

# Biosynthesis of Bio-friendly Polymers

# U.S. Wood, Paper and Hydrocarbons

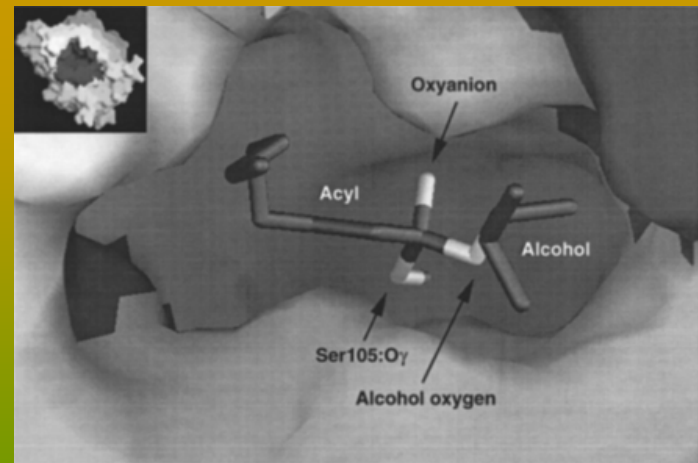
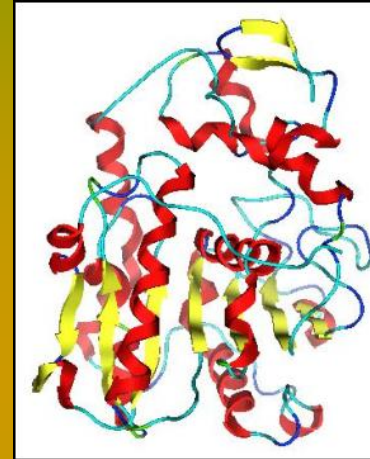
- U.S. forest product industry
  - 1.3 million employees
  - Estimated payroll of 50 billion dollars
- U.S. imports of paper and wood products have increased
  - Closure of 350 paper and wood mills (1995-2005)
  - Loss of more than 150,000 jobs
- 2005 oil consumption 20.8 million barrels/day
- Imported hydrocarbons make of 59% total consumption
  - 20% result in plastics and chemical building blocks

# Biocatalysts in Organic Chemistry

- Advantages of Biocatalysts
  - Mild reaction conditions
  - High stereoselectivity
  - Do not require co-factors
  - Catalysts recyclability
  - Avoid organic solvents and toxic catalysts
- Common Biocatalysts
  - Lipases (i.e. *Candida antartica*, *Psuedomonas cepacia*, etc.)

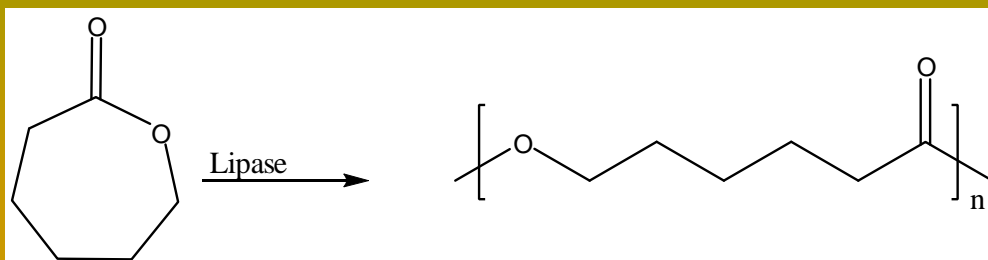
# *Candida antarctica* lipase B

- Isolated in 1990
- 33 kDa
- 2 binding sites
  - Acyl-binding site
  - Alcohol binding site
- Member of Serine Hydrolase class
- Catalytic ability up to 130°C

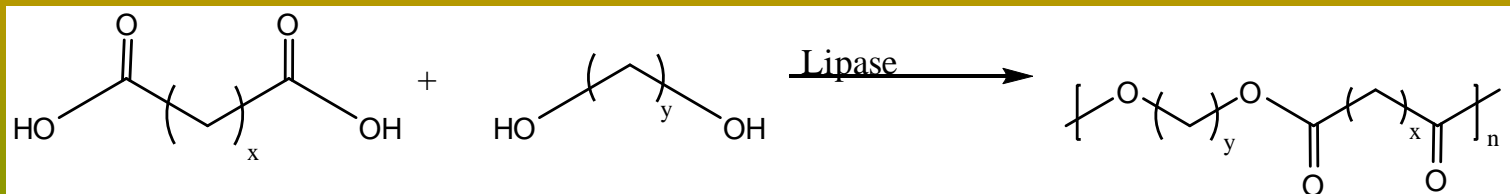


# CALB catalyzed Polymerization Reactions

Ring-opening polymerization of lactones, carbonates, depsipeptides, etc.



