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About us

The focus of Enzymicals:
is the utilization of innovative biocatalysts. Dedicated to design and implement cost-effective, sustainable and scalable chemo-biocatalytic routes, Enzymicals offers recognized expertise in the use of enzymatic processes for complex chemicals synthesis. We provide enzymes suitable for research and production of fine & speciality chemicals, APIs & intermediates as well as for bulk chemicals. Our service includes the route scouting for the synthesis of your desired compounds, up to feasibility studies and final applications orientated on your demands. Enzymicals is integrated in a network which covers the whole value chain from identification and improvement of biocatalysts, process development and optimization up to commercial production under cGMP conditions, distribution and regulatory issues.

Enzymicals product portfolio 2014 offers unique biocatalysts to solve synthetic problems at best performance meeting the needs of our customers.

Own enzyme collections:
- Transaminases (33)*
- Halohydrin Dehalogenases (33)*
- Imine Reductases (4)*
- Lipases/Esterases (47)*
- Baeyer-Villiger-Monoxygenases (12)*
- Acylases (5)*

Enzyme collections from partners:
- beta-Galactosidases
- Glycosyltransferases
- P450-Monoxygenases
- Epoxide-Hydrolases
- Proteases
- Amylases
- Nitrilhydratases
- Alcohol-Dehydrogenases
- O-Methyltransferases

*Number of available enzymes, most of them unique

The present catalogue reflect a small selection of our catalyst portfolio.
### Enzyme Portfolio

#### Recombinant pig liver esterases:

<table>
<thead>
<tr>
<th>Product name</th>
<th>Origin</th>
<th>Catalog no.</th>
<th>Quantity</th>
<th>Price</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLE isoenzyme 1</td>
<td>pig liver, rec. from <em>E. coli</em></td>
<td>ECS-PLE01</td>
<td>50 mg</td>
<td>150 €</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>PLE isoenzyme 2</td>
<td>pig liver, rec. from <em>E. coli</em></td>
<td>ECS-PLE02</td>
<td>50 mg</td>
<td>150 €</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>PLE isoenzyme 3</td>
<td>pig liver, rec. from <em>E. coli</em></td>
<td>ECS-PLE03</td>
<td>50 mg</td>
<td>150 €</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>PLE isoenzyme 4</td>
<td>pig liver, rec. from <em>E. coli</em></td>
<td>ECS-PLE04</td>
<td>50 mg</td>
<td>150 €</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>PLE isoenzyme 5</td>
<td>pig liver, rec. from <em>E. coli</em></td>
<td>ECS-PLE05</td>
<td>50 mg</td>
<td>150 €</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>PLE isoenzyme 6</td>
<td>pig liver, rec. from <em>E. coli</em></td>
<td>ECS-PLE06</td>
<td>50 mg</td>
<td>150 €</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>PLE screening kit</td>
<td>pig liver, rec. from <em>E. coli</em></td>
<td>ECS-PLE-KIT</td>
<td></td>
<td>690 €</td>
<td>8</td>
</tr>
<tr>
<td>(contains all six pig liver esterase isoenzymes 50 mg each)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Other recombinant esterases:

<table>
<thead>
<tr>
<th>Product name</th>
<th>Origin</th>
<th>Catalog no.</th>
<th>Quantity</th>
<th>Price</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esterase 01</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es01</td>
<td>50 mg</td>
<td>150 €</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase 02</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es02</td>
<td>50 mg</td>
<td>150 €</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase 03</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es03</td>
<td>50 mg</td>
<td>150 €</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase 04</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es04</td>
<td>50 mg</td>
<td>150 €</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
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## Other recombinant esterases:

<table>
<thead>
<tr>
<th>Product name</th>
<th>Origin</th>
<th>Catalog no.</th>
<th>Quantity</th>
<th>Price</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esterase 05</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es05</td>
<td>50 mg</td>
<td>150 €</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase 06</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es06</td>
<td>50 mg</td>
<td>150 €</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase 07</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es07</td>
<td>50 mg</td>
<td>150 €</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase 08</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es08</td>
<td>50 mg</td>
<td>150 €</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase 09</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es09</td>
<td>50 mg</td>
<td>150 €</td>
<td>18</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase 10</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Es10</td>
<td>50 mg</td>
<td>150 €</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>Esterase screening kit</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-ES-KIT</td>
<td></td>
<td>990 €</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(contains all ten bacterial esterases 50 mg each)</td>
<td></td>
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## Baeyer-Villiger monooxygenases:

<table>
<thead>
<tr>
<th>Product name</th>
<th>Origin</th>
<th>Catalog no.</th>
<th>Quantity</th>
<th>Price</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>BVMO 01</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Mo01</td>
<td>50 mg / 0.5 ml</td>
<td>150 €</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg / 5.00 ml</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>BVMO 02</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Mo02</td>
<td>50 mg</td>
<td>150 €</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>BVMO 03</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Mo03</td>
<td>50 mg</td>
<td>150 €</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>BVMO 04</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Mo04</td>
<td>0.50 ml</td>
<td>150 €</td>
<td>24</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5.00 ml</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>BVMO 05</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Mo05</td>
<td>0.50 ml</td>
<td>150 €</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.00 ml</td>
<td>580 €</td>
<td></td>
</tr>
<tr>
<td>BVMO 06</td>
<td>bacterial, rec. from <em>E. coli</em></td>
<td>ECS-Mo06</td>
<td>50 mg</td>
<td>150 €</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
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</table>
Baeyer-Villiger monooxygenases:

<table>
<thead>
<tr>
<th>Product name</th>
<th>Origin</th>
<th>Catalog no.</th>
<th>Quantity</th>
<th>Price</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>BVMO screening kit</td>
<td>bacterial, rec. from E. coli</td>
<td>ECS-BVMO-KIT</td>
<td>50 mg</td>
<td>690 €</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(contains all six bacterial BVMOs 50 mg each)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

Amine Transaminases:

<table>
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<th>Product name</th>
<th>Origin</th>
<th>Catalog no.</th>
<th>Quantity</th>
<th>Price</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaminase 01</td>
<td>eukaryotic, rec. from E. coli</td>
<td>ECS-ATA01</td>
<td>50 mg</td>
<td>150 €</td>
<td>28</td>
</tr>
<tr>
<td>Transaminase 02</td>
<td>eukaryotic, rec. from E. coli</td>
<td>ECS-ATA02</td>
<td>50 mg</td>
<td>150 €</td>
<td>28</td>
</tr>
<tr>
<td>Transaminase 03</td>
<td>eukaryotic, rec. from E. coli</td>
<td>ECS-ATA03</td>
<td>50 mg</td>
<td>150 €</td>
<td>28</td>
</tr>
<tr>
<td>Transaminase 04</td>
<td>eukaryotic, rec. from E. coli</td>
<td>ECS-ATA04</td>
<td>50 mg</td>
<td>150 €</td>
<td>28</td>
</tr>
<tr>
<td>Transaminase 05</td>
<td>eukaryotic, rec. from E. coli</td>
<td>ECS-ATA05</td>
<td>50 mg</td>
<td>150 €</td>
<td>28</td>
</tr>
<tr>
<td>Transaminase 06</td>
<td>eukaryotic, rec. from E. coli</td>
<td>ECS-ATA06</td>
<td>50 mg</td>
<td>150 €</td>
<td>28</td>
</tr>
<tr>
<td>Transaminase 07</td>
<td>bacterial, rec. from E. coli</td>
<td>ECS-ATA07</td>
<td>50 mg</td>
<td>150 €</td>
<td>28</td>
</tr>
<tr>
<td>Transaminase 08</td>
<td>bacterial, rec. from E. coli</td>
<td>ECS-ATA08</td>
<td>50 mg</td>
<td>150 €</td>
<td>28</td>
</tr>
<tr>
<td>ATA screening kit</td>
<td>rec. from E. coli</td>
<td>ECS-ATA-KIT</td>
<td>50 mg</td>
<td>990 €</td>
<td></td>
</tr>
<tr>
<td>„Ready to use“ kit</td>
<td>available upon request</td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
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</table>

Other Enzymes:

<table>
<thead>
<tr>
<th>Product name</th>
<th>Origin</th>
<th>Catalog no.</th>
<th>Quantity</th>
<th>Price</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoacylase 01</td>
<td>eukaryotic, rec. from E. coli</td>
<td>ECS-Ac01</td>
<td>50 mg</td>
<td>150 €</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 mg</td>
<td>580 €</td>
<td></td>
</tr>
</tbody>
</table>
Esterases

General properties:

Esterases represent a diverse group of hydrolases catalyzing the cleavage and formation of ester bonds. Carboxylesterases (EC 3.1.1.1) are a subset of esterases that specifically hydrolyse carboxylic esters to give two products: a carboxylic acid and an alcohol.

\[
\begin{align*}
\text{R}^1\text{R}^2\text{R}^3 & \xrightarrow{\text{Esterase}} \text{H}_2\text{O} \quad \text{R}^1\text{R}^2 + \text{R}^3\text{COOH} \\
\end{align*}
\]

Many of them show a wide substrate tolerance and also high regio- and stereospecificity, which make them attractive biocatalysts for the production of optically pure compounds for fine chemical synthesis. The interest in these enzymes also resides in the fact that they do not require cofactors, are stable and are even active in organic solvents. Preferred substrates are esters and short-chain triglycerides.

