>

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        </bqs:Property>
    </dc:publisher>
</bqs:Book>
</rdf:Description>
</rdf:RDF>

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

<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>

<!--
    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 glycolysis.
-->

<component name="Glycogen" cmeta:id="Glycogen">
    <variable name="Glycogen" public_interface="out" initial_value="1.0" units="micromolar" />
    <variable name="delta_Glycogen_rxn2" public_interface="in" units="flux" />
    <variable name="delta_Glycogen_rxn0" 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>
    </math>

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        <ci>Glycogen</ci>
    </apply>
    <apply><plus />
        <ci>delta_Glycogen_rxn2</ci>
        <ci>delta_Glycogen_rxn0</ci>
    </apply>
</math>
</component>

<component name="UDP" cmeta:id="UDP">
    <variable name="UDP" public_interface="out" initial_value="1.0" units="micromolar" />
    <variable name="delta_UDP_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>UDP</ci>
            </apply>
            <ci>delta_UDP_rxn2</ci>
        </apply>
    </math>
</component>

<component name="UDP_glucose" cmeta:id="UDP_glucose">
    <variable name="UDP_glucose" public_interface="out" initial_value="1.0" units="micromolar" />
    <variable name="delta_UDP_glucose_rxn3" public_interface="in" units="flux" />
    <variable name="delta_UDP_glucose_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>UDP_glucose</ci>
            </apply>
            <apply><plus />
                <ci>delta_UDP_glucose_rxn3</ci>
                <ci>delta_UDP_glucose_rxn2</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_rxn1" public_interface="in" units="flux" />
    <variable name="delta_Pi_rxn6" public_interface="in" units="flux" />
    <variable name="delta_Pi_rxn9" public_interface="in" units="flux" />
    <variable name="delta_Pi_rxn11" public_interface="in" units="flux" />
    <variable name="delta_Pi_rxn0" 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 />

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    <bvar>
      <ci>time</ci>
    </bvar>
    <ci>Pi</ci>
  </apply>
  <apply><plus />
    <ci>delta_Pi_rxn1</ci>
    <ci>delta_Pi_rxn6</ci>
    <ci>delta_Pi_rxn9</ci>
    <ci>delta_Pi_rxn11</ci>
    <ci>delta_Pi_rxn0</ci>
  </apply>
</apply>
</math>
</component>

<component name="Glucose_1_phosphate" cmeta:id="Glucose_1_phosphate">
  <variable name="Glucose_1_phosphate" public_interface="out" private_interface="out" units="micromolar" />
  <variable name="delta_Glucose_1_phosphate_rxn0" public_interface="in" units="flux" />
  <variable name="delta_Glucose_1_phosphate_rxn3" public_interface="in" units="flux" />
  <variable name="delta_Glucose_1_phosphate_rxn4" public_interface="in" units="flux" />
  <variable name="delta_Glucose_1_phosphate_rxn5" private_interface="in" units="flux" />
  <variable name="delta_Glucose_1_phosphate_rxn6" private_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />

  <variable name="Glucose_1_phosphatase" public_interface="in" private_interface="out" units="micromolar" />
  <variable name="Glucose" public_interface="in" private_interface="out" units="micromolar" />
  <variable name="ATP" public_interface="in" private_interface="out" units="micromolar" />
  <variable name="ADP" public_interface="in" private_interface="out" units="micromolar" />
  <variable name="Pi" public_interface="in" private_interface="out" units="micromolar" />
  <variable name="H2O" public_interface="in" private_interface="out" units="micromolar" />
  <variable name="Hexokinase" public_interface="in" private_interface="out" units="micromolar" />

  <variable name="delta_ATP_rxn5" public_interface="out" private_interface="in" units="flux" />
  <variable name="delta_ADP_rxn5" public_interface="out" private_interface="in" units="flux" />
  <variable name="delta_Glucose_rxn5" public_interface="out" private_interface="in" units="flux" />
  <variable name="delta_Pi_rxn6" public_interface="out" private_interface="in" units="flux" />
  <variable name="delta_H2O_rxn6" public_interface="out" private_interface="in" units="flux" />
  <variable name="delta_Glucose_rxn6" public_interface="out" private_interface="in" units="flux" />

  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply><eq />
      <apply><diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>Glucose_1_phosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Glucose_1_phosphate_rxn0</ci>
        <ci>delta_Glucose_1_phosphate_rxn3</ci>
        <ci>delta_Glucose_1_phosphate_rxn4</ci>
        <ci>delta_Glucose_1_phosphate_rxn5</ci>
        <ci>delta_Glucose_1_phosphate_rxn6</ci>
      </apply>
    </math>
  </component>

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<component name="UTP" cmeta:id="UTP">
  <variable name="UTP" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_UTP_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>
          <ci>time</ci>
        </bvar>
        <ci>UTP</ci>
      </apply>
      <ci>delta_UTP_rxn3</ci>
    </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_rxn3" public_interface="in" units="flux" />
  <variable name="delta_PPi_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>PPi</ci>
      </apply>
      <apply><plus />
        <ci>delta_PPi_rxn3</ci>
        <ci>delta_PPi_rxn1</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="Glucose" cmeta:id="Glucose">
  <variable name="Glucose" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Glucose_rxn6" public_interface="in" units="flux" />
  <variable name="delta_Glucose_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>Glucose</ci>
      </apply>
      <apply><plus />
        <ci>delta_Glucose_rxn6</ci>
        <ci>delta_Glucose_rxn5</ci>
      </apply>
    </apply>
  </math>
</component>

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<component name="ATP" cmeta:id="ATP">
  <variable name="ATP" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_ATP_rxn20" public_interface="in" units="flux" />
  <variable name="delta_ATP_rxn5" public_interface="in" units="flux" />
  <variable name="delta_ATP_rxn8" public_interface="in" units="flux" />
  <variable name="delta_ATP_rxn10" public_interface="in" units="flux" />
  <variable name="delta_ATP_rxn15" 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>ATP</ci>
      </apply>
      <apply><plus />
        <ci>delta_ATP_rxn20</ci>
        <ci>delta_ATP_rxn5</ci>
        <ci>delta_ATP_rxn8</ci>
        <ci>delta_ATP_rxn10</ci>
        <ci>delta_ATP_rxn15</ci>
      </apply>
    </math>
</component>

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<component name="ADP" cmeta:id="ADP">
  <variable name="ADP" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_ADP_rxn5" public_interface="in" units="flux" />
  <variable name="delta_ADP_rxn8" public_interface="in" units="flux" />
  <variable name="delta_ADP_rxn10" public_interface="in" units="flux" />
  <variable name="delta_ADP_rxn15" public_interface="in" units="flux" />
  <variable name="delta_ADP_rxn20" 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_rxn5</ci>
        <ci>delta_ADP_rxn8</ci>
        <ci>delta_ADP_rxn10</ci>
        <ci>delta_ADP_rxn15</ci>
        <ci>delta_ADP_rxn20</ci>
      </apply>
    </math>
</component>

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<component name="H2O" cmeta:id="H2O">
  <variable name="H2O" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_H2O_rxn19" public_interface="in" units="flux" />
  <variable name="delta_H2O_rxn6" public_interface="in" units="flux" />
  <variable name="delta_H2O_rxn9" public_interface="in" units="flux" />

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<variable name="delta_H2O_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>H2O</ci>
    </apply>
    <apply><plus />
      <ci>delta_H2O_rxn19</ci>
      <ci>delta_H2O_rxn6</ci>
      <ci>delta_H2O_rxn9</ci>
      <ci>delta_H2O_rxn11</ci>
    </apply>
  </apply>
</math>
</component>

<component name="Glucose_6_phosphate" cmeta:id="Glucose_6_phosphate">
  <variable name="Glucose_6_phosphate" public_interface="out" initial_value="1.0" units="m">

  <variable name="delta_Glucose_6_phosphate_rxn4" public_interface="in" units="flux" />
  <variable name="delta_Glucose_6_phosphate_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>Glucose_6_phosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Glucose_6_phosphate_rxn4</ci>
        <ci>delta_Glucose_6_phosphate_rxn7</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="Fructose_6_phosphate" cmeta:id="Fructose_6_phosphate">
  <variable name="Fructose_6_phosphate" public_interface="out" initial_value="1.0" units="m">
  <variable name="delta_Fructose_6_phosphate_rxn9" public_interface="in" units="flux" />
  <variable name="delta_Fructose_6_phosphate_rxn11" public_interface="in" units="flux" />
  <variable name="delta_Fructose_6_phosphate_rxn7" public_interface="in" units="flux" />
  <variable name="delta_Fructose_6_phosphate_rxn8" public_interface="in" units="flux" />
  <variable name="delta_Fructose_6_phosphate_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>Fructose_6_phosphate</ci>
      </apply>
    </math>
  </component>

