

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

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

```
CREATED : 6th June 2002
```

```
LAST MODIFIED : 5th April 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  
pyrimidine nucleotide (UMP and CMP) degradation.
```

```
CHANGES:
```

```
22/07/2002 - CML - Added more metadata.
```

```
05/04/2003 - AAC - Changed the model name so the model loads in the database  
easier.
```

```
-->
```

```
<model name="pyrimidine_nucleotide_degradation_UMP_and_CMP_model" pathway_editor:rendering_c
```

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:bgs="http://www.cel
```

```
<!--
```

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

```
-->
```

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

```
<!--
```

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

```
-->
```

```
<dc:creator rdf:parseType="Resource">
```

```
<vCard:N rdf:parseType="Resource">
```

```
<vCard:Family>Lloyd</vCard:Family>
```

```
<vCard:Given>Catherine</vCard:Given>
```

```
<vCard:Other>May</vCard:Other>
```

```
</vCard:N>
```

```
<vCard:EMAIL rdf:parseType="Resource">
```

```
<rdf:value>c.lloyd@auckland.ac.nz</rdf:value>
```

```
<rdf:type rdf:resource="http://imc.org/vCard/3.0#internet" />
```

```
</vCard:EMAIL>
```

```
<vCard:ORG rdf:parseType="Resource">
```

```
<vCard:Orgname>The University of Auckland</vCard:Orgname>
```

```
<vCard:Orgunit>The Bioengineering Institute</vCard:Orgunit>
```

```
</vCard:ORG>
```

```
</dc:creator>
```

```
<!--
```

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

```
-->
```

```
<dcterms:created rdf:parseType="Resource">
```

```
<dcterms:W3CDTF>2002-06-06</dcterms:W3CDTF>
```

```

</dcterms:created>

<!--
  The Last Modified Date metadata. This is the date on which
  the model was last changed.
-->
<cmeta:modification rdf:parseType="Resource">
  <rdf:value>
    Changed the model name so the model loads in the database easier.
  </rdf:value>
  <cmeta:modifier rdf:parseType="Resource">
    <vCard:N rdf:parseType="Resource">
      <vCard:Family>Cuellar</vCard:Family>
      <vCard:Given>Autumn</vCard:Given>
      <vCard:Other>A</vCard:Other>
    </vCard:N>
  </cmeta:modifier>
  <dcterms:modified rdf:parseType="Resource">
    <dcterms:W3CDTF>2003-04-05</dcterms:W3CDTF>
  </dcterms:modified>
</cmeta:modification>
<cmeta:modification rdf:parseType="Resource">
  <rdf:value>
    Added more metadata.
  </rdf:value>
  <cmeta:modifier rdf:parseType="Resource">
    <vCard:N rdf:parseType="Resource">
      <vCard:Family>Lloyd</vCard:Family>
      <vCard:Given>Catherine</vCard:Given>
      <vCard:Other>May</vCard:Other>
    </vCard:N>
  </cmeta:modifier>
  <dcterms:modified rdf:parseType="Resource">
    <dcterms:W3CDTF>2002-07-22</dcterms:W3CDTF>
  </dcterms:modified>
</cmeta:modification>

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

<!--
  The following metadata refers to the model itself, as indicated by the
  reference to the ID
  "pyrimidine_nucleotide_degradation_UMP_and_CMP_pathways", which is
  declared on the <model> element.
-->
<rdf:Description rdf:about="#pyrimidine_nucleotide_degradation_UMP_and_CMP_pathways">
  <!-- A human readable name for the model. -->
  <dc:title>
    A Generic Model Of Pyrimidine Nucleotide (UMP and CMP) Degradation
  </dc:title>

  <!-- A comment regarding the model. -->
  <cmeta:comment rdf:parseType="Resource">
    <rdf:value>

```

Below is a CellML description of a general model of pyrimidine nucleotide (UMP and CMP) degradation. It is not based on a specific published mathematical model, but instead it is based on a textbook defined pathway. The general sequential structure and all the reactant, product and enzyme components are included. Michaelis-Menten enzyme kinetics are assumed.

The purpose of this description is to illustrate how CellML can be used to model a general metabolic pathway.

