# L3 Enzyme application continued

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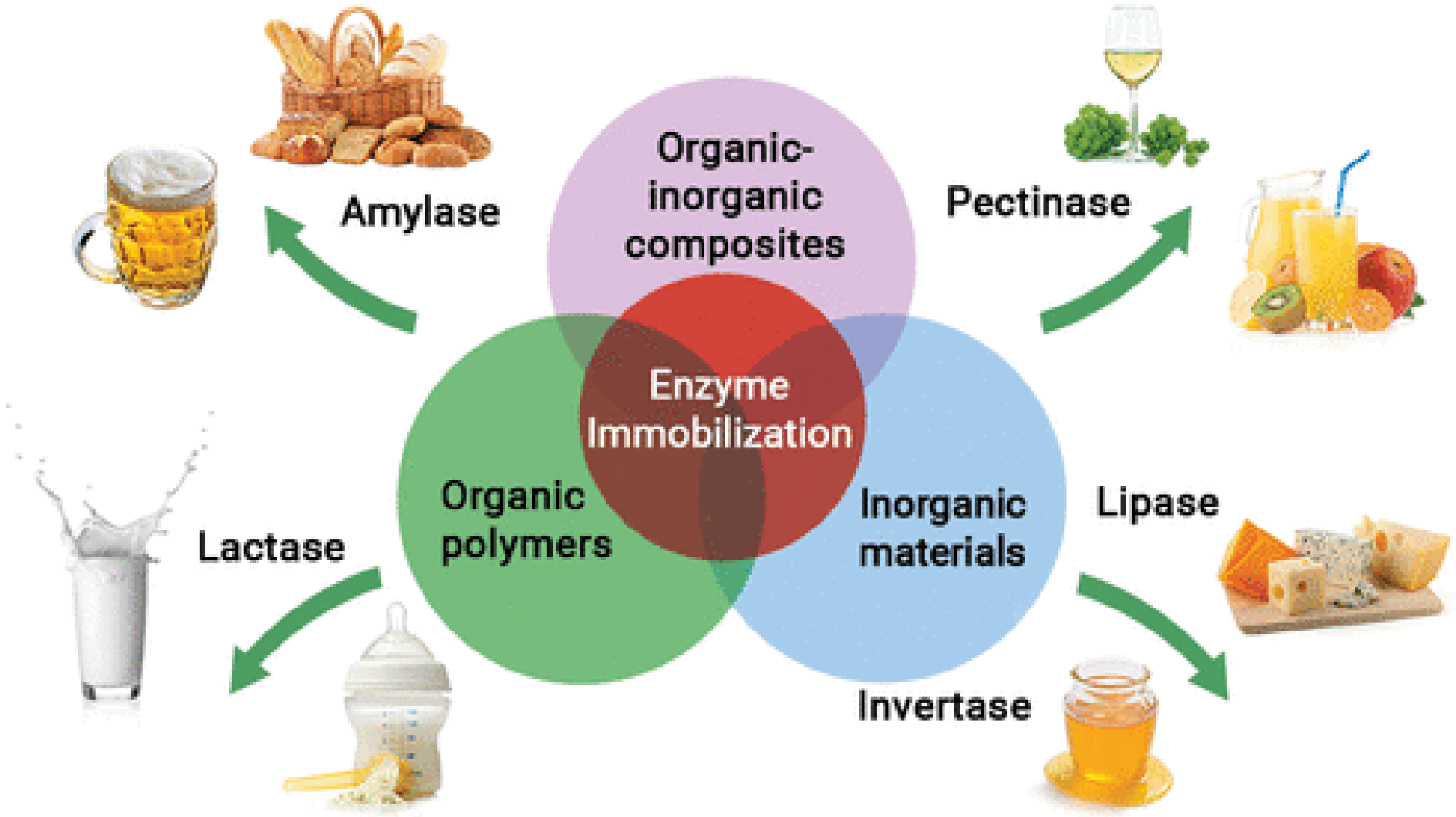
# Enzyme application in food industry