Esterification and Transesterifications

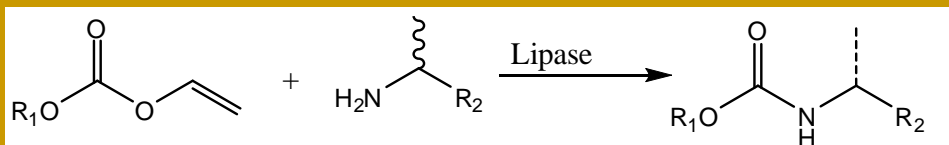


# CALB catalyzed Bond Formation

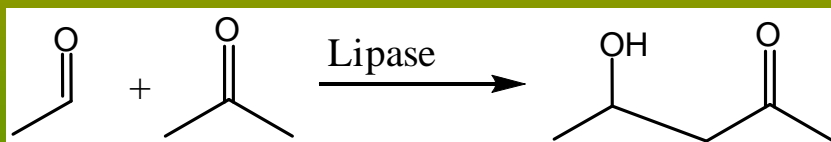
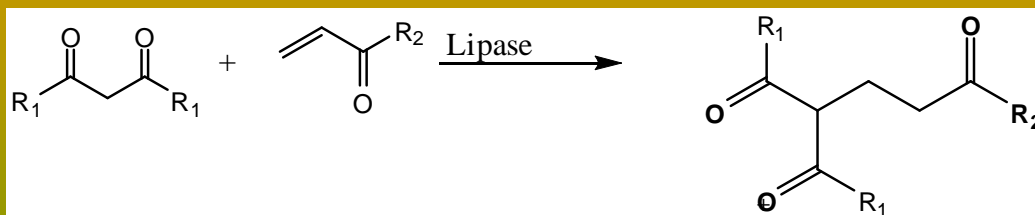
Amide Bonds: Aminolysis and Ammonolysis of esters



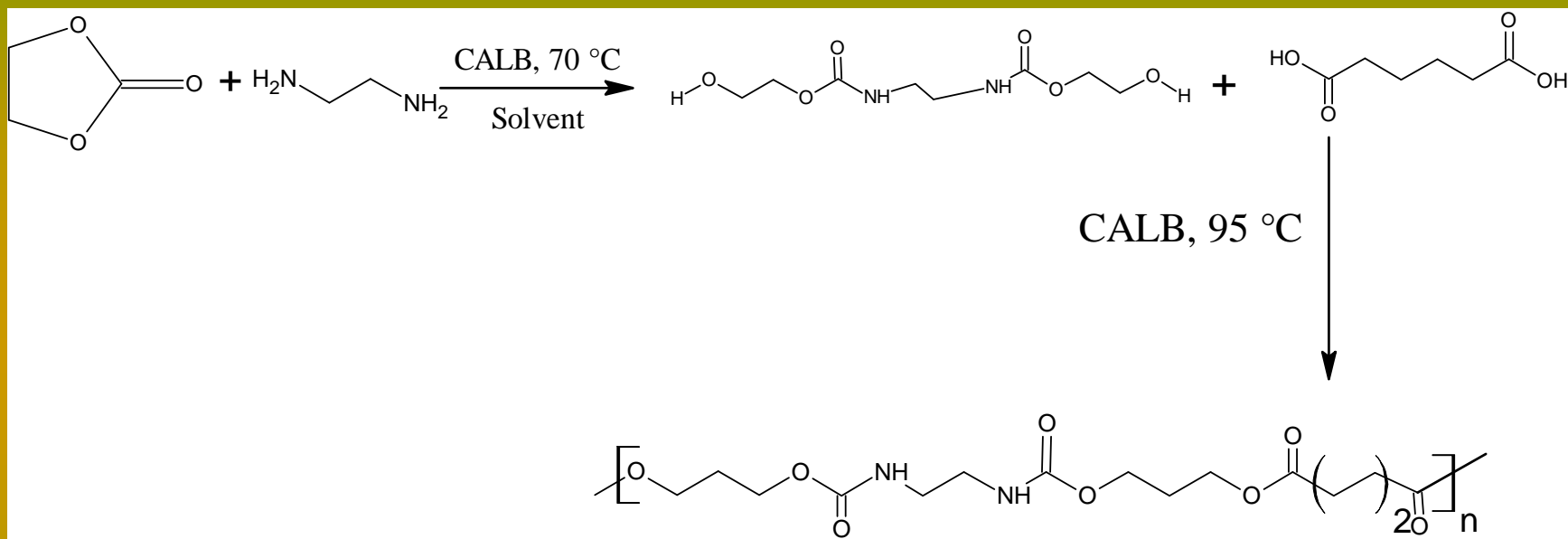
Carbamate Bonds: Alkoxycarbonylation of vinyl carbonates