```
</rdf:value>
```

```
<!-- The creator of the comment. -->
```

```
<dc:creator>
```

```
  <vCard:FN>Catherine Lloyd</vCard:FN>
```

```
</dc:creator>
```

```
</cmeta:comment>
```

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

```
<!-- Keyword(s) -->
```

```
<bqs:reference rdf:parseType="Resource">
```

```
  <dc:subject rdf:parseType="Resource">
```

```
    <bqs:subject_type>keyword</bqs:subject_type>
```

```
    <rdf:value>metabolism</rdf:value>
```

```
  </dc:subject>
```

```
</bqs:reference>
```

```
<bqs:Book rdf:parseType="Resource">
```

```
  <dc:creator rdf:parseType="Resource">
```

```
    <bqs:Person rdf:parseType="Resource">
```

```
      <vCard:N rdf:parseType="Resource">
```

```
        <vCard:Family>Bronk</vCard:Family>
```

```
        <vCard:Given>J</vCard:Given>
```

```
        <vCard:Other>Ramsey</vCard:Other>
```

```
      </vCard:N>
```

```
    </bqs:Person>
```

```
  </dc:creator>
```

```
  <dc:title>Human Metabolism</dc:title>
```

```
  <dcterms:issued rdf:parseType="Resource">
```

```
    <dcterms:W3CDTF>1999</dcterms:W3CDTF>
```

```
  </dcterms:issued>
```

```
  <dc:publisher rdf:parseType="Resource">
```

```
    <bqs:Organisation>Addison Wesley Longman Limited</bqs:Organisation>
```

```
    <bqs:Property rdf:parseType="Resource">
```

```
      <bqs:property_type>location</bqs:property_type>
```

```
      <rdf:value>England</rdf:value>
```

```
    </bqs:Property>
```

```
  </dc:publisher>
```

```
</bqs:Book>
```

```
</rdf:Description>
```

```
</rdf:RDF>
```

```
<!--
```

```
  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="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 pyrimidine nucleotide (UMP and CMP) degradation.
-->

<component name="UMP" cmeta:id="UMP">
  <variable name="UMP" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_UMP_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>
        <ci>UMP</ci>
      </apply>
      <ci>delta_UMP_rxn0</ci>
    </apply>
  </math>
</component>

<component name="Uridine" cmeta:id="Uridine">
  <variable name="Uridine" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Uridine_rxn0" public_interface="in" units="flux" />
  <variable name="delta_Uridine_rxn3" public_interface="in" units="flux" />
  <variable name="delta_Uridine_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>Uridine</ci>
    </apply>
    <apply>
      <plus />
      <ci>delta_Uridine_rxn0</ci>
      <ci>delta_Uridine_rxn3</ci>
      <ci>delta_Uridine_rxn1</ci>
    </apply>
  </math>
</component>

<component name="Uracil" cmeta:id="Uracil">
  <variable name="Uracil" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Uracil_rxn1" public_interface="in" units="flux" />
  <variable name="delta_Uracil_rxn4" public_interface="in" units="flux" />
  <variable name="time" public_interface="in" units="second" />
  <math xmlns="http://www.w3.org/1998/Math/MathML">
    <apply>
      <eq />
      <apply>
        <diff />
        <bvar>
          <ci>time</ci>
        </bvar>
        <ci>Uracil</ci>
      </apply>
      <apply>
        <plus />
        <ci>delta_Uracil_rxn1</ci>
        <ci>delta_Uracil_rxn4</ci>
      </apply>
    </math>
  </component>

<component name="Dihydrouracil" cmeta:id="Dihydrouracil">
  <variable name="Dihydrouracil" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Dihydrouracil_rxn4" public_interface="in" units="flux" />
  <variable name="delta_Dihydrouracil_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>Dihydrouracil</ci>
      </apply>
      <apply>
        <plus />
        <ci>delta_Dihydrouracil_rxn4</ci>
      </apply>
    </math>
  </component>

```

```

        <ci>delta_Dihydrouracil_rxn5</ci>
    </apply>
</apply>
</math>
</component>

```