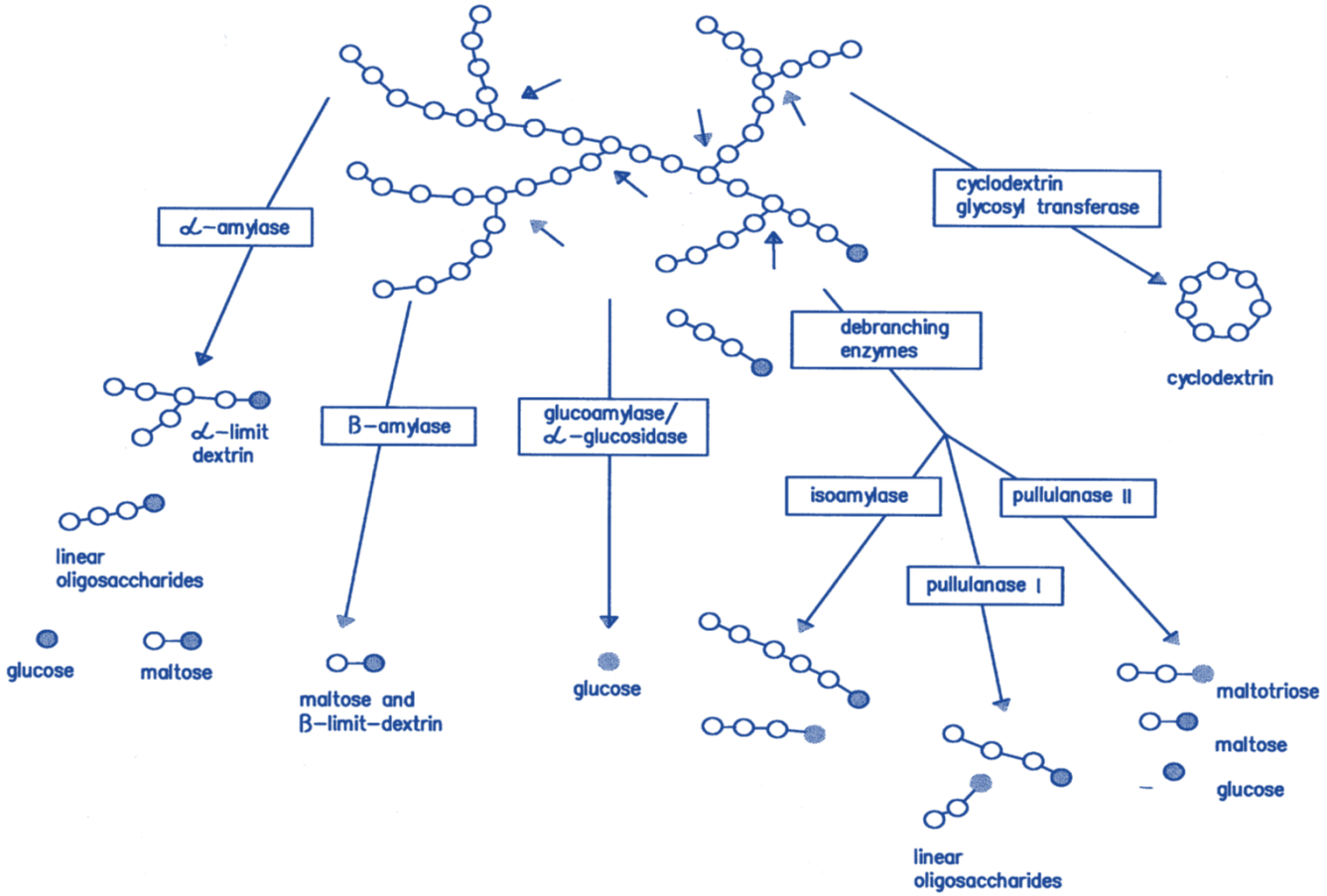


# Enzyme application in food industry

| Application Fields of Food rocessing | Enzymes | Technical Benefits |
|---|---|---|
| Dairy Industry | Chymosin, lipases, lysozymes | Cheese manufacturing. |
| | β-galactosidase, lactases | Breaking down lactose to glucose and galactose in milk processing to avoid lactose intolerance. |
| | lactoperoxidase | Cold sterilisation of milk: milk replacers for calves |
| | Acid proteinases | Milk coagulation |
| | Neutral proteinases and peptidases | Accelerated cheese ripening; de-bittering; enzyme modified cheese; production of hypoallergenic milk-based foods |
| Baking Industry | α-amylases | Degrading starch in flours and controlling the volume and crumb structure of bread. |
| | β-xylanases | Improving dough handling and dough stability. |
| | Oxidoreductase | Giving increased gluten strength. |
| | Lipases | Improving stability of the gas cells in dough. |
| | Proteases | Reducing the protein in flour |