Further information can be found in:

Pig liver esterases

Background:

The pig liver esterase (PLE) is a widely used enzyme in organic synthesis. Due to its ability to work under mild conditions and with organic solvents it is a very useful biocatalyst for the synthesis of optically pure compounds. The traditional use of isolates from pig liver had the disadvantage of being an ill-defined mixture of hydrolases including PLE-isoenzymes. Six isoenzymes of the pig liver esterase have been identified and are commercially available from Enzymicals. The application of single isoenzymes guarantees a reproducible enzyme activity and prevents undesired side reactions. Our recombinant expression platform ensures their animal free manufacturing and direct production scale-up. Final formulation can be adapted to meet specific process requirements.

All isoenzymes show high enantioselectivities and even opposite enantiopreferences in the kinetic resolution of several secondary alcohols (see Figure 1). They also exhibit different specific activities towards chiral esters and offer diverse selectivities for the desymmetrization of prochiral compounds.

*Enantioselectivity of PLE isoenzymes towards selected secondary alcohol esters. Data for Fluka-PLE refers to a commercially available enzyme preparation which contains a mixture of isoenzymes.*
Examples:

Enantioselective resolutions and desymmetrizations.

Stereoselective hydrolysis of tertiary alcohol esters.

Chiral products obtained from PLE-mediated hydrolysis of carboxylic esters.

Enzymicals offers a PLE screening kit with samples of six isoenzymes of the pig liver esterase (50 mg each). This enables the quick and easy identification of the best isoenzyme with respect to enantioselectivity and enantiopreference. For quality assurance enzymes are tested against p-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.
**ECS-Esterase 01 - Bacillus subtilis**  
(EC 3.1.1.1)

**Properties:**  
Removes tert-butyl ester protecting group, e.g. from peptides  
Acts on tertiary alcohols in the kinetic resolution of racemic esters  
Exhibits promiscuous amidase activity  
Optimum conditions: 40°C, pH 8-9

**Examples:**  
De-protection by ECS-Es01 with various alcohol moieties.

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Es01 is tested against p-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.  
Several mutants with enhanced substrate specificity and/or increased stereoselectivity and/or inverted stereopreference are available upon request.
ECS-Esterase 02 - *Bacillus subtilis*  
(EC 3.1.1.1)

**Properties:**
Acts on esters with medium chain length fatty acids  
Good acceptance of branched alcohol moieties  
Active towards several lactones  
Optimum conditions: 40°C, pH 7.5-8

**Examples:**

```
O
\leftarrow
```

\begin{align*}
\text{Substrates hydrolyzed by ECS-Es02.} \\
\text{Chiral product obtained from hydrolysis of carboxylic ester by ECS-Es02.}
\end{align*}

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Es02 is tested against *p*-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.
**ECS-Esterase 03 - Bacillus stearothermophilus**  
(EC 3.1.1.1)

**Properties:**
- Active towards various carboxylic acid esters
- Accepts substrates with sterically demanding carboxylic acid groups
- Active towards several lactones
- High temperature stability
- Optimum conditions: 65°C, pH 7

**Examples:**

```
O
O

O
O

O
O
```

*Substrates hydrolyzed by ECS-Es03.*

```

```

*Chiral product obtained from hydrolysis of carboxylic ester by ECS-Es03.*

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Es03 is tested against p-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.
**ECS-Esterase 04 - Pseudomonas fluorescens**

(EC 3.1.1.1)

**Properties:**
- Acts on a wide range of aliphatic and aromatic esters
- Active and stable at elevated temperatures and in organic solvents
- Can be used for acetylation reactions
- Optimum conditions: 45°C, pH 7.5-8

**Examples:**
- Substrates hydrolyzed by ECS-Es04.

```
\begin{align*}
\text{CH}_2\text{COO} & \quad \text{O}\text{O} \quad \text{HO}\text{O} \\
\text{C}_6\text{H}_5\text{COO} & \quad \text{C}_6\text{H}_5\text{COO} \quad \text{C}_6\text{H}_5\text{COO} \quad \text{C}_6\text{H}_5\text{COO}
\end{align*}
```

**Formulation:**
Lyophilized powder

**Comment:**
For quality assurance ECS-Es04 is tested against \( p \)-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.

Several mutants with enhanced substrate specificity and/or increased stereoselectivity are available upon request.