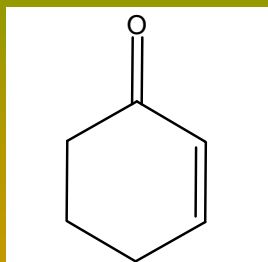
Carbon-Carbon bonds: Michael additions and Aldol reactions



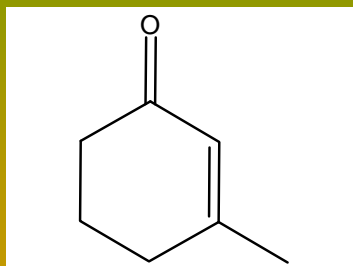
# More Possibilities



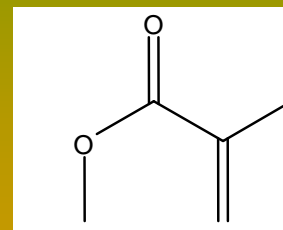
# Michael Acceptors



2-cyclohexen-1-one

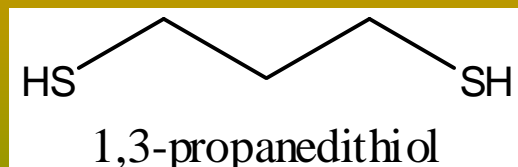


3-methylcyclohex-2-enone

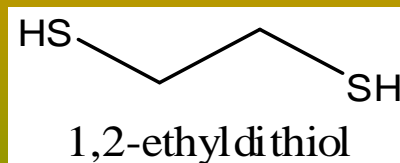


Methyl methacrylate

# Michael Donors



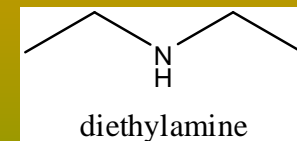
1,3-propanedithiol



1,2-ethanedithiol



1-butanethiol



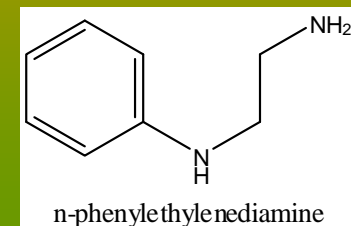
diethylamine



1,5-pentanedithiol



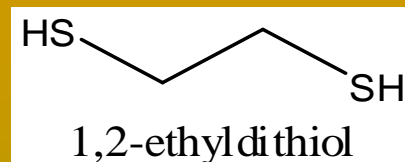
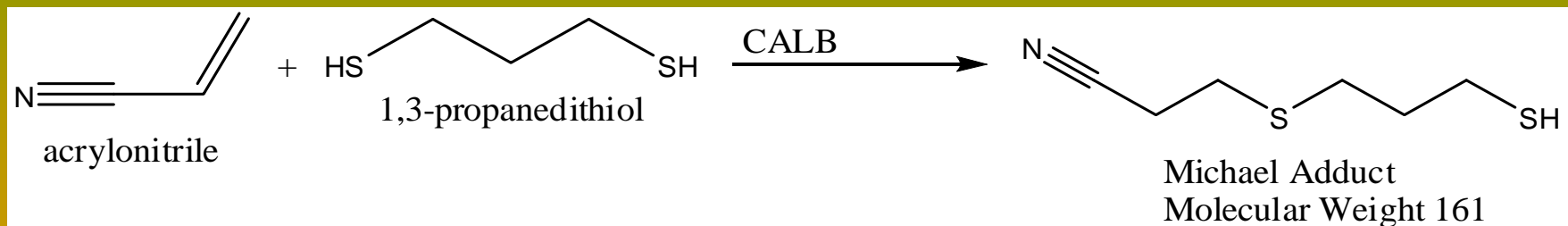
1-pentanethiol



