Enzymatica - Transforming Chemistry...

IMMOBILIZED ENZYMES & BIOCATALYSIS TECHNOLOGIES
BIOCATALYSIS CREATES GREEN CHEMISTRY

About us:
Fermenta Biotech Ltd. (FBL), founded in 1986, is a pioneer in immobilized enzyme technology with the mission to contribute to the emerging transformation of Biocatalysis. The company's objective is to identify, validate, patent and commercialize enzyme based technologies for green manufacturing. The enzyme manufacturing unit in Kullu and the DBT approved R&D facility in Thane have consistently developed and sustained FBL’s leadership in providing advanced enzyme technologies.

Products:
Variants of Penicillin G Amidase enzyme (E.C.3.5.1.11) and Candida antartica Lipase (CALB) enzyme (E.C. 3.1.1.3)  
Both type of enzymes serve as remarkable tools for biocatalysing specific organic reactions in aqueous / suspension / solvent phase providing benefits such as high specificity, mechanical stability, recyclability and reduced chemical production. CALB lipase finds widescale application in Green Fuels and Chiral Chemistry.
A. **PENICILLIN G AMIDASE - BIOCATALYST - (FERMASE PA 850)**

*Enzyme Code:* E.C.3.5.1.11 / CAS No. 9014-06-6  
*Source:* *E. coli*

For biocatalytic hydrolysis of amide bonds for β-lactam intermediates

**REACTION SCHEMATICS**

- Penicillin G Potassium Salt (PenG) → 6-Amino Penicillanic Acid (6-APA)
- Cephalosporin G (CephG) → 7-Amino Deacetoxy Cephalosphoronic Acid (7-ADCA)

- High operational stability of product
- High yield
- Short reaction time
- Simple recovery process
- Consistent performance

B. **PENICILLIN G AMIDASE BIOCATALYST (FERMASE PS 250)**

*Enzyme Code:* E.C.3.5.1.11 / CAS No. 9014-06-6  
*Source:* *Achromobacter* CCM 4824

For biocatalytic synthesis of β-lactam antibiotics (Amoxicillin / Ampicillin)

**REACTION SCHEMATICS**

**Enzymatic Amoxicillin**

- 6-Amino Penicillanic Acid (6-APA) + D-Hydroxy Phenylglycine Methyl Ester Hydrochloride (HPGM.HCl) → Amoxicillin.3H₂O

**Enzymatic Ampicillin**

- 6-Amino Penicillanic Acid (6-APA) + D-Phenylglycine Methyl Ester Hydrochloride (PGM.HCl) → Ampicillin.3H₂O
- Suitable in suspension reaction
- High conversion & yield
- Totally aqueous phase reaction
- Easy product recovery

**Diagram:**

- **Penicillin G (Pen G)**
  - PA850
  - ENZYME
  - 6-Amino Penicillanic Acid (6-APA)
    - ENZYME
    - PS250
    - AMOXICILLIN
    - AMPICILLIN

**Chemical Structures:**

- 7-Amino Desacetoxy Cephalosporanic Acid (7-ADCA)
- D-Phenylglycine Methyl Ester Hydrochloride (PGM.HCl)
- Cefalexin Monohydrate
C. CANDIDA ANTARCTICA LIPASE B

**Enzyme Code:** E.C.3.1.1.3 / CAS No. 9001-62-1
- Candida antarctica lipase B (CALB) expressed in GRAS Strains
- Available as liquid and immobilized Biocatalyst
- Immobilized biocatalyst on varied epoxy and adsorbent supports which offer different specificity and stability

**PRODUCT VERSIONS:**

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Form</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOCATALYST CALB 1L - 10L</td>
<td>Liquid</td>
<td>NLT 1000 - 10000 TBU/mL</td>
</tr>
<tr>
<td>BIOCATALYST CALB 10L</td>
<td>Liquid</td>
<td>NLT 10000 TBU/mL</td>
</tr>
<tr>
<td>BIOCATALYST CALB, 10000</td>
<td>Immobilized</td>
<td>NLT 10000 PLU/g</td>
</tr>
<tr>
<td>BIOCATALYST CALB 1000 - 5000</td>
<td>Immobilized</td>
<td>NLT 1000 - 5000 PLU/g</td>
</tr>
</tbody>
</table>
APPLICATIONS:

- **PHARMACEUTICALS**
- **COSMETICS & PERSONAL CARE**
- **LEATHER**
- **FOOD & OIL**

**CALB**

- Desymmetrization of Complex drug intermediates
- Modifications of Sugars & related compounds
- Resolution of Chiral alcohols & amines
- Ring opening of β-lactams

Examples:

**Biodiesel synthesis**

\[
\begin{align*}
\text{Triglyceride (Fat or Oil)} & \quad \text{Alcohol (methanol)} \\
\text{CH}_2\text{O} & \quad \text{H}_2\text{C-OH} \\
\text{HC-} & \quad \text{HC-OH} \\
\text{CH}_2\text{O} & \quad \text{H}_2\text{OH} \\
\text{CR}_2 & \quad \text{CR}_3
\end{align*}
\]

\[ \text{CALB} \quad + \quad 3 \text{CH}_3\text{OH} \quad \rightarrow \quad \text{CH}_3\text{O-COR}_1 \quad + \quad \text{H}_2\text{C-OH} \]

Biodiesel (methyl esters)
Glycerol

For Pregabalin by enzymatic kinetic resolution of a cyano-diester

\[ \text{CALB} \quad \rightarrow \quad \text{EtO}_2\text{C} \quad \text{CN} \quad \rightarrow \quad \text{K}_2\text{OEt} \quad \text{CN} \quad \text{EtO}_2\text{C} \]

\[ \text{Ni Raney} \quad \text{H}_2 \quad \rightarrow \quad \text{HO}_2\text{C} \quad \text{NH} \quad \rightarrow \quad \text{HCl, H}_2\text{O} \quad \text{Pregabalin} \]

**Enantioselective acylation of racemic Propranolol**

\[ \text{R/S Propranolol} + \text{Vinyl Acetate} \quad \text{CALB} \quad \text{Toluene} \quad \rightarrow \quad \text{S-Propranolol} \]
For chiral alcohol

Esterification of fatty acids (e.g., Myristic acid) with fatty alcohols (e.g., Myristyl alcohol) catalyzed by immobilized CALB to produce wax esters (myristyl myristate).

\[
\text{H}_2\text{C} - \text{C} - \text{O} - \text{OH} + \text{H}_2\text{C} - \text{C} - \text{OH} \xrightarrow{\text{Immobilized CALB}} \text{H}_2\text{C} - \text{C} - \text{C} - \text{O} + \text{H}_2\text{O}
\]

Synthesis of FAME (Fatty Acid Methyl Ester)

Triacylglycerol (oil) + 3 x MeOH \xrightarrow{\text{CALB}} \text{Glycerol} + \text{Fatty Acid Methyl Ester (FAME)}

Epoxy resin \xrightarrow{\text{Enzyme}} \text{Covalently immobilized enzyme}