*Chiral product obtained from hydrolysis of carboxylic ester by ECS-Es04.*
ECS-Esterase 05 - *Pseudomonas fluorescens*  
(EC 3.1.1.1)

**Properties:** Active towards various carboxylic acid esters and lactones  
Optimum conditions: 43°C, pH 7.5

**Examples:**

Substrates hydrolyzed by ECS-Es05.

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Es05 is tested against *p*-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.
ECS-Esterase 06 - *Paenibacillus barcinonensis* (EC 3.1.1.1)

**Properties:**
- Active towards various carboxylic acid esters
- Variants act on tertiary alcohols esters
- Optimum conditions: 37°C, pH 7.5

**Examples:**

Substrates hydrolyzed by ECS-Es06.

\[
\begin{align*}
&\text{O} \\
&\text{R}^1\text{R}^2\text{R}^3 \quad \text{ECS-Es06-M1} \quad \text{H}_2\text{O} \quad \text{O} \\
&\text{R}^4 \\
&\text{R}^3 \quad + \quad \text{R}^4\text{COOH}
\end{align*}
\]

Stereoselective hydrolysis of tertiary alcohol esters by ECS-Es06 variant.

Chiral products obtained from hydrolysis of carboxylic esters by variant of ECS-Es06.

**Formulation:** Lyophilized powder

**Comment:**
- For quality assurance ECS-Es06 is tested against \( p \)-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.

Several mutants with enhanced substrate specificity and/or increased stereoselectivity towards tertiary alcohols are available upon request.
ECS-Esterase 07 - *Pyrobaculum calidifontis*  
(EC 3.1.1.1)

**Properties:**  
Active towards esters with short to medium chain length  
Accepts straight and branched chain alcohols  
Excellent enantioselectivity in the resolution of tertiary alcohol esters  
Active in organic media  
Optimum conditions: 90°C, pH 7

**Examples:**

Substrates hydrolyzed by ECS-Es07.

**Formulation:**  
Lyophilized powder

**Comment:**  
For quality assurance ECS-Es07 is tested against *p*-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.
ECS-Esterase 08 - *Nocardia farcinica*  
(EC 3.1.1.1)

**Properties:** Acts on a range of tertiary alcohols in the kinetic resolution of racemic esters  
Excellent enantioselectivity (E>100) in the hydrolysis of menthyl acetate  
Optimum conditions: pH 7.5

**Examples:**

\[
\begin{array}{c}
\text{R}_1 \\
\text{R}_2
\end{array}
\]

\[
\text{O} \quad \text{R}_4
\]

\[
\begin{array}{c}
\text{R}_1 \\
\text{R}_2
\end{array}
\]

\[
\begin{array}{c}
\text{O} \quad \text{R}_4
\end{array}
\]

\[
\begin{array}{c}
\text{R}_1 \\
\text{R}_2 \quad \text{R}_3
\end{array}
\]

\[
\begin{array}{c}
\text{OH} \\
\text{R}_1 \quad \text{R}_2 \quad \text{R}_3
\end{array}
\]

\[
\text{+ R}_4\text{COOH}
\]

*Stereoselective hydrolysis of tertiary alcohol esters by ECS-Es08.*

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Es08 is tested against \(p\)-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.
ECS-Esterase 09 - *Methylobacterium populi* (EC 3.1.1.1)

**Properties:** Acts on a range of tertiary alcohols in the kinetic resolution of racemic esters

Optimum conditions: pH 8.0

**Examples:**

```
R1
O
R2

R3
O
R4
```

\[
\text{ECS-Es09} \rightarrow \text{R1} \text{R3} \text{R4} \text{COOH} + \text{R1} \text{R2} \text{R3} \text{OH}
\]

*Stereoselective hydrolysis of tertiary alcohol esters by ECS-Es09.*

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Es09 is tested against *p*-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.
ECS-Esterase 10 - *Pelobacter propionicus*  
(EC 3.1.1.1)

**Properties:** Acts on tertiary alcohols in the kinetic resolution of racemic esters  
Optimum conditions: pH 7.5

**Examples:**

\[
\begin{array}{c}
\text{O} \\
R_1 \\
\text{R}_3 \\
\text{R} \\
\text{R}_2 \\
\end{array}
\xrightarrow{\text{ECS-Es10}}
\begin{array}{c}
\text{O} \\
R_1 \\
\text{R}_3 \\
\text{R} \\
\text{R}_2 \\
\end{array} +
\begin{array}{c}
\text{OH} \\
R_1 \\
\text{R}_3 \\
\text{R}_2 \\
\end{array} + R^4\text{COOH}
\]