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    <apply><plus />
      <ci>delta_Fructose_6_phosphate_rxn9</ci>
      <ci>delta_Fructose_6_phosphate_rxn11</ci>
      <ci>delta_Fructose_6_phosphate_rxn7</ci>
      <ci>delta_Fructose_6_phosphate_rxn8</ci>
      <ci>delta_Fructose_6_phosphate_rxn10</ci>
    </apply>
  </apply>
</math>
</component>

<component name="Fructose_2_6_bisphosphate" cmeta:id="Fructose_2_6_bisphosphate">
  <variable name="Fructose_2_6_bisphosphate" public_interface="out" initial_value="1.0" un
  <variable name="delta_Fructose_2_6_bisphosphate_rxn8" public_interface="in" units="flux"
  <variable name="delta_Fructose_2_6_bisphosphate_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>Fructose_2.6_bisphosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Fructose_2.6_bisphosphate_rxn8</ci>
        <ci>delta_Fructose_2.6_bisphosphate_rxn9</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="Fructose_1_6_bisphosphate" cmeta:id="Fructose_1_6_bisphosphate">
  <variable name="Fructose_1_6_bisphosphate" public_interface="out" initial_value="1.0" un
  <variable name="delta_Fructose_1_6_bisphosphate_rxn10" public_interface="in" units="flux"
  <variable name="delta_Fructose_1_6_bisphosphate_rxn11" public_interface="in" units="flux"
  <variable name="delta_Fructose_1_6_bisphosphate_rxn12" public_interface="in" units="flux"
  <variable name="delta_Fructose_1_6_bisphosphate_rxn13" 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>Fructose_1.6_bisphosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Fructose_1.6_bisphosphate_rxn10</ci>
        <ci>delta_Fructose_1.6_bisphosphate_rxn11</ci>
        <ci>delta_Fructose_1.6_bisphosphate_rxn12</ci>
        <ci>delta_Fructose_1.6_bisphosphate_rxn13</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="Glyceraldehyde_3_phosphate" cmeta:id="Glyceraldehyde_3_phosphate">
  <variable name="Glyceraldehyde_3_phosphate" public_interface="out" initial_value="1.0" un

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<variable name="delta_Glyceraldehyde_3_phosphate_rxn12" public_interface="in" units="flux" />
<variable name="delta_Glyceraldehyde_3_phosphate_rxn14" public_interface="in" units="flux" />
<variable name="delta_Glyceraldehyde_3_phosphate_rxn17" 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>Glyceraldehyde_3_phosphate</ci>
    </apply>
    <apply><plus />
      <ci>delta_Glyceraldehyde_3_phosphate_rxn12</ci>
      <ci>delta_Glyceraldehyde_3_phosphate_rxn14</ci>
      <ci>delta_Glyceraldehyde_3_phosphate_rxn17</ci>
    </apply>
  </math>
</component>

<component name="Dihydroxyacetone_phosphate" cmeta:id="Dihydroxyacetone_phosphate">
  <variable name="Dihydroxyacetone_phosphate" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Dihydroxyacetone_phosphate_rxn13" public_interface="in" units="flux" />
  <variable name="delta_Dihydroxyacetone_phosphate_rxn14" public_interface="in" units="flux" />
  <variable name="delta_Dihydroxyacetone_phosphate_rxn16" 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>Dihydroxyacetone_phosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Dihydroxyacetone_phosphate_rxn13</ci>
        <ci>delta_Dihydroxyacetone_phosphate_rxn14</ci>
        <ci>delta_Dihydroxyacetone_phosphate_rxn16</ci>
      </apply>
    </math>
</component>

<component name="Glycerol" cmeta:id="Glycerol">
  <variable name="Glycerol" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Glycerol_rxn15" 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>Glycerol</ci>
      </apply>
      <ci>delta_Glycerol_rxn15</ci>
    </math>
</component>

```

</component>

```
<component name="Glycerol_3_phosphate" cmeta:id="Glycerol_3_phosphate">
  <variable name="Glycerol_3_phosphate" public_interface="out" initial_value="1.0" units="m" />
  <variable name="delta_Glycerol_3_phosphate_rxn15" public_interface="in" units="flux" />
  <variable name="delta_Glycerol_3_phosphate_rxn16" 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>Glycerol_3_phosphate</ci>
      </apply>
      <apply><plus />
        <ci>delta_Glycerol_3_phosphate_rxn15</ci>
        <ci>delta_Glycerol_3_phosphate_rxn16</ci>
      </apply>
    </apply>
  </math>
</component>
```

```
<component name="NAD" cmeta:id="NAD">
  <variable name="NAD" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_NAD_rxn16" public_interface="in" units="flux" />
  <variable name="delta_NAD_rxn21" public_interface="in" units="flux" />
  <variable name="delta_NAD_rxn17" 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>NAD</ci>
      </apply>
      <apply><plus />
        <ci>delta_NAD_rxn16</ci>
        <ci>delta_NAD_rxn21</ci>
        <ci>delta_NAD_rxn17</ci>
      </apply>
    </apply>
  </math>
</component>
```

```
<component name="NADH" cmeta:id="NADH">
  <variable name="NADH" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_NADH_rxn17" public_interface="in" units="flux" />
  <variable name="delta_NADH_rxn16" public_interface="in" units="flux" />
  <variable name="delta_NADH_rxn21" 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>NADH</ci>
      </apply>
    </math>
</component>
```

```

    </apply>
    <apply><plus />
      <ci>delta_NADH_rxn17</ci>
      <ci>delta_NADH_rxn16</ci>
      <ci>delta_NADH_rxn21</ci>
    </apply>
  </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_rxn17" public_interface="in" units="flux" />
  <variable name="delta_H_rxn16" public_interface="in" units="flux" />
  <variable name="delta_H_rxn21" 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_rxn17</ci>
        <ci>delta_H_rxn16</ci>
        <ci>delta_H_rxn21</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="Lactate" cmeta:id="Lactate">
  <variable name="Lactate" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Lactate_rxn21" 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>Lactate</ci>
      </apply>
      <ci>delta_Lactate_rxn21</ci>
    </apply>
  </math>
</component>

<component name="Pyruvate" cmeta:id="Pyruvate">
  <variable name="Pyruvate" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Pyruvate_rxn20" public_interface="in" units="flux" />
  <variable name="delta_Pyruvate_rxn21" 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>Pyruvate</ci>
</apply>
<apply><plus />
    <ci>delta_Pyruvate_rxn20</ci>
    <ci>delta_Pyruvate_rxn21</ci>
</apply>
</apply>
</math>
</component>

<component name="Phosphoenolpyruvate" cmeta:id="Phosphoenolpyruvate">
    <variable name="Phosphoenolpyruvate" public_interface="out" initial_value="1.0" units="m
    <variable name="delta_Phosphoenolpyruvate_rxn19" public_interface="in" units="flux" />
    <variable name="delta_Phosphoenolpyruvate_rxn20" 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>Phosphoenolpyruvate</ci>
            </apply>
            <apply><plus />
                <ci>delta_Phosphoenolpyruvate_rxn19</ci>
                <ci>delta_Phosphoenolpyruvate_rxn20</ci>
            </apply>
        </apply>
    </math>
</component>

<component name="Phosphoglycerate_2" cmeta:id="Phosphoglycerate_2">
    <variable name="Phosphoglycerate_2" public_interface="out" initial_value="1.0" units="mi
    <variable name="delta_Phosphoglycerate_2_rxn18" public_interface="in" units="flux" />
    <variable name="delta_Phosphoglycerate_2_rxn19" 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>Phosphoglycerate_2</ci>
            </apply>
            <apply><plus />
                <ci>delta_Phosphoglycerate_2_rxn18</ci>
                <ci>delta_Phosphoglycerate_2_rxn19</ci>
            </apply>
        </apply>
    </math>
</component>

<component name="Phosphoglycerate_3" cmeta:id="Phosphoglycerate_3">
    <variable name="Phosphoglycerate_3" public_interface="out" initial_value="1.0" units="mi
    <variable name="delta_Phosphoglycerate_3_rxn18" 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>Phosphoglycerate_3</ci>
      </apply>
      <ci>delta_Phosphoglycerate_3_rxn18</ci>
    </apply>
  </math>
</component>