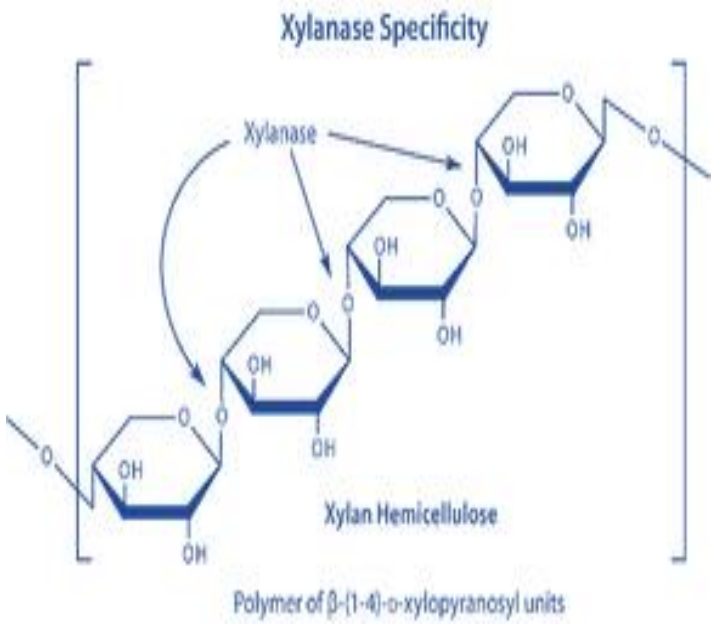
# Enzyme application in starch modification

1.Alpha-amylase: This enzyme breaks down the large, complex starch molecules into smaller, simpler sugars like glucose and maltose.
2.Glucoamylase: This enzyme specifically hydrolyzes the alpha-1,4-glucosidic linkages of starch, which convert the glucose and dextrins into glucose. Glucoamylase can be used to produce a high fructose syrup, glucose syrup and corn syrup.
3.Pullulanase: This enzyme breaks down the branches in amylopectin, a component of starch, and thus increases the availability of the glucose units.
4.Beta-amylase: This enzyme breaks down the starch by attacking the alpha-1,4 linkages, releasing maltose and dextrin as the main products. Beta-amylase is used in production of beer, malt syrups, and malted milk.
5.Debranching enzymes: these enzymes are a group of enzymes which include alpha-1,6-glucosidase and limit dextrinase.



# Enzyme application of Xylanase

Xylanase – preferred are those that act on the non-water soluble arabinoxylan fraction. It interferes with the formation of gluten network. Removal of not-extractable with water arabinoxylan fraction results in increase of high molecular weight solubilized in water arabinoxylans that in turns increase viscosity and dough stability; provide better crumb texture and increased loaf volume.