*Stereoselective hydrolysis of tertiary alcohol esters by ECS-Es10.*

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Es10 is tested against \( p \)-nitrophenyl acetate as standard substrate at 30°C and pH 7.5.
Baeyer-Villiger monooxygenases (BVMOs)

General properties:

BVMOs are flavoenzymes and belong to the class of oxidoreductases. They catalyze the oxidation of linear, cyclic and aromatic ketones to esters or lactones, respectively, highly similar to the chemical Baeyer-Villiger oxidation. During the enzymatic oxidation one atom of molecular oxygen is incorporated into a carbon-carbon bond of a non-activated ketone, whereas the other oxygen atom ends up in a water molecule with the hydrogen atoms originating from the cofactor NAD(P)H.

\[
\begin{align*}
\text{R}_1 \text{R}_2 \quad \xrightarrow{\text{BVMO}} \quad \text{R}_1 \text{O}_\text{R}_2 + \text{R}_1 \text{O}_-\text{R}_2
\end{align*}
\]

BVMOs are typical soluble proteins and work without additional proteins. Furthermore these enzymes require NADH or NADPH as cofactors.

Further information can be found in:

**ECS-BVMO 01 - Acinetobacter calcoaceticus**

(EC 1.14.13)

**Properties:**
Baeyer-Villiger-Oxidation of aliphatic and alicyclic ketones
High regio- and enantioselectivity
NADPH-dependent

**Examples:**

**Chiral products obtained from reactions catalyzed by ECS-Mo01 with isolated enzyme or whole cell systems.**

**Formulation:**
Lyophilized powder / Liquid formulation

**Comment:**
For quality assurance ECS-Mo01 is tested against cyclohexanone as standard substrate at 30°C and pH 8.5.
ECS-BVMO 02 - Thermobifida fusca  

**Properties:** Baeyer-Villiger-Oxidation of aromatic and aliphatic ketones  
Able to perform sulfur oxidations  
Moderate thermostability  
High regio- and enantioselectivity  
NADPH-dependent

**Examples:**

- \( \text{ee } 98\% \)
- \( \text{ee } 97\% \)
- \( \text{ee } 95\% \)
- \( \text{ee } > 99\% \)

*Chiral products obtained from reactions catalyzed by ECS-Mo02 with isolated enzyme or whole cell systems.*

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Mo02 is tested against benzylacetone as standard substrate at 30°C and pH 8.5.
ECS-BVMO 03 - Thermobifida fusca

(EC 1.14.13)

**Properties:**
- Baeyer-Villiger-Oxidation of aromatic ketones and amines
- Able to perform sulfur oxidations
- Moderate thermostability
- High regio- and enantioselectivity
- NADPH-dependent

**Examples:**

- Chiral products obtained from reactions catalyzed by ECS-Mo03 with isolated enzyme or whole cell systems.

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Mo03 is tested against benzylacetone as standard substrate at 30°C and pH 8.5.
ECS-BVMO 04 - *Pseudomonas putida* (EC 1.14.13)

**Properties:**
- Baeyer-Villiger-Oxidation of aromatic ketones
- Able to perform sulfur oxidations
- High regio- and enantioselectivity
- NADPH-dependent

**Examples:**

- ![Chemical structure](image1)
  - ee 99%
- ![Chemical structure](image2)
  - ee 99%
- ![Chemical structure](image3)
  - ee > 99%
- ![Chemical structure](image4)
  - ee > 99%

*Chiral products obtained from reactions catalyzed by ECS-Mo04 with isolated enzyme or whole cell systems.*

**Formulation:** Liquid formulation

**Comment:** For quality assurance ECS-Mo04 is tested against 4-Hydroxyacetophenone as standard substrate at 30°C and pH 8.5.
ECS-BVMO 05 - *Pseudomonas fluorescens*  
(EC 1.14.13)

**Properties:**  
Baeyer-Villiger-Oxidation of aromatic ketones  
Able to perform sulfur oxidations  
High regio- and enantioselectivity  
NADPH-dependent

**Examples:**

- ![Substrate 1](image1)
- ![Substrate 2](image2)
- ![Substrate 3](image3)
- ![Substrate 4](image4)
- ![Substrate 5](image5)
- ![Substrate 6](image6)
- ![Substrate 7](image7)
- ![Substrate 8](image8)

Substrates converted by ECS-Mo05.

