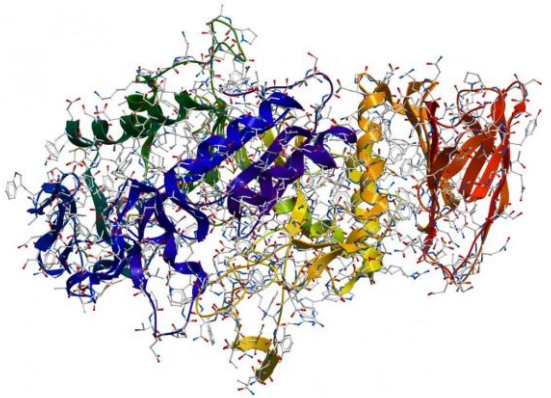


CEN-CHE 422
ENZYME ENGINEERING

ENZYMES AND ENZYME CATALYTIC REACTIONS

- **Enzyme ⇨ Bio(catalyst)**

  (Catalysts accelerate chemical reaction rates

  (Not being altered or consumed during reactions/remain unchanged/reusable)

  Enzymes increase the rate of chemical reactions taking place within living cells without suffering any overall change

- **Enzymes are proteins that have catalytic property**
- **Enzymes have important roles in the synthesis and degradation reactions that occur in living cells**
- **Enzymes are very effective catalysts and have advantages over chemical catalysts**
- **Over 2,000 known enzymes**
- **Further developments continue for industrial processes, consumer goods, biosensors, medical treatments, etc.**

A BRIEF HISTORY OF ENZYMES

1833: **The active agent breaking down the sugar was partially isolated and given the name *diastase* (now known as *amylase*).**

A little later, a substance which digested dietary protein was extracted from gastric juice and called *pepsin*

ferment

Liebig recognized that these ferments could be non-living materials obtained from living cells

But, Pasteur and others still maintained that ferments must contain living materials

1878: **The term ferment was replaced by the name *enzyme*, which comes from Greek *enzume* (meaning in yeast)**

1897: **It was showed that sugar fermentation could take place when a yeast cell extract was added even though no living cells were present**

1926: **Sumner crystallized *urease* from Jack-bean extracts**

In the next few years *many other enzymes* were purified and crystallized

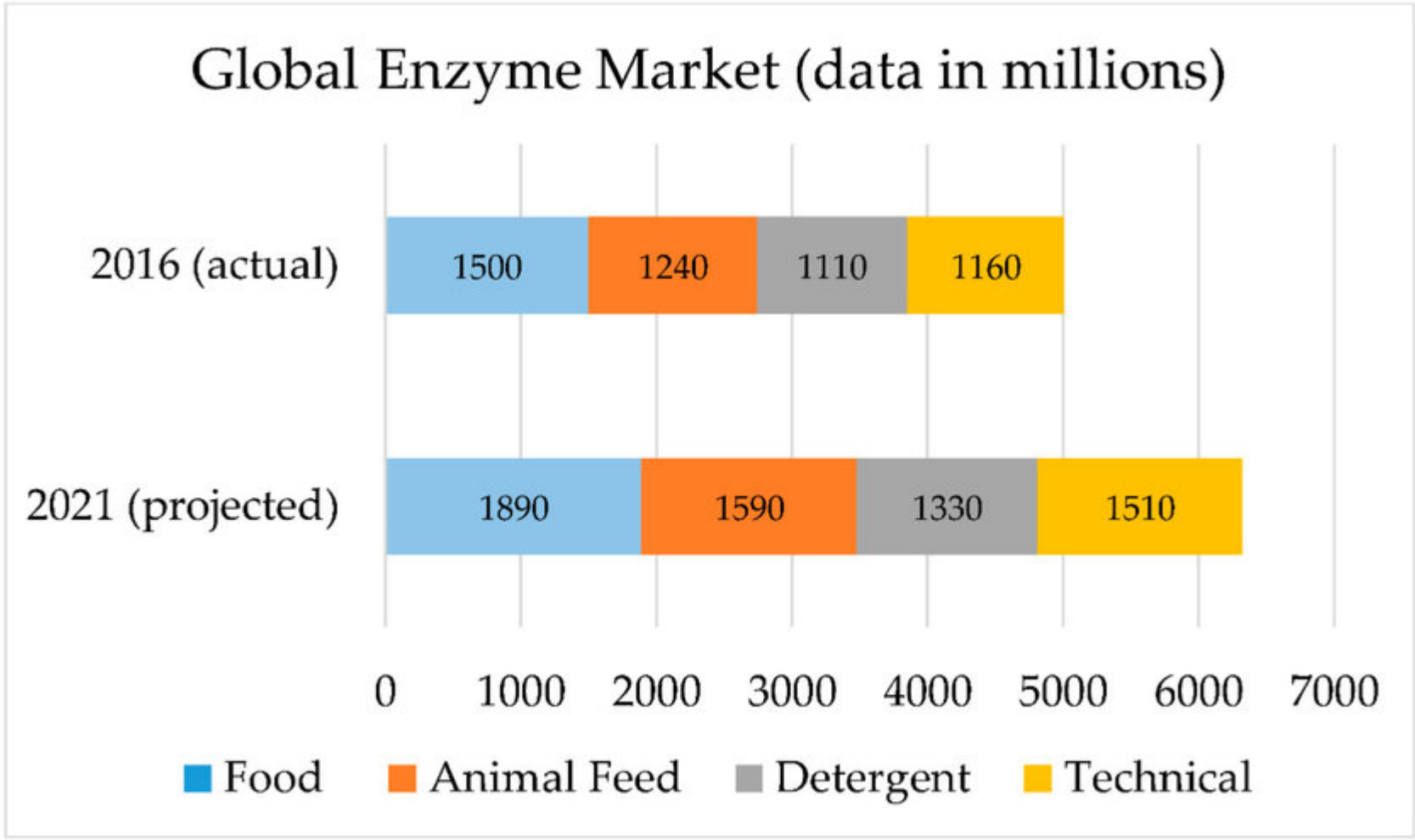
Today, enzymes are among the major subjects of academic and industrial research.