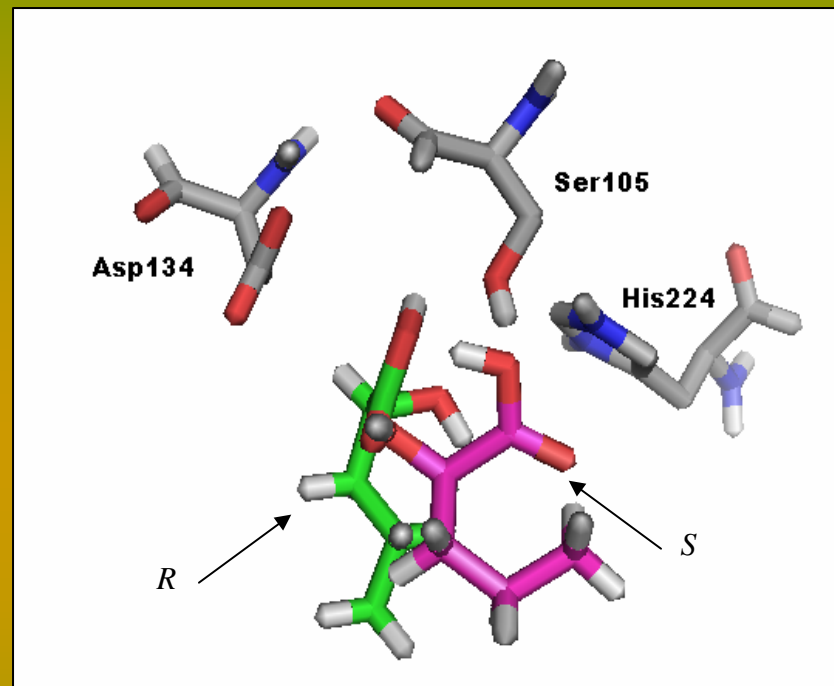
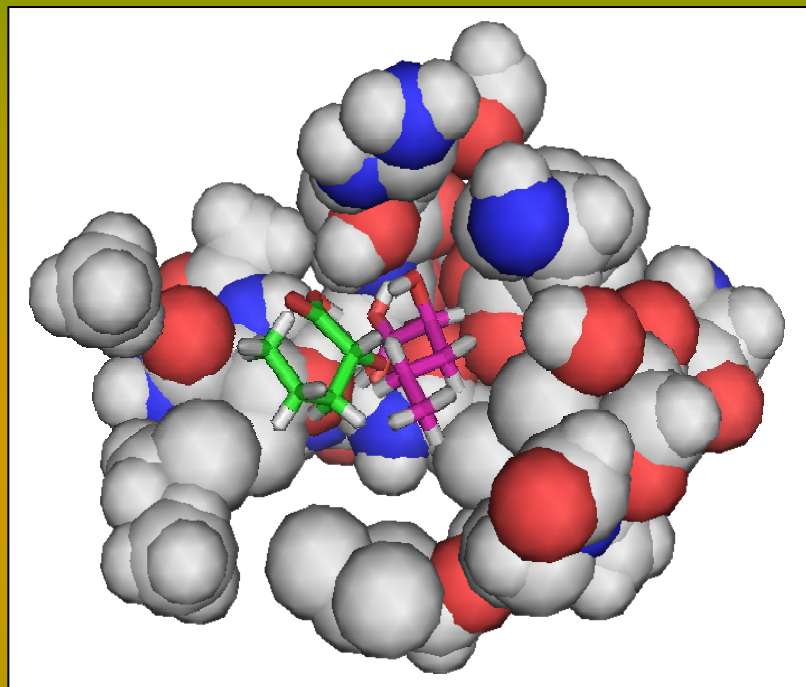
n-phenylethylenediamine



# Current Investigations

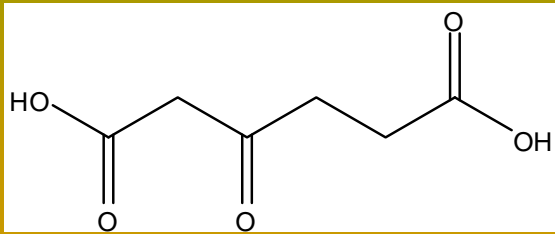


# Molecular Operating Environment

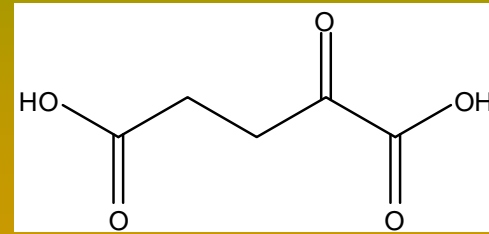


*(S)*- $\alpha$ -hydroxy valeric acid preferred by CALB

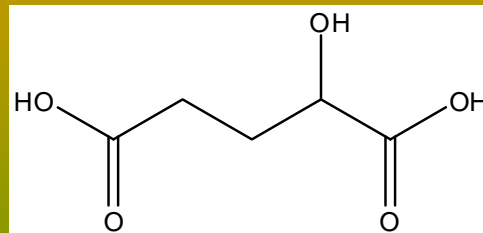
# Renewable Feedstocks



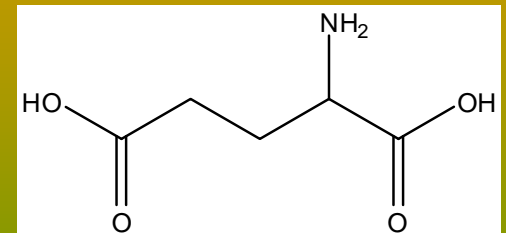
$\beta$ - ketoadipic acid



$\beta$ -ketoglutaric acid



2-hydroxyglutaric acid



Glutamate

# Acknowledgments

- NSF
- Georgia Institute of Technology
- Dr. Sheldon May and Group
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