**Formulation:**  
Liquid formulation

**Comment:**  
For quality assurance ECS-Mo05 is tested against 4-Hydroxyacetophenone as standard substrate at 30°C and pH 8.5.
ECS-BVMO 06 - *Pseudomonas veronii*  
(EC 1.14.13)

**Properties:**  
Baeyer-Villiger-Oxidation of linear ketones  
High regio- and enantioselectivity  
NADPH-dependent

**Examples:**

![Chemical structures](image)

*Substrates converted by ECS-Mo06.*

**Formulation:** Lyophilized powder

**Comment:** For quality assurance ECS-Mo06 is tested against 4-Decanone as standard substrate at 30°C and pH 8.5.
**Amine Transaminases (ATAs)**

**General properties:**

Amine transaminases catalyze the transfer of an amino group from a primary amine to a pro-chiral ketone (or aldehyde). Amine transaminases are highly enantioselective and therefore can be used for the resolution of racemic amines or the synthesis of chiral amines from inexpensive ketones.

ATAs are pyridoxal-5'-phosphate dependent enzymes and their substrate range includes alkyl and aromatic amines, amino acids, amino esters and amino alcohols. Typical amine donors are: alanine, ethylamine, 1- and 2-propylamine, 1- and 2-butylamine and others. Our recombinant microbial expression platform ensures stable quality and easy production scale-up.

Final formulation can be adapted to meet the production process requirements.

Further information can be found in:

ECS-Transaminase 01-08

(EC 2.6.1)

Properties: Catalytic tool box for the evaluation of synthesis routes
ATA01-07 strict (R)-selective, ATA08 strict (S)-selective
Conversion of aliphatic, arylaliphatic and aromatic ketones

Origins: ATA01  Aspergillus fumigatus  ATA02  Gibberella zeae  ATA03  Neosartorya fischeri
ATA04  Aspergillus oryzae  ATA05  Aspergillus terreus  ATA06  Penicillium chrysogenum
ATA07  Mycobacterium vanbaalenii  ATA08  Silicibacter pomeroyi

Examples:

CHIRAL PRODUCTS OBTAINED BY ASYMMETRIC SYNTHESIS CATALYZED BY ECS-ATAS.

Formulation: Lyophilized powder

Comment: For quality assurance ATA01-07 are tested against (R)-1-phenylethanamine at pH 8.5 and ATA08 against (S)-1-phenylethanamine as standard substrate at pH 9.5 and 25°C.

“Ready to use” kit for asymmetric synthesis of chiral amines from ketones:

The kit contains seven diverse catalysts, co-factors and co-substrates, reaction buffer, the needed enzyme cascade for an equilibrium shift and a well described protocol to perform the asymmetric synthesis of (R)-amines in less than 10 easy-to-perform steps.

The “Ready to use” screening kit and more ATAs are available upon request.
Other enzymes

ECS-Aminoacylase 01 - Sus scrofa

(EC 3.5.1.14)

Properties: Catalyzes the deacylation of N-acylated L-amino acids
Optimum conditions: 37°C, pH 7-8

Examples:

Substrates hydrolyzed by ECS-Ac01.

Formulation: Lyophilized powder

Comment: For quality assurance ECS-Ac01 is tested against N-furylacryloyl-L-methionine as standard substrate at 30°C and pH 7.5.

Mutant ECS-Ac01-M1 with activity towards para-amino substituted benzoylamino acids is available.
Ordering information

For ordering please refer to the pricing information on page 4. To place an order, please contact us by phone or e-mail or fill in the fax form on the next page and fax it to +49 (0)3834-515-473.

For any further information or ordering of bulk quantities, please contact us by phone or e-mail.

We are looking forward to your request!
Order Form

To place an order please fill in this form and send it by mail or fax to:

**Enzymicals AG**
Walther-Rathenau-Straße 49a
D-17489 Greifswald
Germany

**Telephone:** +49 (0)3834-515-470
**Fax.:** +49 (0)3834-515-473
**e-mail:** info@enzymicals.com
**web:** www.enzymicals.com

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Terms and Conditions

§ 1 General

(1) These terms and conditions are the basis of all offers, supplies and services of Enzymicals AG. Conflicting or additional terms and conditions of the customer are denied. They will become part of a contract only if Enzymicals AG agreed to their inclusion in written form.

(2) These general terms and conditions have been built in the German language. Any English translation is made available for reading purposes only and the German version prevails in case of any discrepancies in the wording.

§ 2 Offer and capacity

(1) All offers of Enzymicals AG are non-binding and subject to change. The scopes of supplies or services are defined by the written order confirmation of Enzymicals AG. If none exist, the offer of Enzymicals AG is relevant.

(2) The supply of a product or contribution of a service by Enzymicals AG does not include any agreement for the use of intellectual property of Enzymicals, embodied or related to the product or service.

§ 3 Prices and terms of payment

(1) Prices of Enzymicals AG are non-binding and represent only net ex-work values, excluding packing, shipping or transport, customs duty, taxes and insurance expenses (Incoterm: EXW).