<component name="Bisphosphoglycerate_1_3" cmeta:id="Bisphosphoglycerate_1_3">
  <variable name="Bisphosphoglycerate_1_3" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Bisphosphoglycerate_1_3_rxn17" 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>Bisphosphoglycerate_1_3</ci>
      </apply>
      <ci>delta_Bisphosphoglycerate_1_3_rxn17</ci>
    </apply>
  </math>
</component>

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

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

<component name="Glucose_1_phosphate_uridylyl_transferase" cmeta:id="Glucose_1_phosphate_uridylyl_transferase">
  <variable name="Glucose_1_phosphate_uridylyl_transferase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

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

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

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

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

<component name="Glucose_1_phosphatase" cmeta:id="Glucose_1_phosphatase">
  <variable name="Glucose_1_phosphatase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

```

```
</component>

<component name="Glucose_6_phosphate_isomerase" cmeta:id="Glucose_6_phosphate_isomerase">
  <variable name="Glucose_6_phosphate_isomerase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Phosphofruktokinase_2" cmeta:id="Phosphofruktokinase_2">
  <variable name="Phosphofruktokinase_2" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Fructose_bisphosphatase_2" cmeta:id="Fructose_bisphosphatase_2">
  <variable name="Fructose_bisphosphatase_2" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

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

<component name="Fructose_1_6_bisphosphatase" cmeta:id="Fructose_1_6_bisphosphatase">
  <variable name="Fructose_1_6_bisphosphatase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

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

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

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

<component name="Glycerol_3_phosphate_dehydrogenase" cmeta:id="Glycerol_3_phosphate_dehydrogenase">
  <variable name="Glycerol_3_phosphate_dehydrogenase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

<component name="Glyceraldehyde_3_phosphate_dehydrogenase" cmeta:id="Glyceraldehyde_3_phosphate_dehydrogenase">
  <variable name="Glyceraldehyde_3_phosphate_dehydrogenase" public_interface="out" initial_value="1.0" units="micromolar" />
</component>

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

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

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

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

<component name="Phosphoglycerate_kinase" cmeta:id="Phosphoglycerate_kinase">
```

```

    <variable name="Phosphoglycerate_kinase" public_interface="out" initial_value="1.0" units="micromolar" />
  </component>

  <!--
    The following components represent the reaction steps of glycolysis.
  -->

  <component name="reaction0">
    <variable name="Glycogen" public_interface="in" units="micromolar" />
    <variable name="Pi" public_interface="in" units="micromolar" />
    <variable name="Glycogen_phosphorylase" public_interface="in" units="micromolar" />
    <variable name="Glucose_1_phosphate" public_interface="in" units="micromolar" />
    <variable name="delta_Glycogen_rxn0" public_interface="out" units="flux" />
    <variable name="delta_Pi_rxn0" public_interface="out" units="flux" />
    <variable name="delta_Glucose_1_phosphate_rxn0" public_interface="out" units="flux" />
    <variable name="vmax0" initial_value="1.0" units="second_order_rate_constant" />
    <variable name="km0" initial_value="1.0" units="micromolar" />
    <variable name="rate" units="flux" />
    <reaction reversible="no">
      <variable_ref variable="Glycogen">
        <role role="reactant" delta_variable="delta_Glycogen_rxn0" stoichiometry="1" />
      </variable_ref>
      <variable_ref variable="Pi">
        <role role="reactant" delta_variable="delta_Pi_rxn0" stoichiometry="1" />
      </variable_ref>
      <variable_ref variable="Glucose_1_phosphate">
        <role role="product" delta_variable="delta_Glucose_1_phosphate_rxn0" stoichiometry="1" />
      </variable_ref>
      <variable_ref variable="Glycogen_phosphorylase">
        <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>vmax0</ci>
                  <ci>Glycogen</ci>
                  <ci>Pi</ci>
                </apply>
                <apply><plus />
                  <ci>km0</ci>
                  <ci>Glycogen</ci>
                  <ci>Pi</ci>
                </apply>
              </apply>
            </math>
          </role>
        </variable_ref>
      </reaction>
    </component>

    <component name="reaction1">
      <variable name="PPi" public_interface="in" units="micromolar" />
      <variable name="Pi" public_interface="in" units="micromolar" />
      <variable name="Pyrophosphatase" public_interface="in" units="micromolar" />
    </component>
  
```

```

<variable name="delta_PP_i_rxn1" public_interface="out" units="flux" />
<variable name="delta_Pi_rxn1" public_interface="out" units="flux" />
<variable name="kml" initial_value="1.0" units="micromolar" />
<variable name="vmax1" initial_value="1.0" units="first_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="no">
  <variable_ref variable="PPi">
    <role role="reactant" delta_variable="delta_PP_i_rxn1" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Pi">
    <role role="product" delta_variable="delta_Pi_rxn1" stoichiometry="2" />
  </variable_ref>
  <variable_ref variable="Pyrophosphatase">
    <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>PPi</ci>
              <ci>vmax1</ci>
            </apply>
            <apply><plus />
              <ci>kml</ci>
              <ci>PPi</ci>
            </apply>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction2">
  <variable name="UDP_glucose" public_interface="in" units="micromolar" />
  <variable name="UDP" public_interface="in" units="micromolar" />
  <variable name="Glycogen" public_interface="in" units="micromolar" />
  <variable name="Glycogen_synthase" public_interface="in" units="micromolar" />
  <variable name="delta_UDP_glucose_rxn2" public_interface="out" units="flux" />
  <variable name="delta_UDP_rxn2" public_interface="out" units="flux" />
  <variable name="delta_Glycogen_rxn2" public_interface="out" units="flux" />
  <variable name="km2" initial_value="1.0" units="micromolar" />
  <variable name="vmax2" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="UDP_glucose">
      <role role="reactant" delta_variable="delta_UDP_glucose_rxn2" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="UDP">
      <role role="product" delta_variable="delta_UDP_rxn2" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Glycogen">
      <role role="product" delta_variable="delta_Glycogen_rxn2" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Glycogen_synthase">

```

```

    <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>UDP_glucose</ci>
              <ci>vmax2</ci>
            </apply>
          <apply><plus />
            <ci>km2</ci>
            <ci>UDP_glucose</ci>
          </apply>
        </apply>
      </math>
    </role>
  </variable_ref>
</reaction>
</component>

```

```

<component name="reaction3">
  <variable name="UTP" public_interface="in" units="micromolar" />
  <variable name="Glucose_1_phosphate" public_interface="in" units="micromolar" />
  <variable name="PPi" public_interface="in" units="micromolar" />
  <variable name="UDP_glucose" public_interface="in" units="micromolar" />
  <variable name="Glucose_1_phosphate_uridyl_transferase" public_interface="in" units="micromolar" />
  <variable name="delta_UTP_rxn3" public_interface="out" units="flux" />
  <variable name="delta_Glucose_1_phosphate_rxn3" public_interface="out" units="flux" />
  <variable name="delta_PPi_rxn3" public_interface="out" units="flux" />
  <variable name="delta_UDP_glucose_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="UTP">
      <role role="reactant" delta_variable="delta_UTP_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Glucose_1_phosphate">
      <role role="reactant" delta_variable="delta_Glucose_1_phosphate_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="PPi">
      <role role="product" delta_variable="delta_PPi_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="UDP_glucose">
      <role role="product" delta_variable="delta_UDP_glucose_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Glucose_1_phosphate_uridyl_transferase">
      <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>UTP</ci>
        <ci>Glucose_1_phosphate</ci>
        <ci>vmax3</ci>
    </apply>
    <apply><plus />
    <ci>km3</ci>
    <ci>UTP</ci>
    <ci>Glucose_1_phosphate</ci>
    </apply>
</apply>
</math>
</role>
</variable_ref>
</reaction>
</component>

<component name="reaction4">
  <variable name="Glucose_1_phosphate" public_interface="in" units="micromolar" />
  <variable name="Glucose_6_phosphate" public_interface="in" units="micromolar" />
  <variable name="Phosphoglucomutase" public_interface="in" units="micromolar" />
  <variable name="delta_Glucose_1_phosphate_rxn4" public_interface="out" units="flux" />
  <variable name="delta_Glucose_6_phosphate_rxn4" public_interface="out" units="flux" />
  <variable name="km4" initial_value="1.0" units="micromolar" />
  <variable name="vmax4" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="km4_" initial_value="1.0" units="micromolar" />
  <variable name="vmax4_" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="yes">
    <variable_ref variable="Glucose_1_phosphate">
      <role role="reactant" direction="forward" delta_variable="delta_Glucose_1_phosphate_rxn4" />
    </variable_ref>
    <variable_ref variable="Glucose_6_phosphate">
      <role role="product" direction="forward" delta_variable="delta_Glucose_6_phosphate_rxn4" />
    </variable_ref>
    <variable_ref variable="Phosphoglucomutase">
      <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><minus />
          <apply><times />
          <ci>vmax4</ci>
          <apply><divide />
          <ci>Glucose_1_phosphate</ci>
          <ci>km4</ci>
          </apply>
          </apply>
          <apply><times />
          <ci>vmax4_</ci>
          <apply><divide />
          <ci>Glucose_6_phosphate</ci>
          <ci>km4_</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

```