```

<component name="beta_Ureidopropionate" cmeta:id="beta_Ureidopropionate">
  <variable name="beta_Ureidopropionate" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_beta_Ureidopropionate_rxn5" public_interface="in" units="flux" />
  <variable name="delta_beta_Ureidopropionate_rxn6" 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>beta_Ureidopropionate</ci>
      </apply>
      <apply>
        <plus />
        <ci>delta_beta_Ureidopropionate_rxn5</ci>
        <ci>delta_beta_Ureidopropionate_rxn6</ci>
      </apply>
    </apply>
  </math>
</component>

```

```

<component name="beta_Alanine" cmeta:id="beta_Alanine">
  <variable name="beta_Alanine" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_beta_Alanine_rxn6" 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>beta_Alanine</ci>
      </apply>
      <ci>delta_beta_Alanine_rxn6</ci>
    </apply>
  </math>
</component>

```

```

<component name="CMP" cmeta:id="CMP">
  <variable name="CMP" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_CMP_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>CMP</ci>
    </apply>
    <ci>delta_CMP_rxn2</ci>
  </apply>
</math>
</component>

```

```

<component name="Cytidine" cmeta:id="Cytidine">
  <variable name="Cytidine" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Cytidine_rxn2" public_interface="in" units="flux" />
  <variable name="delta_Cytidine_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>Cytidine</ci>
      </apply>
      <apply>
        <plus />
        <ci>delta_Cytidine_rxn2</ci>
        <ci>delta_Cytidine_rxn3</ci>
      </apply>
    </apply>
  </math>
</component>

```

```

<component name="Ribose_1_phosphate" cmeta:id="Ribose_1_phosphate">
  <variable name="Ribose_1_phosphate" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_Ribose_1_phosphate_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>Ribose_1_phosphate</ci>
      </apply>
      <ci>delta_Ribose_1_phosphate_rxn1</ci>
    </apply>
  </math>
</component>

```

```

<component name="H2O" cmeta:id="H2O">
  <variable name="H2O" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_H2O_rxn0" public_interface="in" units="flux" />
  <variable name="delta_H2O_rxn2" public_interface="in" units="flux" />
  <variable name="delta_H2O_rxn3" public_interface="in" units="flux" />
  <variable name="delta_H2O_rxn5" public_interface="in" units="flux" />
  <variable name="delta_H2O_rxn6" 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_rxn0</ci>
      <ci>delta_H2O_rxn2</ci>
      <ci>delta_H2O_rxn3</ci>
      <ci>delta_H2O_rxn5</ci>
      <ci>delta_H2O_rxn6</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_rxn0" public_interface="in" units="flux" />
  <variable name="delta_Pi_rxn2" public_interface="in" units="flux" />
  <variable name="delta_Pi_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>Pi</ci>
      </apply>
      <apply>
        <plus />
        <ci>delta_Pi_rxn0</ci>
        <ci>delta_Pi_rxn2</ci>
        <ci>delta_Pi_rxn1</ci>
      </apply>
    </apply>
  </math>
</component>

<component name="NH4" cmeta:id="NH4">
  <variable name="NH4" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_NH4_rxn3" public_interface="in" units="flux" />
  <variable name="delta_NH4_rxn6" 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>NH4</ci>
    </apply>
    <apply>
        <plus />
        <ci>delta_NH4_rxn3</ci>
        <ci>delta_NH4_rxn6</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_rxn4" public_interface="in" units="flux" />
    <variable name="time" public_interface="in" units="second" />
    <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply>
            <eq />
            <apply>
                <diff />
                <bvar>
                    <ci>time</ci>
                </bvar>
                <ci>NADH</ci>
            </apply>
            <ci>delta_NADH_rxn4</ci>
        </apply>
    </math>
</component>

<component name="H" cmeta:id="H">
    <variable name="H" public_interface="out" initial_value="1.0" units="micromolar" />
    <variable name="delta_H_rxn4" public_interface="in" units="flux" />
    <variable name="time" public_interface="in" units="second" />
    <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply>
            <eq />
            <apply>
                <diff />
                <bvar>
                    <ci>time</ci>
                </bvar>
                <ci>H</ci>
            </apply>
            <ci>delta_H_rxn4</ci>
        </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_rxn4" public_interface="in" units="flux" />
    <variable name="time" public_interface="in" units="second" />
    <math xmlns="http://www.w3.org/1998/Math/MathML">
        <apply>
            <eq />

```