(2) If any supply is made on the basis of scheduled prices of Enzymicals AG and the delivery takes place more than three months after signing of the agreement the scheduled prices at the time of delivery are relevant.

(3) In case of increase of costs, Enzymicals AG reserve a proportional addition to agreed prices. This also includes current orders.

(4) Invoices have to be paid within 14 days starting from the date of issue.

(5) After this mentioned time limit a delay of payment accrues. During the delay of payment the full debt is charged with interests at the legal interest-rate for delay of payment. We are entitled to charge a higher damage caused by the delay.

(6) In case of delay of payment of more than 30 days or of more than 5,000.00 €, cessation of payment or in case of a known substantial debasement of the economic situation of the customer, which might compromise the pecuniary claim of Enzymicals AG we are entitled to request immediate payment, return of already adduced services, to request advance payments or to retain outstanding supplies.

(7) Credits are given exclusively for compensations. A claim on reimbursement does not exist.

(8) Enzymicals is not obliged to accept drafts.

(9) The exchange rates at date of invoicing are relevant if payments are made in other currencies than EURO.

(10) Payments are considered as complete on the day at which Enzymicals AG received the invoiced amount.
(11) The customer shall have no right to set-off counterclaims and the retention of payments, except counterclaim has not been disputed or been determined by a final and binding decision.

§ 4 Reservation of title

(1) Enzymicals AG retains legal title to any good or service supplied by us until current or future accounts for such product has been fully paid.

(2) The customer is not be entitled to pledge or to transfer for security reasons any good or service supplied by Enzymicals AG which is under retention of title. The customer has to inform us in written form immediately if any third party occupies our goods.

(3) In case of breach of contract by the customer, in particular nonpayment, we are entitled to terminate the contract by law and to demand our goods or services due to our retention of title. In the case of nonpayment we are not entitled before the customer failed to pay within a given time limit, except a time limit is legally expendable.

(4) The customer is entitled to resell and/or manufacture products delivered by us which are under retention of title in the ordinary course of its business. In that case the following rules apply:
   a) The retention of title comprises also the goods originated by manufacture, mixture or combination in the full amount. Enzymicals will be seen as the producer. If in that case any title of a third party remains, we acquire co-property in the equal ratio as the value of the manufactured, mixed or combined goods. Apart from that we stipulate the same retention of title as for the originated goods.
   b) The customer hereby assigns to us any claims arising from any resale in the full amount or the ratio mentioned above for security reasons. We accept the assignment. The obligation mentioned in paragraph 4 (2) applies also for the assigned claims.
   c) The customer is authorized to assert the claims assigned to us. We commit ourselves not to assert the claim as long as no nonpayment occurs, no application for insolvency proceedings were made or none other fault of financial capacity occurs. If any of the latter applies the customer is obliged to inform us about its debtors and to give us all information and documents to assert the claims. In that case the customer is also obliged to inform his debtors about the assignment.
   d) If the value of our securities exceeds the amount of our claims by more than 10% we resign on securities in our own choice if the customer demands.

§ 5 Period of time for deliveries or services

(1) Indicated delivery times, starting from the confirmation date of order, are non-binding, unless a fixed period or a fixed date is given in a quote or agreed in a specific contract.

(2) Terms for delivery and dates of delivery refer to the time of delivery by the third party who is in charge of transport if a shipment was agreed in a contract.

(3) Delays by circumstances which Enzymicals AG is not responsible for (force majeure, unpredictable obstacles, delay through no fault by a preliminary distributor) do not qualify for compensation.
(4) In case of framework agreements the obligation of Enzymicals AG to supply expires if the customer does not perform requests in agreed periods and quantities. Enzymicals AG is still authorized to request the takeover of goods or to claim compensation, even after expiration of the agreed period of time.

(5) If Enzymicals AG delays with a supply or service, or a supply and a service becomes unfeasible, for any reason ever, then the liability of Enzymicals AG is limited to the compensation stated in § 9 of the present terms and condition.

§ 6 Transfer of risk

(1) The delivery takes place at the risk of the customer. The risk shall pass to customer as soon as the delivery has left Enzymicals AG registered place of business.

(2) If the delivery is delayed due to circumstances, which the customer is responsible for, the risk passes over to the customer from the day of readiness of the shipment completion. Enzymicals AG is willing to insure the shipment at the expense of the customer if requested by the customer.

§ 7 Shipping, packing, commercial sample

(1) Shipment is carried out via a transport company of our choice.

(2) The packing is calculated at lowest prices and will not be taken back.

(3) In case of abandonment of commercial samples by Enzymicals AG to the customer, the customer is obligated to use these samples exclusively for internal evaluation and/or test purposes. A commercial utilization or use is prohibited. In particular the customer does not have the right to sell and/or distribute these samples to third parties.