```

        </apply>
      </apply>
    <apply><plus />
      <cn cellml:units="dimensionless">1.0</cn>
      <apply><divide />
        <ci>Glucose_1_phosphate</ci>
        <ci>km4</ci>
      </apply>
      <apply><divide />
        <ci>Glucose_6_phosphate</ci>
        <ci>km4</ci>
      </apply>
    </apply>
  </math>
</role>
</variable_ref>
</reaction>
</component>

```

```

<component name="reaction5">
  <variable name="Glucose" public_interface="in" units="micromolar" />
  <variable name="ATP" public_interface="in" units="micromolar" />
  <variable name="Glucose_1_phosphate" public_interface="in" units="micromolar" />
  <variable name="ADP" public_interface="in" units="micromolar" />
  <variable name="Hexokinase" public_interface="in" units="micromolar" />
  <variable name="delta_Glucose_rxn5" public_interface="out" units="flux" />
  <variable name="delta_ATP_rxn5" public_interface="out" units="flux" />
  <variable name="delta_Glucose_1_phosphate_rxn5" public_interface="out" units="flux" />
  <variable name="delta_ADP_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="Glucose">
      <role role="reactant" delta_variable="delta_Glucose_rxn5" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="ATP">
      <role role="reactant" delta_variable="delta_ATP_rxn5" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Glucose_1_phosphate">
      <role role="product" delta_variable="delta_Glucose_1_phosphate_rxn5" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="ADP">
      <role role="product" delta_variable="delta_ADP_rxn5" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Hexokinase">
      <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>Glucose</ci>

```

```

        <ci>vmax5</ci>
      </apply>
    <apply><plus />
      <ci>km5</ci>
      <ci>ATP</ci>
      <ci>Glucose</ci>
    </apply>
  </apply>
</math>
</role>
</variable_ref>
</reaction>
</component>

<component name="reaction6">
  <variable name="Glucose_1_phosphate" public_interface="in" units="micromolar" />
  <variable name="H2O" public_interface="in" units="micromolar" />
  <variable name="Pi" public_interface="in" units="micromolar" />
  <variable name="Glucose" public_interface="in" units="micromolar" />
  <variable name="Glucose_1_phosphatase" public_interface="in" units="micromolar" />
  <variable name="delta_Glucose_1_phosphate_rxn6" public_interface="out" units="flux" />
  <variable name="delta_H2O_rxn6" public_interface="out" units="flux" />
  <variable name="delta_Pi_rxn6" public_interface="out" units="flux" />
  <variable name="delta_Glucose_rxn6" public_interface="out" units="flux" />
  <variable name="km6" initial_value="1.0" units="micromolar" />
  <variable name="vmax6" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Glucose_1_phosphate">
      <role role="reactant" delta_variable="delta_Glucose_1_phosphate_rxn6" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="H2O">
      <role role="reactant" delta_variable="delta_H2O_rxn6" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Pi">
      <role role="product" delta_variable="delta_Pi_rxn6" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Glucose">
      <role role="product" delta_variable="delta_Glucose_rxn6" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Glucose_1_phosphatase">
      <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>H2O</ci>
                <ci>Glucose_1_phosphate</ci>
                <ci>vmax6</ci>
              </apply>
            <apply><plus />
              <ci>km6</ci>
              <ci>H2O</ci>
              <ci>Glucose_1_phosphate</ci>
          </math>
        </role>
      </variable_ref>
    </reaction>
  </component>

```

```

        </apply>
      </apply>
    </apply>
  </math>
</role>
</variable_ref>
</reaction>
</component>

<component name="reaction7">
  <variable name="Fructose_6_phosphate" public_interface="in" units="micromolar" />
  <variable name="Glucose_6_phosphate" public_interface="in" units="micromolar" />
  <variable name="Glucose_6_phosphate_isomerase" public_interface="in" units="micromolar" />
  <variable name="delta_Fructose_6_phosphate_rxn7" public_interface="out" units="flux" />
  <variable name="delta_Glucose_6_phosphate_rxn7" public_interface="out" units="flux" />
  <variable name="km7" initial_value="1.0" units="dimensionless" />
  <variable name="vmax7" initial_value="1.0" units="dimensionless" />
  <variable name="km7_" initial_value="1.0" units="dimensionless" />
  <variable name="vmax7_" initial_value="1.0" units="dimensionless" />
  <variable name="rate" units="flux" />
  <reaction reversible="yes">
    <variable_ref variable="Fructose_6_phosphate">
      <role role="reactant" direction="forward" delta_variable="delta_Fructose_6_phosphate_rxn7" />
    </variable_ref>
    <variable_ref variable="Glucose_6_phosphate">
      <role role="product" direction="forward" delta_variable="delta_Glucose_6_phosphate_rxn7" />
    </variable_ref>
    <variable_ref variable="Glucose_6_phosphate_isomerase">
      <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><minus />
                <apply><times />
                  <ci>vmax7</ci>
                  <apply><divide />
                    <ci>Fructose_6_phosphate</ci>
                    <ci>km7</ci>
                  </apply>
                </apply>
              <apply><times />
                <ci>vmax7_</ci>
                <apply><divide />
                  <ci>Glucose_6_phosphate</ci>
                  <ci>km7_</ci>
                </apply>
              </apply>
            </apply>
          </math>
        </variable_ref>
      </role>
    </variable_ref>
  </reaction>

```

```

        <ci>Glucose_6_phosphate</ci>
        <ci>km7</ci>
    </apply>
</apply>
</apply>
</math>
</role>
</variable_ref>
</reaction>
</component>

<component name="reaction8">
  <variable name="Fructose_6_phosphate" public_interface="in" units="micromolar" />
  <variable name="ATP" public_interface="in" units="micromolar" />
  <variable name="Fructose_2_6_bisphosphate" public_interface="in" units="micromolar" />
  <variable name="ADP" public_interface="in" units="micromolar" />
  <variable name="Phosphofructokinase_2" public_interface="in" units="micromolar" />
  <variable name="delta_Fructose_6_phosphate_rxn8" public_interface="out" units="flux" />
  <variable name="delta_ATP_rxn8" public_interface="out" units="flux" />
  <variable name="delta_Fructose_2_6_bisphosphate_rxn8" public_interface="out" units="flux" />
  <variable name="delta_ADP_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="Fructose_6_phosphate">
      <role role="reactant" delta_variable="delta_Fructose_6_phosphate_rxn8" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="ATP">
      <role role="reactant" delta_variable="delta_ATP_rxn8" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Fructose_2_6_bisphosphate">
      <role role="product" delta_variable="delta_Fructose_2_6_bisphosphate_rxn8" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="ADP">
      <role role="product" delta_variable="delta_ADP_rxn8" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Phosphofructokinase_2">
      <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>Fructose_6_phosphate</ci>
                <ci>vmax8</ci>
              </apply>
            <apply><plus />
              <ci>km8</ci>
              <ci>ATP</ci>
              <ci>Fructose_6_phosphate</ci>
            </apply>
          </math>
        </role>
      </variable_ref>
    </reaction>
  </component>

```

```

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

<component name="reaction9">
  <variable name="Fructose_2_6_bisphosphate" public_interface="in" units="micromolar" />
  <variable name="H2O" public_interface="in" units="micromolar" />
  <variable name="Fructose_6_phosphate" public_interface="in" units="micromolar" />
  <variable name="Pi" public_interface="in" units="micromolar" />
  <variable name="Fructose_bisphosphatase_2" public_interface="in" units="micromolar" />
  <variable name="delta_Fructose_2_6_bisphosphate_rxn9" public_interface="out" units="flux" />
  <variable name="delta_H2O_rxn9" public_interface="out" units="flux" />
  <variable name="delta_Fructose_6_phosphate_rxn9" public_interface="out" units="flux" />
  <variable name="delta_Pi_rxn9" public_interface="out" units="flux" />
  <variable name="km9" initial_value="1.0" units="micromolar" />
  <variable name="vmax9" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Fructose_2_6_bisphosphate">
      <role role="reactant" delta_variable="delta_Fructose_2_6_bisphosphate_rxn9" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="H2O">
      <role role="reactant" delta_variable="delta_H2O_rxn9" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Fructose_6_phosphate">
      <role role="product" delta_variable="delta_Fructose_6_phosphate_rxn9" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Pi">
      <role role="product" delta_variable="delta_Pi_rxn9" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Fructose_bisphosphatase_2">
      <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>H2O</ci>
                <ci>Fructose_2_6_bisphosphate</ci>
                <ci>vmax9</ci>
              </apply>
            <apply><plus />
              <ci>km9</ci>
              <ci>H2O</ci>
              <ci>Fructose_2_6_bisphosphate</ci>
            </apply>
          </math>
        </role>
      </variable_ref>
    </reaction>
  </component>

```