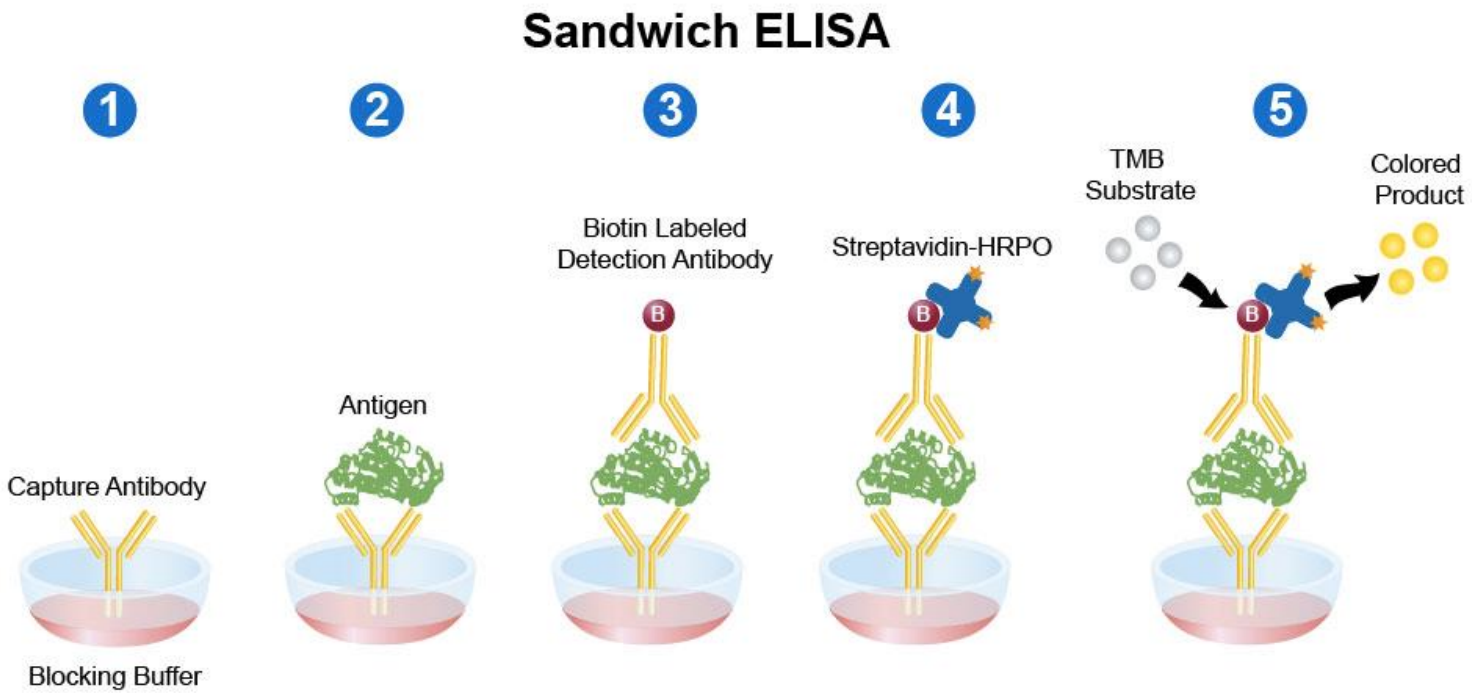



Increasing the efficiency of animal feed: Xylanase can also be added to animal feed to improve its nutritional value and increase the efficiency of animal growth. The enzyme breaks down the xylan in the feed, which makes the nutrients in the feed more accessible to the animals. This leads to faster growth rates and improved feed conversion efficiency.

Xylanase can be used to enhance the nutritional value of food products by breaking down the xylan and releasing the trapped nutrients.

Xylanase can be used to break down the xylan in plant-based materials, such as corn stalks, corn cobs, and wood chips, which are used to make bioethanol. This allows more of the starch in the material to be converted into ethanol, which results in more efficient and cost-effective bioethanol production.

# Enzyme application in analytical industry

# Enzymes as therapeutic agents

- Therapeutic enzymes have a broad variety of specific uses
  - Oncolytics
  - Anticoagulants
  - Thrombolytics
  - Replacements for metabolic deficiencies
    - Digestive aids
    - Metabolic storage disorders, etc
  - Miscellaneous enzymes of diverse function

| Enzyme | Reaction | Use |
|---|---|---|
| Asparaginase | L-Asparagine $H_2O$ → L-aspartate + $NH_3$ | Leukaemia |
| Collagenase | Collagen hydrolysis | Skin ulcers |
| Glutaminase | L-Glutamine $H_2O$ → L-glutamate + $NH_3$ | Leukaemia |
| Hyaluronidase a | Hyaluronate hydrolysis | Heart attack |
| Lysozyme | Bacterial cell wall hydrolysis | Antibiotic |
| Rhodanase b | $S_2O_3^{2-}$ + $CN^-$ → $SO_3^{2-}$ + $SCN^-$ | Cyanide poisoning |
| Ribonuclease | RNA hydrolysis | Antiviral |
| β-Lactamase | Penicillin → penicilloate | Penicillin allergy |
| Streptokinase c | Plasminogen → plasmin | Blood clots |
| Trypsin | Protein hydrolysis | Inflammation |
| Uricase d | Urate + $O_2$ → allantoin | Gout |
| Urokinase e | Plasminogen → plasmin | Blood clots |

# Enzyme application in medical treatments

Challenges of Using Enzymes in Medical Treatments

- Enzymes are too large to be enter many of the body's cells.
- Antigenic proteins elicit immune responses.
- Effective half-life in the circulatory system may be only a few minutes.
- Must be very pure and administered in very small concentrations.
- Must exhibit low Km and high Vmax to be maximally efficient at low concentrations.