```

    <apply>
      <diff />
      <bvar>
        <ci>time</ci>
      </bvar>
      <ci>NAD</ci>
    </apply>
    <ci>delta_NAD_rxn4</ci>
  </apply>
</math>
</component>

<component name="CO2" cmeta:id="CO2">
  <variable name="CO2" public_interface="out" initial_value="1.0" units="micromolar" />
  <variable name="delta_CO2_rxn6" 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>CO2</ci>
      </apply>
      <ci>delta_CO2_rxn6</ci>
    </apply>
  </math>
</component>

<!--
  The following components describe all the enzymes involved in pyrimidine
  nucleotide (UMP and CMP) degradation.
-->

<component name="Nucleotidase_5" cmeta:id="Nucleotidase_5">
  <variable name="Nucleotidase_5" public_interface="out" initial_value="1.0" units="micro
  <variable name="time" public_interface="in" units="second" />
</component>

<component name="Cytidine_deaminase" cmeta:id="Cytidine_deaminase">
  <variable name="Cytidine_deaminase" public_interface="out" initial_value="1.0" units="
  <variable name="time" public_interface="in" units="second" />
</component>

<component name="Nucleoside_phosphorylase" cmeta:id="Nucleoside_phosphorylase">
  <variable name="Nucleoside_phosphorylase" public_interface="out" initial_value="1.0" un
  <variable name="time" public_interface="in" units="second" />
</component>

<component name="Dihydrouracil_dehydrogenase" cmeta:id="Dihydrouracil_dehydrogenase">
  <variable name="Dihydrouracil_dehydrogenase" public_interface="out" initial_value="1.0
  <variable name="time" public_interface="in" units="second" />
</component>

<component name="Dihydropyrimidinase" cmeta:id="Dihydropyrimidinase">
  <variable name="Dihydropyrimidinase" public_interface="out" initial_value="1.0" units=
  <variable name="time" public_interface="in" units="second" />

```

```

</component>

<component name="beta_Ureidopropionase" cmeta:id="beta_Ureidopropionase">
  <variable name="beta_Ureidopropionase" public_interface="out" initial_value="1.0" units="second" />
  <variable name="time" public_interface="in" units="second" />
</component>

<!--
  The following components represent the reaction steps of pyrimidine
  nucleotide (UMP and CMP) degradation.
-->

<component name="reaction0">
  <variable name="H2O" public_interface="in" units="micromolar" />
  <variable name="UMP" public_interface="in" units="micromolar" />
  <variable name="Pi" public_interface="in" units="micromolar" />
  <variable name="Uridine" public_interface="in" units="micromolar" />
  <variable name="Nucleotidase_5" public_interface="in" units="micromolar" />
  <variable name="delta_H2O_rxn0" public_interface="out" units="flux" />
  <variable name="delta_UMP_rxn0" public_interface="out" units="flux" />
  <variable name="delta_Pi_rxn0" public_interface="out" units="flux" />
  <variable name="delta_Uridine_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="H2O">
      <role role="reactant" delta_variable="delta_H2O_rxn0" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="UMP">
      <role role="reactant" delta_variable="delta_UMP_rxn0" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Pi">
      <role role="product" delta_variable="delta_Pi_rxn0" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Uridine">
      <role role="product" delta_variable="delta_Uridine_rxn0" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Nucleotidase_5">
      <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>H2O</ci>
                <ci>UMP</ci>
              </apply>
            <apply><plus />
              <ci>km0</ci>
              <ci>H2O</ci>
              <ci>UMP</ci>
            </apply>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

```