```

<component name="reaction10">
  <variable name="ATP" public_interface="in" units="micromolar" />
  <variable name="Fructose_6_phosphate" public_interface="in" units="micromolar" />
  <variable name="ADP" public_interface="in" units="micromolar" />
  <variable name="Fructose_1_6_bisphosphate" public_interface="in" units="micromolar" />
  <variable name="Phosphofructokinase" public_interface="in" units="micromolar" />
  <variable name="delta_ATP_rxn10" public_interface="out" units="flux" />
  <variable name="delta_Fructose_6_phosphate_rxn10" public_interface="out" units="flux" />
  <variable name="delta_ADP_rxn10" public_interface="out" units="flux" />
  <variable name="delta_Fructose_1_6_bisphosphate_rxn10" public_interface="out" units="flux" />
  <variable name="km10" initial_value="1.0" units="micromolar" />
  <variable name="vmax10" 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_rxn10" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Fructose_6_phosphate">
      <role role="reactant" delta_variable="delta_Fructose_6_phosphate_rxn10" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="ADP">
      <role role="product" delta_variable="delta_ADP_rxn10" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Fructose_1_6_bisphosphate">
      <role role="product" delta_variable="delta_Fructose_1_6_bisphosphate_rxn10" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Phosphofructokinase">
      <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>Fructose_6_phosphate</ci>
                <ci>vmax10</ci>
              </apply>
            <apply><plus />
              <ci>km10</ci>
              <ci>ATP</ci>
              <ci>Fructose_6_phosphate</ci>
            </apply>
          </math>
        </role>
      </variable_ref>
    </reaction>
  </component>

<component name="reaction11">
  <variable name="H2O" public_interface="in" units="micromolar" />
  <variable name="Fructose_1_6_bisphosphate" public_interface="in" units="micromolar" />
  <variable name="Fructose_6_phosphate" public_interface="in" units="micromolar" />
  <variable name="Pi" public_interface="in" units="micromolar" />
  <variable name="Fructose_1_6_bisphosphatase" public_interface="in" units="micromolar" />

```

```

<variable name="delta_H2O_rxn11" public_interface="out" units="flux" />
<variable name="delta_Fructose_1_6_bisphosphate_rxn11" public_interface="out" units="flux" />
<variable name="delta_Fructose_6_phosphate_rxn11" public_interface="out" units="flux" />
<variable name="delta_Pi_rxn11" public_interface="out" units="flux" />
<variable name="km11" initial_value="1.0" units="micromolar" />
<variable name="vmax11" initial_value="1.0" units="second_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="no">
  <variable_ref variable="H2O">
    <role role="reactant" delta_variable="delta_H2O_rxn11" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Fructose_1_6_bisphosphate">
    <role role="reactant" delta_variable="delta_Fructose_1_6_bisphosphate_rxn11" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Fructose_6_phosphate">
    <role role="product" delta_variable="delta_Fructose_6_phosphate_rxn11" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Pi">
    <role role="product" delta_variable="delta_Pi_rxn11" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Fructose_1_6_bisphosphatase">
    <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>H2O</ci>
              <ci>Fructose_1.6_bisphosphate</ci>
              <ci>vmax11</ci>
            </apply>
          <apply><plus />
            <ci>km11</ci>
            <ci>H2O</ci>
            <ci>Fructose_1.6_bisphosphate</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction12">
  <variable name="Fructose_1_6_bisphosphate" public_interface="in" units="micromolar" />
  <variable name="Glyceraldehyde_3_phosphate" public_interface="in" units="micromolar" />
  <variable name="Aldolase" public_interface="in" units="micromolar" />
  <variable name="delta_Fructose_1_6_bisphosphate_rxn12" public_interface="out" units="flux" />
  <variable name="delta_Glyceraldehyde_3_phosphate_rxn12" public_interface="out" units="flux" />
  <variable name="km12" initial_value="1.0" units="micromolar" />
  <variable name="vmax12" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="km12_" initial_value="1.0" units="micromolar" />
  <variable name="vmax12_" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="yes">

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```

<variable_ref variable="Fructose_1_6_bisphosphate">
  <role role="reactant" direction="forward" delta_variable="delta_Fructose_1_6_bisphosphate" />
</variable_ref>
<variable_ref variable="Glyceraldehyde_3_phosphate">
  <role role="product" direction="forward" delta_variable="delta_Glyceraldehyde_3_phosphate" />
</variable_ref>
<variable_ref variable="Aldolase">
  <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><minus />
      <apply><times />
      <ci>vmax12</ci>
      <apply><divide />
      <ci>Fructose_1_6_bisphosphate</ci>
      <ci>km12</ci>
      </apply>
      </apply>
      <apply><times />
      <ci>vmax12_</ci>
      <apply><divide />
      <ci>Glyceraldehyde_3_phosphate</ci>
      <ci>km12_</ci>
      </apply>
      </apply>
      <apply><plus />
      <cn cellml:units="dimensionless">1.0</cn>
      <apply><divide />
      <ci>Fructose_1_6_bisphosphate</ci>
      <ci>km12</ci>
      </apply>
      <apply><divide />
      <ci>Glyceraldehyde_3_phosphate</ci>
      <ci>km12_</ci>
      </apply>
      </apply>
      </apply>
      </math>
    </role>
  </variable_ref>
</reaction>
</component>

<component name="reaction13">
  <variable name="Fructose_1_6_bisphosphate" public_interface="in" units="micromolar" />
  <variable name="Dihydroxyacetone_phosphate" public_interface="in" units="micromolar" />
  <variable name="Aldolase" public_interface="in" units="micromolar" />
  <variable name="delta_Fructose_1_6_bisphosphate_rxn13" public_interface="out" units="flux" />
  <variable name="delta_Dihydroxyacetone_phosphate_rxn13" public_interface="out" units="flux" />
  <variable name="km13" initial_value="1.0" units="micromolar" />
  <variable name="vmax13" initial_value="1.0" units="first_order_rate_constant" />
  <variable name="km13_" initial_value="1.0" units="micromolar" />

```

```

<variable name="vmax13_" initial_value="1.0" units="first_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="yes">
  <variable_ref variable="Fructose_1_6_bisphosphate">
    <role role="reactant" direction="forward" delta_variable="delta_Fructose_1_6_bisphosphate" />
  </variable_ref>
  <variable_ref variable="Dihydroxyacetone_phosphate">
    <role role="product" direction="forward" delta_variable="delta_Dihydroxyacetone_phosphate" />
  </variable_ref>
  <variable_ref variable="Aldolase">
    <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><minus />
              <apply><times />
                <ci>vmax13</ci>
                <apply><divide />
                  <ci>Fructose_1_6_bisphosphate</ci>
                  <ci>km13</ci>
                </apply>
              </apply>
            <apply><times />
              <ci>vmax13_</ci>
              <apply><divide />
                <ci>Dihydroxyacetone_phosphate</ci>
                <ci>km13_</ci>
              </apply>
            </apply>
          </apply>
          <apply><plus />
            <cn cellml:units="dimensionless">1.0</cn>
            <apply><divide />
              <ci>Fructose_1_6_bisphosphate</ci>
              <ci>km13</ci>
            </apply>
          <apply><divide />
            <ci>Dihydroxyacetone_phosphate</ci>
            <ci>km13_</ci>
          </apply>
        </apply>
      </math>
    </role>
  </variable_ref>
</reaction>
</component>

<component name="reaction14">
  <variable name="Dihydroxyacetone_phosphate" public_interface="in" units="micromolar" />
  <variable name="Glyceraldehyde_3_phosphate" public_interface="in" units="micromolar" />
  <variable name="Triose_phosphate_isomerase" public_interface="in" units="micromolar" />
  <variable name="delta_Dihydroxyacetone_phosphate_rxn14" public_interface="out" units="flux" />
  <variable name="delta_Glyceraldehyde_3_phosphate_rxn14" public_interface="out" units="flux" />

```