Uricase is an enzyme that converts uric acid, which is a waste product of purine metabolism, into a more soluble form called allantoin. Uric acid can build up in the body and form crystals, which can deposit in joints and cause inflammation and pain, a condition known as gout.

# Advantages of Biocatalysis

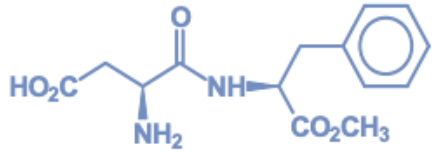
- Enzymes have a very good selectivity :

  Stereoselectivity – enantioselectivity in most cases are > 99 %

  Chemo- and regioselectivity – react on one location over another similar group without the need for protection groups.
- Mild reaction conditions:

  aqueous solvent, room temperature, normal pressure, neutral pH
- Environmentally friendly: enzymes are biodegradable
- Fewer side reactions
- High efficiency
- Cheap and simple starting material can be used.

- Overall lower cost of production.



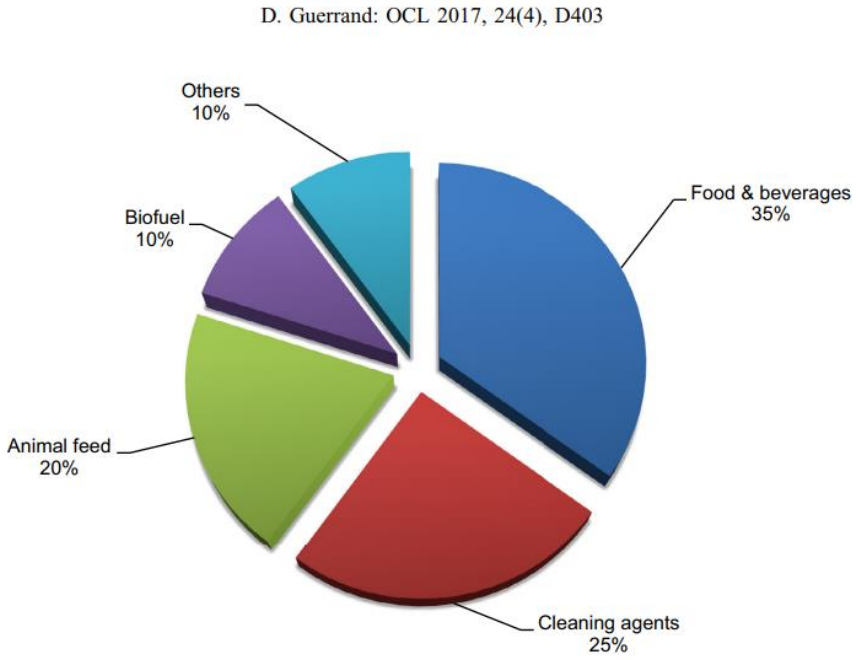

Aspartame (200)

**Table 1 Enzymes commonly used in organic synthesis**

| Enzymes | Reactions |
|---|---|
| Esterase, lipases | Ester hydrolysis, formation |
| Amidases (proteases, acylases) | Amide hydrolysis, formation |
| Dehydrogenases | Oxidoreduction of alcohols and ketones |
| Oxidases (mono- and dioxygenases) | Oxidation |
| Peroxidases | Oxidation, epoxidation, halohydration |
| Kinases | Phosphorylation (ATP-dependent) |
| Aldolases, transketolases | Aldol reaction (C–C bond) |
| Glycosidases, glycosyltransferases | Glycosidic bond formation |
| Phosphorylases, phosphatases | Formation and hydrolysis of phosphate |
| Sulphotransferases | Formation of sulphate esters |
| Transaminases | Amino acid synthesis (C–N bond) |
| Hydrolases | Hydrolysis |
| Isomerases, lyases, hydratases | Isomerization, addition, elimination, replacement |

# Enzyme application of Lipase enzyme

1.Food industry: Lipases are used in the production of various types of food, such as cheeses, chocolate, and flavors.
2.Biofuel production: Lipase enzymes can be used to break down vegetable oils and animal fats into fatty acids, which can then be converted into biodiesel.
3.Detergent industry: Lipases are used in laundry detergents to help remove stains from clothes by breaking down the fats and oils that make up the stains.
4.Pharmaceutical industry: Lipases are used in the production of certain drugs, such as oral lipid-based formulations, which are designed to improve the solubility and bioavailability of drugs.
5.Biotechnology: Lipases are used in various biotechnology applications such as the synthesis of natural and non-natural fatty acids and in the production of biodegradable plastics.