```

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

<component name="reaction1">
  <variable name="Pi" public_interface="in" units="micromolar" />
  <variable name="Uridine" public_interface="in" units="micromolar" />
  <variable name="Ribose_1_phosphate" public_interface="in" units="micromolar" />
  <variable name="Uracil" public_interface="in" units="micromolar" />
  <variable name="Nucleoside_phosphorylase" public_interface="in" units="micromolar" />
  <variable name="delta_Pi_rxn1" public_interface="out" units="flux" />
  <variable name="delta_Uridine_rxn1" public_interface="out" units="flux" />
  <variable name="delta_Ribose_1_phosphate_rxn1" public_interface="out" units="flux" />
  <variable name="delta_Uracil_rxn1" public_interface="out" units="flux" />
  <variable name="kml" initial_value="1.0" units="micromolar" />
  <variable name="vmax1" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="Pi">
      <role role="reactant" delta_variable="delta_Pi_rxn1" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Uridine">
      <role role="reactant" delta_variable="delta_Uridine_rxn1" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Ribose_1_phosphate">
      <role role="product" delta_variable="delta_Ribose_1_phosphate_rxn1" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Uracil">
      <role role="product" delta_variable="delta_Uracil_rxn1" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Nucleoside_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>Pi</ci>
                <ci>Uridine</ci>
                <ci>vmax1</ci>
              </apply>
            </apply>
            <apply>
              <plus />
              <ci>kml</ci>
              <ci>Pi</ci>
              <ci>Uridine</ci>
            </apply>
          </math>
        </role>
      </variable_ref>
    </reaction>
  </component>

```

```

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

<component name="reaction2">
  <variable name="CMP" public_interface="in" units="micromolar" />
  <variable name="H2O" public_interface="in" units="micromolar" />
  <variable name="Pi" public_interface="in" units="micromolar" />
  <variable name="Cytidine" public_interface="in" units="micromolar" />
  <variable name="Nucleotidase_5" public_interface="in" units="micromolar" />
  <variable name="delta_CMP_rxn2" public_interface="out" units="flux" />
  <variable name="delta_H2O_rxn2" public_interface="out" units="flux" />
  <variable name="delta_Pi_rxn2" public_interface="out" units="flux" />
  <variable name="delta_Cytidine_rxn2" public_interface="out" units="flux" />
  <variable name="km2" initial_value="1.0" units="micromolar" />
  <variable name="vmax2" initial_value="1.0" units="second_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="CMP">
      <role role="reactant" delta_variable="delta_CMP_rxn2" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="H2O">
      <role role="reactant" delta_variable="delta_H2O_rxn2" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Pi">
      <role role="product" delta_variable="delta_Pi_rxn2" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Cytidine">
      <role role="product" delta_variable="delta_Cytidine_rxn2" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Nucleotidase_5">
      <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>CMP</ci>
                <ci>H2O</ci>
                <ci>vmax2</ci>
              </apply>
            </apply>
            <plus />
            <ci>km2</ci>
            <ci>CMP</ci>
            <ci>H2O</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

```

```

</reaction>
</component>

<component name="reaction3">
  <variable name="H2O" public_interface="in" units="micromolar" />
  <variable name="Cytidine" public_interface="in" units="micromolar" />
  <variable name="Cytidine_deaminase" public_interface="in" units="micromolar" />
  <variable name="NH4" public_interface="in" units="micromolar" />
  <variable name="Uridine" public_interface="in" units="micromolar" />
  <variable name="delta_H2O_rxn3" public_interface="out" units="flux" />
  <variable name="delta_Cytidine_rxn3" public_interface="out" units="flux" />
  <variable name="delta_NH4_rxn3" public_interface="out" units="flux" />
  <variable name="delta_Uridine_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="H2O">
      <role role="reactant" delta_variable="delta_H2O_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Cytidine">
      <role role="reactant" delta_variable="delta_Cytidine_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="NH4">
      <role role="product" delta_variable="delta_NH4_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Uridine">
      <role role="product" delta_variable="delta_Uridine_rxn3" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Cytidine_deaminase">
      <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>H2O</ci>
                <ci>Cytidine</ci>
                <ci>vmax3</ci>
              </apply>
            </apply>
            <plus />
            <ci>km3</ci>
            <ci>H2O</ci>
            <ci>Cytidine</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

```