```

<variable name="km14" initial_value="1.0" units="micromolar" />
<variable name="vmax14" initial_value="1.0" units="first_order_rate_constant" />
<variable name="km14_" initial_value="1.0" units="micromolar" />
<variable name="vmax14_" initial_value="1.0" units="first_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="yes">
  <variable_ref variable="Dihydroxyacetone_phosphate">
    <role role="reactant" direction="forward" delta_variable="delta_Dihydroxyacetone_phos
  </variable_ref>
  <variable_ref variable="Glyceraldehyde_3_phosphate">
    <role role="product" direction="forward" delta_variable="delta_Glyceraldehyde_3_phos
  </variable_ref>
  <variable_ref variable="Triose_phosphate_isomerase">
    <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><minus />
              <apply><times />
                <ci>vmax14</ci>
                <apply><divide />
                  <ci>Dihydroxyacetone_phosphate</ci>
                  <ci>km14</ci>
                </apply>
              </apply>
              <apply><times />
                <ci>vmax14_</ci>
                <apply><divide />
                  <ci>Glyceraldehyde_3_phosphate</ci>
                  <ci>km14_</ci>
                </apply>
              </apply>
            </apply>
          <apply><plus />
            <cn cellml:units="dimensionless">1.0</cn>
            <apply><divide />
              <ci>Dihydroxyacetone_phosphate</ci>
              <ci>km14</ci>
            </apply>
            <apply><divide />
              <ci>Glyceraldehyde_3_phosphate</ci>
              <ci>km14_</ci>
            </apply>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction15">
  <variable name="Glycerol" public_interface="in" units="micromolar" />
  <variable name="ATP" public_interface="in" units="micromolar" />

```

```

<variable name="ADP" public_interface="in" units="micromolar" />
<variable name="Glycerol_3_phosphate" public_interface="in" units="micromolar" />
<variable name="Glycerol_kinase" public_interface="in" units="micromolar" />
<variable name="delta_Glycerol_rxn15" public_interface="out" units="flux" />
<variable name="delta_ATP_rxn15" public_interface="out" units="flux" />
<variable name="delta_ADP_rxn15" public_interface="out" units="flux" />
<variable name="delta_Glycerol_3_phosphate_rxn15" public_interface="out" units="flux" />
<variable name="km15" initial_value="1.0" units="micromolar" />
<variable name="vmax15" initial_value="1.0" units="second_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="no">
  <variable_ref variable="Glycerol">
    <role role="reactant" delta_variable="delta_Glycerol_rxn15" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="ATP">
    <role role="reactant" delta_variable="delta_ATP_rxn15" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="ADP">
    <role role="product" delta_variable="delta_ADP_rxn15" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Glycerol_3_phosphate">
    <role role="product" delta_variable="delta_Glycerol_3_phosphate_rxn15" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Glycerol_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>ATP</ci>
              <ci>Glycerol</ci>
              <ci>vmax15</ci>
            </apply>
          <apply><plus />
            <ci>km15</ci>
            <ci>ATP</ci>
            <ci>Glycerol</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction16">
  <variable name="NADH" public_interface="in" units="micromolar" />
  <variable name="H" public_interface="in" units="micromolar" />
  <variable name="Dihydroxyacetone_phosphate" public_interface="in" units="micromolar" />
  <variable name="Glycerol_3_phosphate" public_interface="in" units="micromolar" />
  <variable name="NAD" public_interface="in" units="micromolar" />
  <variable name="Glycerol_3_phosphate_dehydrogenase" public_interface="in" units="micromolar" />
  <variable name="delta_NADH_rxn16" public_interface="out" units="flux" />
  <variable name="delta_H_rxn16" public_interface="out" units="flux" />

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<variable name="delta_Dihydroxyacetone_phosphate_rxn16" public_interface="out" units="flux" />
<variable name="delta_Glycerol_3_phosphate_rxn16" public_interface="out" units="flux" />
<variable name="delta_NAD_rxn16" public_interface="out" units="flux" />
<variable name="km16" initial_value="1.0" units="micromolar" />
<variable name="vmax16" initial_value="1.0" units="third_order_rate_constant" />
<variable name="km16_" initial_value="1.0" units="micromolar" />
<variable name="vmax16_" initial_value="1.0" units="second_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="yes">
  <variable_ref variable="NADH">
    <role role="reactant" direction="forward" delta_variable="delta_NADH_rxn16" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="H">
    <role role="reactant" direction="forward" delta_variable="delta_H_rxn16" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Dihydroxyacetone_phosphate">
    <role role="reactant" direction="forward" delta_variable="delta_Dihydroxyacetone_phosphate_rxn16" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Glycerol_3_phosphate">
    <role role="product" direction="forward" delta_variable="delta_Glycerol_3_phosphate_rxn16" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="NAD">
    <role role="product" direction="forward" delta_variable="delta_NAD_rxn16" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Glycerol_3_phosphate_dehydrogenase">
    <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><minus />
              <apply><times />
                <ci>vmax16</ci>
                <apply><divide />
                  <apply><times />
                    <ci>NADH</ci>
                    <ci>H</ci>
                    <ci>Dihydroxyacetone_phosphate</ci>
                  </apply>
                <ci>km16</ci>
              </apply>
            </apply>
          <apply><times />
            <ci>vmax16_</ci>
            <apply><divide />
              <apply><times />
                <ci>Glycerol_3_phosphate</ci>
                <ci>NAD</ci>
              </apply>
            <ci>km16_</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>

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```

        <apply><times />
        <ci>NADH</ci>
        <ci>H</ci>
        <ci>Dihydroxyacetone_phosphate</ci>
    </apply>
    <ci>km16</ci>
</apply>
<apply><divide />
    <apply><times />
    <ci>Glycerol_3_phosphate</ci>
    <ci>NAD</ci>
    </apply>
    <ci>km16_</ci>
</apply>
</apply>
</math>
</role>
</variable_ref>
</reaction>
</component>

```

```

<component name="reaction17">
  <variable name="Glyceraldehyde_3_phosphate" public_interface="in" units="micromolar" />
  <variable name="NAD" public_interface="in" units="micromolar" />
  <variable name="Bisphosphoglycerate_1_3" public_interface="in" units="micromolar" />
  <variable name="NADH" public_interface="in" units="micromolar" />
  <variable name="H" public_interface="in" units="micromolar" />
  <variable name="Glyceraldehyde_3_phosphate_dehydrogenase" public_interface="in" units="m
  <variable name="delta_Glyceraldehyde_3_phosphate_rxn17" public_interface="out" units="flu
  <variable name="delta_NAD_rxn17" public_interface="out" units="flux" />
  <variable name="delta_Bisphosphoglycerate_1_3_rxn17" public_interface="out" units="flux"
  <variable name="delta_NADH_rxn17" public_interface="out" units="flux" />
  <variable name="delta_H_rxn17" public_interface="out" units="flux" />
  <variable name="km17" initial_value="1.0" units="micromolar" />
  <variable name="vmax17" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="km17_" initial_value="1.0" units="micromolar" />
  <variable name="vmax17_" initial_value="1.0" units="third_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="yes">
    <variable_ref variable="Glyceraldehyde_3_phosphate">
      <role role="reactant" direction="forward" delta_variable="delta_Glyceraldehyde_3_phos
    </variable_ref>
    <variable_ref variable="NAD">
      <role role="reactant" direction="forward" delta_variable="delta_NAD_rxn17" stoichiome
    </variable_ref>
    <variable_ref variable="Bisphosphoglycerate_1_3">
      <role role="product" direction="forward" delta_variable="delta_Bisphosphoglycerate_1
    </variable_ref>
    <variable_ref variable="NADH">
      <role role="product" direction="forward" delta_variable="delta_NADH_rxn17" stoichiome
    </variable_ref>
    <variable_ref variable="H">
      <role role="product" direction="forward" delta_variable="delta_H_rxn17" stoichiometry
    </variable_ref>
    <variable_ref variable="Glyceraldehyde_3_phosphate_dehydrogenase">
      <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><minus />
            <apply><times />
              <ci>vmax17</ci>
              <apply><divide />
                <apply><times />
                  <ci>NAD</ci>
                  <ci>Glyceraldehyde_3_phosphate</ci>
                </apply>
              <ci>km17</ci>
            </apply>
          </apply>
        <apply><times />
          <ci>vmax17_</ci>
          <apply><divide />
            <apply><times />
              <ci>Bisphosphoglycerate_1_3</ci>
              <ci>NADH</ci>
              <ci>H</ci>
            </apply>
          <ci>km17_</ci>
        </apply>
      </apply>
    </math>
  </role>
</variable_ref>
</reaction>
</component>