§ 8 Receipt

(1) The customer is obligated to accept contractual goods.

(2) Enzymicals AG is authorized to withdraw from the contract and/or to request compensations or to supply a similar type of products in an appropriate delivery time to agreed conditions, after setting an extension time limit of 14 days, if the customer comes into delay with receipt of goods. Any additional arising expenses are charged to the customer.

(3) The customer/recipient is committed to examine contents of shipments immediately for transport or other damages and to get possible damage confirmed, to ensure any claims.

(4) Aberrations in order quantities of up to 5% have to be accepted.

(5) Returns will only be accepted by Enzymicals AG on request with the delivery number given by Enzymicals AG.

(6) Partial deliveries are allowed, unless agreed otherwise.

§ 9 Liability

(1) Periods of time are relevant as specified in offers or catalogs or other media.
(2) The liability of Enzymicals AG on compensation is limited as follows:
   a) For damages of property up to 100,000 EURO per damaging event, but not exceeding a total amount of up to 300,000 EURO per contract;
   b) The liability for financial loss is limited to a total amount of up to 300,000 EURO per contract;
   c) claims for lost profits are excluded.
(3) If Enzymicals AG provides technical information or acts consultative and these information and consulting services are not defined in a contract in a written form, this is done without charge and without any liability of Enzymicals AG.
(4) Liability of Enzymicals AG is excluded if damages result from improper handling, particularly incorrect storage, and/or application of supplied goods and products in household and/or at humans and animals.
(5) Liability for material defects does not refer to natural wear and tear or to damage resulting from improper use.
(6) Any other claims such as conversion, reduction, reimbursement of damages as well as payments of contractual penalties are excluded except for obligatory subject to provisions of Product Liability Act.

§ 10 Warranty

(1) The warranty depends on a promptly upon delivery inspection to the product by the costumer with due care. The delivered product shall be deemed to be approved by the costumer unless the defect is notified to us in (i) case of any obvious defects within a period of one week upon delivery or otherwise (ii) within a week from the day when the defect has been identified. It is adequate to keep the term to send off the notice timely. If the customer misses this time limit our warranty is excluded in relation to the non-notified defect.
(2) Enzymicals AG assumes no liability for any statements of manufacturers or third parties (e.g. advertising statements).
(3) In general the warranty period is 12 months starting from the date of delivery.
(4) In case stability or minimum durability for an object of agreement shorter than 12 months is pointed out in a contract, warranty is only effective for the stated stability period or minimum durability period.
(5) The customer has to give an opportunity to Enzymicals AG to examine the object of agreement if the customer claims a material defect.
(6) Enzymicals AG will correct defects of products or services supplied by Enzymicals AG briefly or will provide a replacement, by Enzymicals AGs own choice. Contribution claims exist only to the legal extent.
(7) In case of products, which Enzymicals AG sells as a distributor, warranty conditions of the manufacturer are legally binding.

§ 11 Copyrights and related rights

(1) All documents of Enzymicals AG handed out to the customer by Enzymicals AG subject to the copyright of Enzymicals AG.
(2) Products supplied by Enzymicals AG are protected by intellectual properties by Enzymicals AG.
(3) The customer is only allowed to use goods/products, cost estimates, charts and other documents for the purpose according to the agreement. Any exceeding transfer to third parties or any other type of use, especially for reconstruction, is allowed only with a prior agreement of Enzymicals AG.
(4) Specified conditions for research results are offered separately in written form.
(5) An evaluation or a publication of an existing business relationship with Enzymicals AG is permissible only with prior agreement of Enzymicals AG.

§ 12 Intended purpose

(1) It is explicitly pointed out that all products of Enzymicals AG are intended exclusively for laboratory, research and industrial applications, and must not be used for application at/with humans and animals.
(2) It is explicitly pointed out that the absence of a hazard label does not imply that the concerning product is harmless. The customer has to consider national or international laws or regulations or property rights of third parties for a certain product, including shipping, storage, processing or trading.
(3) The customer is obligated to exempt Enzymicals AG from requirements of any kind of third parties for any reason caused by the customer, in particular acting unlawfully or incorrectly, application without necessary permission, infringe application against this general terms and conditions or any improper handling.
(4) The indemnification includes also legal costs (e.g. court fees and lawyer’s fees).

§ 13 Place of performance, jurisdiction and commitment

(1) Place of performance and jurisdiction for all contracts is the place of business of Enzymicals AG in Greifswald.
(2) The law of the Federal Republic of Germany is legally binding only.
(3) Contract language is German.