```

<component name="reaction4">
  <variable name="H" public_interface="in" units="micromolar" />
  <variable name="Uracil" public_interface="in" units="micromolar" />
  <variable name="NADH" public_interface="in" units="micromolar" />
  <variable name="NAD" public_interface="in" units="micromolar" />
  <variable name="Dihydrouracil" public_interface="in" units="micromolar" />
  <variable name="Dihydrouracil_dehydrogenase" public_interface="in" units="micromolar" />
  <variable name="delta_H_rxn4" public_interface="out" units="flux" />
  <variable name="delta_Uracil_rxn4" public_interface="out" units="flux" />
  <variable name="delta_NADH_rxn4" public_interface="out" units="flux" />
  <variable name="delta_NAD_rxn4" public_interface="out" units="flux" />
  <variable name="delta_Dihydrouracil_rxn4" public_interface="out" units="flux" />
  <variable name="km4" initial_value="1.0" units="micromolar" />
  <variable name="vmax4" initial_value="1.0" units="third_order_rate_constant" />
  <variable name="rate" units="flux" />
  <reaction reversible="no">
    <variable_ref variable="H">
      <role role="reactant" delta_variable="delta_H_rxn4" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Uracil">
      <role role="reactant" delta_variable="delta_Uracil_rxn4" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="NADH">
      <role role="reactant" delta_variable="delta_NADH_rxn4" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="NAD">
      <role role="product" delta_variable="delta_NAD_rxn4" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Dihydrouracil">
      <role role="product" delta_variable="delta_Dihydrouracil_rxn4" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Dihydrouracil_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>
                <times />
                <ci>H</ci>
                <ci>Uracil</ci>
                <ci>NADH</ci>
                <ci>vmax4</ci>
              </apply>
            </apply>
            <plus />
            <ci>km4</ci>
            <ci>H</ci>
            <ci>Uracil</ci>
            <ci>NADH</ci>
          </math>
        </role>
      </variable_ref>
    </reaction>
  </component>

```

```

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

<component name="reaction5">
  <variable name="H2O" public_interface="in" units="micromolar" />
  <variable name="Dihydrouracil" public_interface="in" units="micromolar" />
  <variable name="beta_Ureidopropionate" public_interface="in" units="micromolar" />
  <variable name="Dihydropyrimidinase" public_interface="in" units="micromolar" />
  <variable name="delta_H2O_rxn5" public_interface="out" units="flux" />
  <variable name="delta_Dihydrouracil_rxn5" public_interface="out" units="flux" />
  <variable name="delta_beta_Ureidopropionate_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="H2O">
      <role role="reactant" delta_variable="delta_H2O_rxn5" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Dihydrouracil">
      <role role="reactant" delta_variable="delta_Dihydrouracil_rxn5" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="beta_Ureidopropionate">
      <role role="product" delta_variable="delta_beta_Ureidopropionate_rxn5" stoichiometry="1" />
    </variable_ref>
    <variable_ref variable="Dihydropyrimidinase">
      <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>Dihydrouracil</ci>
                <ci>vmax5</ci>
              </apply>
              <apply>
                <plus />
                <ci>km5</ci>
                <ci>H2O</ci>
                <ci>Dihydrouracil</ci>
              </apply>
            </apply>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>
</component>

<component name="reaction6">

```

```

<variable name="H2O" public_interface="in" units="micromolar" />
<variable name="beta_Ureidopropionate" public_interface="in" units="micromolar" />
<variable name="beta_Ureidopropionase" public_interface="in" units="micromolar" />
<variable name="CO2" public_interface="in" units="micromolar" />
<variable name="NH4" public_interface="in" units="micromolar" />
<variable name="beta_Alanine" public_interface="in" units="micromolar" />
<variable name="delta_H2O_rxn6" public_interface="out" units="flux" />
<variable name="delta_beta_Ureidopropionate_rxn6" public_interface="out" units="flux" />
<variable name="delta_CO2_rxn6" public_interface="out" units="flux" />
<variable name="delta_NH4_rxn6" public_interface="out" units="flux" />
<variable name="delta_beta_Alanine_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="H2O">
    <role role="reactant" delta_variable="delta_H2O_rxn6" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="beta_Ureidopropionate">
    <role role="reactant" delta_variable="delta_beta_Ureidopropionate_rxn6" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="CO2">
    <role role="product" delta_variable="delta_CO2_rxn6" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="NH4">
    <role role="product" delta_variable="delta_NH4_rxn6" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="beta_Alanine">
    <role role="product" delta_variable="delta_beta_Alanine_rxn6" stoichiometry="1" />
  </variable_ref>
  <variable_ref variable="beta_Ureidopropionase">
    <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>beta_Ureidopropionate</ci>
              <ci>vmax6</ci>
            </apply>
          </apply>
          <apply>
            <plus />
            <ci>km6</ci>
            <ci>H2O</ci>
            <ci>beta_Ureidopropionate</ci>
          </apply>
        </math>
      </role>
    </variable_ref>
  </reaction>

```