<component name="reaction18">
  <variable name="Phosphoglycerate_3" public_interface="in" units="micromolar" />
  <variable name="Phosphoglycerate_2" public_interface="in" units="micromolar" />
  <variable name="Phosphoglyceromutase" public_interface="in" units="micromolar" />

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<variable name="delta_Phosphoglycerate_3_rxn18" public_interface="out" units="flux" />
<variable name="delta_Phosphoglycerate_2_rxn18" public_interface="out" units="flux" />
<variable name="km18" initial_value="1.0" units="micromolar" />
<variable name="vmax18" initial_value="1.0" units="first_order_rate_constant" />
<variable name="km18_" initial_value="1.0" units="micromolar" />
<variable name="vmax18_" initial_value="1.0" units="first_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="yes">
  <variable_ref variable="Phosphoglycerate_3">
    <role role="reactant" direction="forward" delta_variable="delta_Phosphoglycerate_3_rxn18" />
  </variable_ref>
  <variable_ref variable="Phosphoglycerate_2">
    <role role="product" direction="forward" delta_variable="delta_Phosphoglycerate_2_rxn18" />
  </variable_ref>
  <variable_ref variable="Phosphoglyceromutase">
    <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><minus />
              <apply><times />
                <ci>vmax18</ci>
                <apply><divide />
                  <ci>Phosphoglycerate_3</ci>
                  <ci>km18</ci>
                </apply>
              </apply>
              <apply><times />
                <ci>vmax18_</ci>
                <apply><divide />
                  <ci>Phosphoglycerate_2</ci>
                  <ci>km18_</ci>
                </apply>
              </apply>
            </apply>
          <apply><plus />
            <cn cellml:units="dimensionless">1.0</cn>
            <apply><divide />
              <ci>Phosphoglycerate_3</ci>
              <ci>km18</ci>
            </apply>
            <apply><divide />
              <ci>Phosphoglycerate_2</ci>
              <ci>km18_</ci>
            </apply>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction19">

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```

<variable name="Phosphoglycerate_2" public_interface="in" units="micromolar" />
<variable name="Phosphoenolpyruvate" public_interface="in" units="micromolar" />
<variable name="H2O" public_interface="in" units="micromolar" />
<variable name="Enolase" public_interface="in" units="micromolar" />
<variable name="delta_Phosphoglycerate_2_rxn19" public_interface="out" units="flux" />
<variable name="delta_Phosphoenolpyruvate_rxn19" public_interface="out" units="flux" />
<variable name="delta_H2O_rxn19" public_interface="out" units="flux" />
<variable name="km19" initial_value="1.0" units="micromolar" />
<variable name="vmax19" initial_value="1.0" units="first_order_rate_constant" />
<variable name="rate" units="flux" />
<reaction reversible="no">
  <variable_ref variable="Phosphoglycerate_2">
    <role role="reactant" delta_variable="delta_Phosphoglycerate_2_rxn19" stoichiometry=
  </variable_ref>
  <variable_ref variable="Phosphoenolpyruvate">
    <role role="product" delta_variable="delta_Phosphoenolpyruvate_rxn19" stoichiometry=
  </variable_ref>
  <variable_ref variable="H2O">
    <role role="product" delta_variable="delta_H2O_rxn19" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="Enolase">
    <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>Phosphoglycerate_2</ci>
              <ci>vmax19</ci>
            </apply>
          <apply><plus />
            <ci>km19</ci>
            <ci>Phosphoglycerate_2</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction20">
  <variable name="ADP" public_interface="in" units="micromolar" />
  <variable name="Phosphoenolpyruvate" public_interface="in" units="micromolar" />
  <variable name="Pyruvate" public_interface="in" units="micromolar" />
  <variable name="ATP" public_interface="in" units="micromolar" />
  <variable name="Pyruvate_kinase" public_interface="in" units="micromolar" />
  <variable name="delta_ADP_rxn20" public_interface="out" units="flux" />
  <variable name="delta_Phosphoenolpyruvate_rxn20" public_interface="out" units="flux" />
  <variable name="delta_Pyruvate_rxn20" public_interface="out" units="flux" />
  <variable name="delta_ATP_rxn20" public_interface="out" units="flux" />
  <variable name="km20" initial_value="1.0" units="micromolar" />
  <variable name="vmax20" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">

```

```

<variable_ref variable="ADP">
  <role role="reactant" delta_variable="delta_ADP_rxn20" stoichiometry="1" />
</variable_ref>
<variable_ref variable="Phosphoenolpyruvate">
  <role role="reactant" delta_variable="delta_Phosphoenolpyruvate_rxn20" stoichiometry="1" />
</variable_ref>
<variable_ref variable="Pyruvate">
  <role role="product" delta_variable="delta_Pyruvate_rxn20" stoichiometry="1" />
</variable_ref>
<variable_ref variable="ATP">
  <role role="product" delta_variable="delta_ATP_rxn20" stoichiometry="1" />
</variable_ref>
<variable_ref variable="Pyruvate_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>Phosphoenolpyruvate</ci>
            <ci>ADP</ci>
            <ci>vmax20</ci>
          </apply>
          <apply><plus />
            <ci>km20</ci>
            <ci>Phosphoenolpyruvate</ci>
            <ci>ADP</ci>
          </apply>
        </apply>
      </math>
    </role>
  </variable_ref>
</reaction>
</component>

<component name="reaction21">
  <variable name="Pyruvate" public_interface="in" units="micromolar" />
  <variable name="NADH" public_interface="in" units="micromolar" />
  <variable name="H" public_interface="in" units="micromolar" />
  <variable name="Lactate" public_interface="in" units="micromolar" />
  <variable name="NAD" public_interface="in" units="micromolar" />
  <variable name="Lactate_dehydrogenase" public_interface="in" units="micromolar" />
  <variable name="delta_Pyruvate_rxn21" public_interface="out" units="flux" />
  <variable name="delta_NADH_rxn21" public_interface="out" units="flux" />
  <variable name="delta_H_rxn21" public_interface="out" units="flux" />
  <variable name="delta_Lactate_rxn21" public_interface="out" units="flux" />
  <variable name="delta_NAD_rxn21" public_interface="out" units="flux" />
  <variable name="km21" initial_value="1.0" units="micromolar" />
  <variable name="vmax21" initial_value="1.0" units="third_order_rate_constant" />
  <variable name="km21_" initial_value="1.0" units="micromolar" />
  <variable name="vmax21_" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="yes">
    <variable_ref variable="Pyruvate">
      <role role="reactant" direction="forward" delta_variable="delta_Pyruvate_rxn21" stoichiometry="1" />
    </variable_ref>
  </reaction>
</component>

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```

</variable_ref>
<variable_ref variable="NADH">
  <role role="reactant" direction="forward" delta_variable="delta_NADH_rxn21" stoichiomet
</variable_ref>
<variable_ref variable="H">
  <role role="reactant" direction="forward" delta_variable="delta_H_rxn21" stoichiometr
</variable_ref>
<variable_ref variable="Lactate">
  <role role="product" direction="forward" delta_variable="delta_Lactate_rxn21" stoichi
</variable_ref>
<variable_ref variable="NAD">
  <role role="product" direction="forward" delta_variable="delta_NAD_rxn21" stoichiomet
</variable_ref>
<variable_ref variable="Lactate_dehydrogenase">
  <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><minus />
            <apply><times />
              <ci>vmax21</ci>
              <apply><divide />
                <apply><times />
                  <ci>NADH</ci>
                  <ci>H</ci>
                  <ci>Pyruvate</ci>
                </apply>
              <ci>km21</ci>
            </apply>
          <apply><times />
            <ci>vmax21.</ci>
            <apply><divide />
              <apply><times />
                <ci>Lactate</ci>
                <ci>NAD</ci>
              </apply>
            <ci>km21.</ci>
          </apply>
        </apply>
      <apply><plus />
        <cn cellml:units="dimensionless">1.0</cn>
        <apply><divide />
          <apply><times />
            <ci>NADH</ci>
            <ci>H</ci>
            <ci>Pyruvate</ci>
          </apply>
          <ci>km21</ci>
        </apply>
      <apply><divide />
        <apply><times />
          <ci>Lactate</ci>
          <ci>NAD</ci>
        </apply>
      </math>

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```

        </apply>
        <ci>km21.</ci>
    </apply>
</apply>
</math>
</role>
</variable_ref>
</reaction>
</component>