Uses of Enzymes in Industry

Enzyme	Source	Application
Amylase	*Bacillus subtilis, Aspergillus niger*	**Starch hydrolysis, glucose production, brewing, baking**
Glucoamylase	*A.niger, Rhizopus niveus, Endomycopsis*	**Saccarification of starch, glucose production**
Tyripsin	Animal pancreas	**Meat tenderizer, bee haze removal**
Papain	Papaya	**Digestive aid, meat tenderizer, medical applications**
Pepsin	Animal stomach	**Digestive and meat tenderizer**
Rennet	Calf stomach	**Cheese manufcturing**
Glucose isomerase	*Flovabacterium arborescens, Bacillus coagulans, Lactobacillus brevis*	**Isomeriation of glucose to fructose (high fructose syrup)**
Protease	**Bacteria**	**Detergent, leather, cosmetics, chesse, beer**

Penicilinase	*B.subtilis*	**Cleavege of penicilline**
Glucose oxydase	*A.niger*	**Gluconic acid production from glucose**
Lipase	*Rhizopus, pankreaz*	**Lipid hydrolysis, flavoring, digestive aid, detergent, cosmetics**
Invertase	*S.cerevisase*	**Sucrose hydrolysis**
Oectinase	*A.oryzae*	**Clarification of fruit juices, hydrolysis of pectin, brewing**
Cellulase	*Trichoderma viride*	**Cellulose hydrolysis, detergent, feed**

https://www.alliedmarketresearch.com/enzymes-market



https://www.researchgate.net/figure/Global-enzyme-market-in-2016-top-and-projected-global-enzyme-market-in-2021-bottom_fig1_325586140

Proteases are important industrial enzymes that hydrolyze proteins into smaller peptide units

Industrial proteases are obtained from bacteria (*Bacillus*), molds (*Aspergillus, Rhizopu* and *Mucor*), animal pancreas and plants

Proteases are used in cheese making (rennet**), bread making, meat tenderizing (**papain, trypsin**) and food processing; in yeast industry (**trypsin, pepsin**); in detergent industry (**subtilisin carlsberg**) for removing protein stains**

It is used in leather tanning and in medical treatment of wounds.

Pectinases are mainly produced from *A.niger.* Its main components are pectin esterase, polygalacturanase and polymethylgalacturonatelysae.

Pectinases are used in juice processing and wine making to increase juice yield, reduce viscosity, and clean.

Lipases hydrolyze lipids (fatty acid esters) to fat and glycerol and are obtained from animal pancreas, some molds and yeasts

Lipases are used in the hydrolysis of oils for the soap industry and in the hydrolysis of lipid-oil components in wastewater

Interesterification of fats and oils can also be catalyzed by lipase (biodiesel manufacturing**)**

Lipases are also used in the cheese and butter industry to give odors as a result of hydrolysis of fats.

Detergents are an important area of the use of lipases.

Amylases are used in the hydrolysis of starch and are produced from many microorganisms such as *A.niger* and *B.subtilis*. The three main types of amylases are α-amylase, β-amylase and glucoamylase.

α-Amylase dissolves amylose by randomly cleaving the α-1,4 bonds on the amylose chain. For this reason, α-amylase is known as the enzyme that liquefies starch.

β-Amylase cleaves β-1,4 glucosidic bonds at the non-reduced ends of amylose to form maltose residues.

The α-1,6 glucosidic bonds in the amylopectin fraction of starch are cleaved by glucoamylase