```
</component>

<connection>
  <map_components component_1="UMP" component_2="reaction0" />
  <map_variables variable_1="UMP" variable_2="UMP" />
  <map_variables variable_1="delta_UMP_rxn0" variable_2="delta_UMP_rxn0" />
</connection>

<connection>
  <map_components component_1="Uridine" component_2="reaction0" />
  <map_variables variable_1="Uridine" variable_2="Uridine" />
  <map_variables variable_1="delta_Uridine_rxn0" variable_2="delta_Uridine_rxn0" />
</connection>

<connection>
  <map_components component_1="Uridine" component_2="reaction3" />
  <map_variables variable_1="Uridine" variable_2="Uridine" />
  <map_variables variable_1="delta_Uridine_rxn3" variable_2="delta_Uridine_rxn3" />
</connection>

<connection>
  <map_components component_1="Uridine" component_2="reaction1" />
  <map_variables variable_1="Uridine" variable_2="Uridine" />
  <map_variables variable_1="delta_Uridine_rxn1" variable_2="delta_Uridine_rxn1" />
</connection>

<connection>
  <map_components component_1="Uracil" component_2="reaction1" />
  <map_variables variable_1="Uracil" variable_2="Uracil" />
  <map_variables variable_1="delta_Uracil_rxn1" variable_2="delta_Uracil_rxn1" />
</connection>

<connection>
  <map_components component_1="Uracil" component_2="reaction4" />
  <map_variables variable_1="Uracil" variable_2="Uracil" />
  <map_variables variable_1="delta_Uracil_rxn4" variable_2="delta_Uracil_rxn4" />
</connection>

<connection>
  <map_components component_1="Dihydrouracil" component_2="reaction4" />
  <map_variables variable_1="Dihydrouracil" variable_2="Dihydrouracil" />
  <map_variables variable_1="delta_Dihydrouracil_rxn4" variable_2="delta_Dihydrouracil_rxn4" />
</connection>

<connection>
  <map_components component_1="Dihydrouracil" component_2="reaction5" />
  <map_variables variable_1="Dihydrouracil" variable_2="Dihydrouracil" />
  <map_variables variable_1="delta_Dihydrouracil_rxn5" variable_2="delta_Dihydrouracil_rxn5" />
</connection>

<connection>
  <map_components component_1="beta_Ureidopropionate" component_2="reaction5" />
  <map_variables variable_1="beta_Ureidopropionate" variable_2="beta_Ureidopropionate" />
  <map_variables variable_1="delta_beta_Ureidopropionate_rxn5" variable_2="delta_beta_Ureidopropionate_rxn5" />
</connection>

<connection>
  <map_components component_1="beta_Ureidopropionate" component_2="reaction6" />
  <map_variables variable_1="beta_Ureidopropionate" variable_2="beta_Ureidopropionate" />
  <map_variables variable_1="delta_beta_Ureidopropionate_rxn6" variable_2="delta_beta_Ureidopropionate_rxn6" />
</connection>
```

```
<map_variables variable_1="delta_beta_Ureidopropionate_rxn6" variable_2="delta_beta_Ureidopropionate_rxn6" />
</connection>

<connection>
  <map_components component_1="beta_Alanine" component_2="reaction6" />
  <map_variables variable_1="beta_Alanine" variable_2="beta_Alanine" />
  <map_variables variable_1="delta_beta_Alanine_rxn6" variable_2="delta_beta_Alanine_rxn6" />
</connection>