<group>
  <relationship_ref relationship="encapsulation" />
  <component_ref component="Glucose_1_phosphate">
    <component_ref component="reaction5" />
    <component_ref component="reaction6" />
  </component_ref>
</group>

<connection>
  <map_components component_1="Glycogen" component_2="reaction2" />
  <map_variables variable_1="Glycogen" variable_2="Glycogen" />
  <map_variables variable_1="delta_Glycogen_rxn2" variable_2="delta_Glycogen_rxn2" />
</connection>

<connection>
  <map_components component_1="Glycogen" component_2="reaction0" />
  <map_variables variable_1="Glycogen" variable_2="Glycogen" />
  <map_variables variable_1="delta_Glycogen_rxn0" variable_2="delta_Glycogen_rxn0" />
</connection>

<connection>
  <map_components component_1="UDP" component_2="reaction2" />
  <map_variables variable_1="UDP" variable_2="UDP" />
  <map_variables variable_1="delta_UDP_rxn2" variable_2="delta_UDP_rxn2" />
</connection>

<connection>
  <map_components component_1="UDP_glucose" component_2="reaction3" />
  <map_variables variable_1="UDP_glucose" variable_2="UDP_glucose" />
  <map_variables variable_1="delta_UDP_glucose_rxn3" variable_2="delta_UDP_glucose_rxn3" />
</connection>

<connection>
  <map_components component_1="UDP_glucose" component_2="reaction2" />
  <map_variables variable_1="UDP_glucose" variable_2="UDP_glucose" />
  <map_variables variable_1="delta_UDP_glucose_rxn2" variable_2="delta_UDP_glucose_rxn2" />
</connection>

<connection>
  <map_components component_1="Pi" component_2="reaction1" />
  <map_variables variable_1="Pi" variable_2="Pi" />
  <map_variables variable_1="delta_Pi_rxn1" variable_2="delta_Pi_rxn1" />
</connection>

<connection>
  <map_components component_1="Pi" component_2="Glucose_1_phosphate" />
  <map_variables variable_1="Pi" variable_2="Pi" />

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    <map_variables variable_1="delta_Pi_rxn6" variable_2="delta_Pi_rxn6" />
</connection>

<connection>
  <map_components component_1="Pi" component_2="reaction9" />
  <map_variables variable_1="Pi" variable_2="Pi" />
  <map_variables variable_1="delta_Pi_rxn9" variable_2="delta_Pi_rxn9" />
</connection>

<connection>
  <map_components component_1="Pi" component_2="reaction11" />
  <map_variables variable_1="Pi" variable_2="Pi" />
  <map_variables variable_1="delta_Pi_rxn11" variable_2="delta_Pi_rxn11" />
</connection>

<connection>
  <map_components component_1="Pi" component_2="reaction0" />
  <map_variables variable_1="Pi" variable_2="Pi" />
  <map_variables variable_1="delta_Pi_rxn0" variable_2="delta_Pi_rxn0" />
</connection>

<connection>
  <map_components component_1="Glucose_1_phosphate" component_2="reaction0" />
  <map_variables variable_1="Glucose_1_phosphate" variable_2="Glucose_1_phosphate" />
  <map_variables variable_1="delta_Glucose_1_phosphate_rxn0" variable_2="delta_Glucose_1_phosphate_rxn0" />
</connection>

<connection>
  <map_components component_1="Glucose_1_phosphate" component_2="reaction3" />
  <map_variables variable_1="Glucose_1_phosphate" variable_2="Glucose_1_phosphate" />
  <map_variables variable_1="delta_Glucose_1_phosphate_rxn3" variable_2="delta_Glucose_1_phosphate_rxn3" />
</connection>

<connection>
  <map_components component_1="Glucose_1_phosphate" component_2="reaction4" />
  <map_variables variable_1="Glucose_1_phosphate" variable_2="Glucose_1_phosphate" />
  <map_variables variable_1="delta_Glucose_1_phosphate_rxn4" variable_2="delta_Glucose_1_phosphate_rxn4" />
</connection>

<connection>
  <map_components component_1="UTP" component_2="reaction3" />
  <map_variables variable_1="UTP" variable_2="UTP" />
  <map_variables variable_1="delta_UTP_rxn3" variable_2="delta_UTP_rxn3" />
</connection>

<connection>
  <map_components component_1="PPi" component_2="reaction3" />
  <map_variables variable_1="PPi" variable_2="PPi" />
  <map_variables variable_1="delta_PPi_rxn3" variable_2="delta_PPi_rxn3" />
</connection>

<connection>
  <map_components component_1="PPi" component_2="reaction1" />
  <map_variables variable_1="PPi" variable_2="PPi" />
  <map_variables variable_1="delta_PPi_rxn1" variable_2="delta_PPi_rxn1" />
</connection>

<connection>
  <map_components component_1="Glycogen_synthase" component_2="reaction2" />

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

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

<connection>
  <map_components component_1="ATP" component_2="reaction20" />
  <map_variables variable_1="ATP" variable_2="ATP" />
  <map_variables variable_1="delta_ATP_rxn20" variable_2="delta_ATP_rxn20" />
</connection>

<connection>
  <map_components component_1="ATP" component_2="reaction8" />
  <map_variables variable_1="ATP" variable_2="ATP" />
  <map_variables variable_1="delta_ATP_rxn8" variable_2="delta_ATP_rxn8" />
</connection>

<connection>
  <map_components component_1="ATP" component_2="reaction10" />
  <map_variables variable_1="ATP" variable_2="ATP" />
  <map_variables variable_1="delta_ATP_rxn10" variable_2="delta_ATP_rxn10" />
</connection>

<connection>
  <map_components component_1="ATP" component_2="reaction15" />
  <map_variables variable_1="ATP" variable_2="ATP" />
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  <map_variables variable_1="delta_H2O_rxn9" variable_2="delta_H2O_rxn9" />
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  <map_variables variable_1="delta_Glucose_6_phosphate_rxn4" variable_2="delta_Glucose_6_phosphate_rxn4" />
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<connection>
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<connection>
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<connection>
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<connection>
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<connection>
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<connection>
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<connection>
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<connection>
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<connection>
  <map_components component_1="Bisphosphoglycerate_1_3" component_2="global_variables" />
  <map_variables variable_1="time" variable_2="time" />
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<connection>
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<connection>
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<connection>
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</connection>

<connection>
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<connection>
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<connection>
    <map_components component_1="Glucose_1_phosphatase" component_2="Glucose_1_phosphate" />
    <map_variables variable_1="Glucose_1_phosphatase" variable_2="Glucose_1_phosphatase" />
</connection>

<connection>
    <map_components component_1="Glucose_1_phosphate" component_2="reaction5" />
    <map_variables variable_1="ATP" variable_2="ATP" />
    <map_variables variable_1="delta_ATP_rxn5" variable_2="delta_ATP_rxn5" />
    <map_variables variable_1="ADP" variable_2="ADP" />
    <map_variables variable_1="delta_ADG_rxn5" variable_2="delta_ADG_rxn5" />
    <map_variables variable_1="Glucose" variable_2="Glucose" />
    <map_variables variable_1="delta_Glucose_rxn5" variable_2="delta_Glucose_rxn5" />
    <map_variables variable_1="Glucose_1_phosphate" variable_2="Glucose_1_phosphate" />
    <map_variables variable_1="delta_Glucose_1_phosphate_rxn5" variable_2="delta_Glucose_1_phosphate_rxn5" />
    <map_variables variable_1="Hexokinase" variable_2="Hexokinase" />

```

```
</connection>
```

```
<connection>
```

```
  <map_components component_1="Glucose_1_phosphate" component_2="reaction6" />
```

```
  <map_variables variable_1="Glucose" variable_2="Glucose" />
```

```
  <map_variables variable_1="delta_Glucose_rxn6" variable_2="delta_Glucose_rxn6" />
```

```
  <map_variables variable_1="Pi" variable_2="Pi" />
```

```
  <map_variables variable_1="delta_Pi_rxn6" variable_2="delta_Pi_rxn6" />
```

```
  <map_variables variable_1="H2O" variable_2="H2O" />
```

```
  <map_variables variable_1="delta_H2O_rxn6" variable_2="delta_H2O_rxn6" />
```

```
  <map_variables variable_1="Glucose_1_phosphate" variable_2="Glucose_1_phosphate" />
```

```
  <map_variables variable_1="delta_Glucose_1_phosphate_rxn6" variable_2="delta_Glucose_1_p
```

```
  <map_variables variable_1="Glucose_1_phosphatase" variable_2="Glucose_1_phosphatase" />
```

```
</connection>
```

```
</model>
```