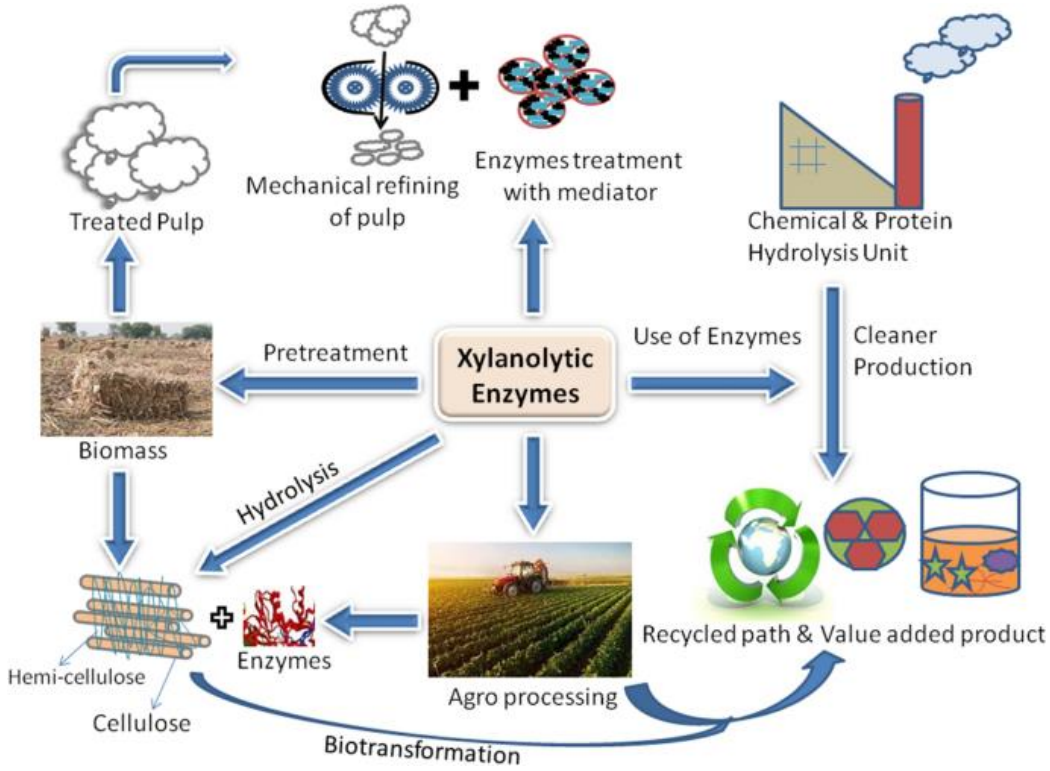



6. Cosmetic Industry: Lipases are used in the production of certain cosmetics, particularly in moisturizers and emollients that are used to hydrate and soften the skin.
7. Waste water treatment: Lipases are also used in the treatment of oily waste-water by breaking down oils and fats present in the waste-water and converting them into smaller molecules that can be more easily removed.

# Enzyme application in paper industry

One major application of enzymes in the pulp and paper industry is in the production of paper from wood fibers. The fibers in wood are bound together by lignin, a complex polymer that is difficult to break down. Enzymes known as **laccases** and **manganese peroxidase** can be used to break down lignin, making the fibers easier to process and resulting in a stronger, whiter, and brighter paper.

Another application of enzymes in the pulp and paper industry is in the recycling of paper. Enzymes like **cellulases and xylanases** are used to break down the fibers in recycled paper, making it possible to recycle paper more efficiently and reduce the need for virgin fibers.




Enzymes are also used to improve the efficiency of the bleaching process, which is used to remove lignin and other impurities from the fibers. Enzymes like **peroxidases, laccases and lignin peroxidases** can be used to reduce the amount of chlorine or chlorine compounds needed in the bleaching process, reducing the environmental impact and production costs.