<connection>
  <map_components component_1="CMP" component_2="reaction2" />
  <map_variables variable_1="CMP" variable_2="CMP" />
  <map_variables variable_1="delta_CMP_rxn2" variable_2="delta_CMP_rxn2" />
</connection>

<connection>
  <map_components component_1="Cytidine" component_2="reaction2" />
  <map_variables variable_1="Cytidine" variable_2="Cytidine" />
  <map_variables variable_1="delta_Cytidine_rxn2" variable_2="delta_Cytidine_rxn2" />
</connection>

<connection>
  <map_components component_1="Cytidine" component_2="reaction3" />
  <map_variables variable_1="Cytidine" variable_2="Cytidine" />
  <map_variables variable_1="delta_Cytidine_rxn3" variable_2="delta_Cytidine_rxn3" />
</connection>

<connection>
  <map_components component_1="Ribose_1_phosphate" component_2="reaction1" />
  <map_variables variable_1="Ribose_1_phosphate" variable_2="Ribose_1_phosphate" />
  <map_variables variable_1="delta_Ribose_1_phosphate_rxn1" variable_2="delta_Ribose_1_phosphate_rxn1" />
</connection>

<connection>
  <map_components component_1="H2O" component_2="reaction0" />
  <map_variables variable_1="H2O" variable_2="H2O" />
  <map_variables variable_1="delta_H2O_rxn0" variable_2="delta_H2O_rxn0" />
</connection>

<connection>
  <map_components component_1="H2O" component_2="reaction2" />
  <map_variables variable_1="H2O" variable_2="H2O" />
  <map_variables variable_1="delta_H2O_rxn2" variable_2="delta_H2O_rxn2" />
</connection>

<connection>
  <map_components component_1="H2O" component_2="reaction3" />
  <map_variables variable_1="H2O" variable_2="H2O" />
  <map_variables variable_1="delta_H2O_rxn3" variable_2="delta_H2O_rxn3" />
</connection>

<connection>
  <map_components component_1="H2O" component_2="reaction5" />
  <map_variables variable_1="H2O" variable_2="H2O" />
  <map_variables variable_1="delta_H2O_rxn5" variable_2="delta_H2O_rxn5" />
</connection>

<connection>
  <map_components component_1="H2O" component_2="reaction6" />
```

```
<map_variables variable_1="H2O" variable_2="H2O" />
<map_variables variable_1="delta_H2O_rxn6" variable_2="delta_H2O_rxn6" />
</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="Pi" component_2="reaction2" />
  <map_variables variable_1="Pi" variable_2="Pi" />
  <map_variables variable_1="delta_Pi_rxn2" variable_2="delta_Pi_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="NH4" component_2="reaction3" />
  <map_variables variable_1="NH4" variable_2="NH4" />
  <map_variables variable_1="delta_NH4_rxn3" variable_2="delta_NH4_rxn3" />
</connection>

<connection>
  <map_components component_1="NH4" component_2="reaction6" />
  <map_variables variable_1="NH4" variable_2="NH4" />
  <map_variables variable_1="delta_NH4_rxn6" variable_2="delta_NH4_rxn6" />
</connection>

<connection>
  <map_components component_1="NADH" component_2="reaction4" />
  <map_variables variable_1="NADH" variable_2="NADH" />
  <map_variables variable_1="delta_NADH_rxn4" variable_2="delta_NADH_rxn4" />
</connection>

<connection>
  <map_components component_1="H" component_2="reaction4" />
  <map_variables variable_1="H" variable_2="H" />
  <map_variables variable_1="delta_H_rxn4" variable_2="delta_H_rxn4" />
</connection>

<connection>
  <map_components component_1="NAD" component_2="reaction4" />
  <map_variables variable_1="NAD" variable_2="NAD" />
  <map_variables variable_1="delta_NAD_rxn4" variable_2="delta_NAD_rxn4" />
</connection>

<connection>
  <map_components component_1="CO2" component_2="reaction6" />
  <map_variables variable_1="CO2" variable_2="CO2" />
  <map_variables variable_1="delta_CO2_rxn6" variable_2="delta_CO2_rxn6" />
</connection>

<connection>
```

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