2007
Volume 2
Number 3

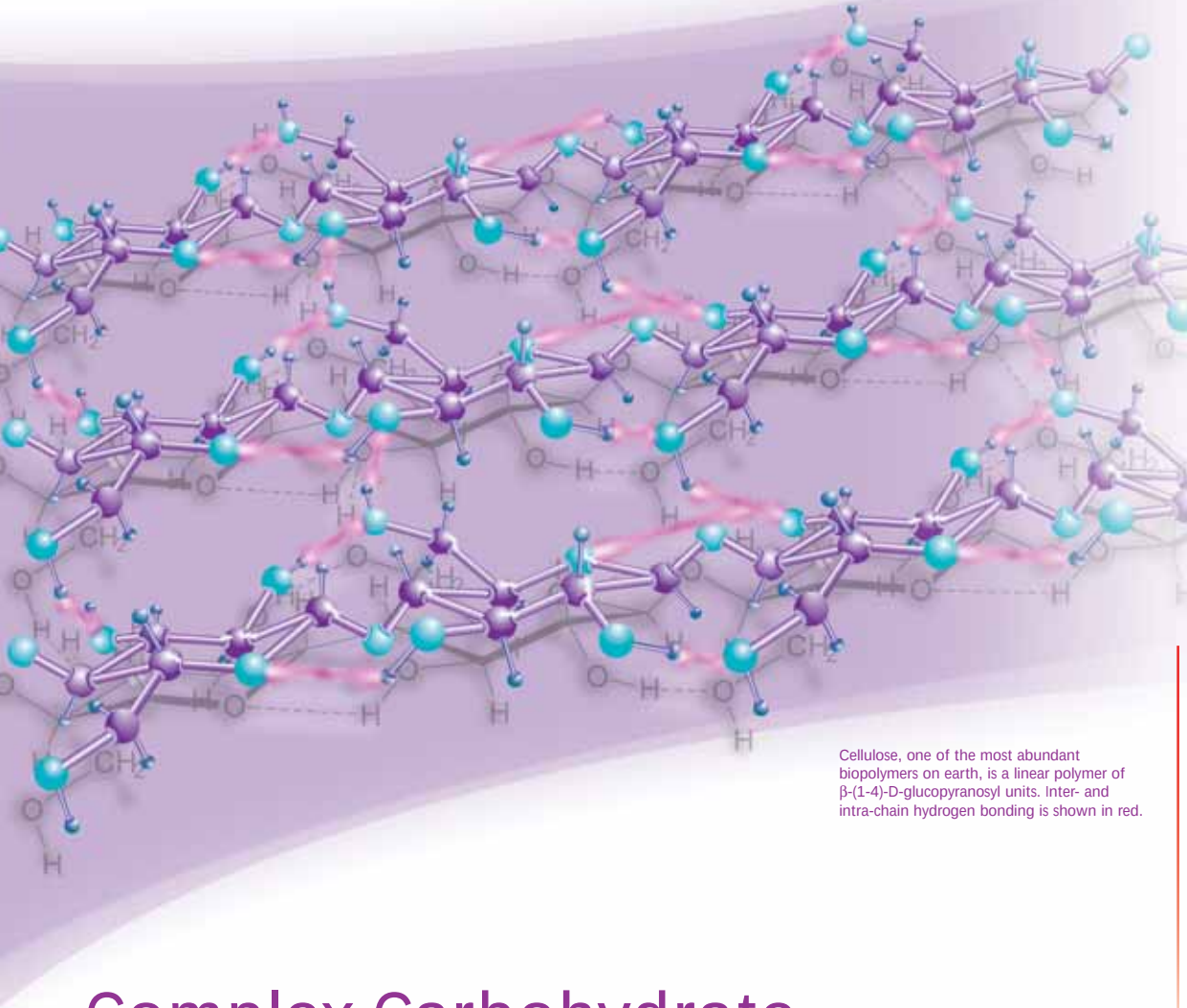
BioFiles

FOR LIFE SCIENCE RESEARCH

SIGMA®

ENZYMES, KITS AND REAGENTS FOR ANALYSIS OF:

- AGAROSE
- ALGINIC ACID
- CELLULOSE, LICHENEN AND GLUCANS
- HEMICELLULOSE AND XYLAN
- CHITIN AND CHITOSAN
- CHONDROITINS
- DEXTRAN
- HEPARANS
- HYALURONIC ACID
- INULIN
- PEPTIDOGLYCAN
- PECTIN
- PULLULAN
- STARCH AND GLYCOGEN



Cellulose, one of the most abundant biopolymers on earth, is a linear polymer of β-(1-4)-D-glucopyranosyl units. Inter- and intra-chain hydrogen bonding is shown in red.

Complex Carbohydrate Analysis: Enzymes, Kits and Reagents

sigma-aldrich.com

SIGMA-ALDRICH

The Online Resource for Nutrition Research Products

Only from Sigma-Aldrich

sigma-aldrich.com/nutrition
BIOACTIVE NUTRIENT explorer

Designed to help you locate the chemicals and kits needed to support your work, the **Bioactive Nutrient Explorer** is an Internet-based tool created to aid medical researchers, pharmacologists, nutrition and animal scientists, and analytical chemists studying dietary plants and supplements.

The **Bioactive Nutrient Explorer** identifies the compounds found in a specific plant and arranges them by chemical family and class. You can also search for compounds having a similar chemical structure or for plants containing a specific compound.

The **Bioactive Nutrient Explorer** now includes a searchable database of plants listed by physiological activity in key areas of research, such as cancer, diabetes, metabolism and other disease or normal states. Plant Detail pages include common and Latin synonyms and display associated physiological activities, while Product Detail pages show the structure family and plants that contain the compound, along with comparative product information for easy selection. When you have found the product you need, a simple mouse click connects you to our easy online ordering system.

- **New!** Search for Plants Associated with Physiological Activity
- Locate Chemicals found in Specific Plants
- Identify Structurally Related Compounds

Bioactive Nutrient Explorer

Helping Scientists Connect Bioactives to Botanicals

sigma-aldrich.com/nutrition

sigma-aldrich.com

SIGMA®

BioFiles
FOR LIFE SCIENCE RESEARCH

2007
Volume 2
Number 3

Table of Contents

Complex Carbohydrate Analysis: Enzymes, Kits and Reagents

Introduction

Complex carbohydrates compose the most abundant class of biopolymers on earth. Because of their structural and functional diversity, they have found applications in biomedical, nutritional, textile, cosmetic and countless other industries.

The complex carbohydrates of the extracellular matrices such as hyaluronic acid and chondroitin sulfate are finding utility in antinflammatory and cell proliferation applications. *In vivo*, hyaluronic acid forms a coating around chondrocytes in articular cartilage and together with the proteoglycan, aggrecan, is responsible for the uptake and retention of water. The two major glycan components of aggrecan are chondroitin sulfate and keratan sulfate. Hyaluronic acid may also interact with cell surface receptors, such as CD44, involved in lymphocyte activation. The degradation products of hyaluronic acid may also interact with Toll-like receptors in macrophages. Heparan sulfate is commonly found as a component of cell surface proteoglycans. It is also found in the extracellular matrix. Heparan sulfate appears to have a broad range of biological functions including regulation of thrombosis, growth factor signaling, cell proliferation, adhesion and mobility. Depending on its morphology, location and ligands, heparan sulfate may inhibit or promote metastasis. Heparan sulfate is known to bind several protein ligands. Most notably, its binding affinity with antithrombin has been extensively utilized in the form of the anticoagulant, heparin.

Dextrans also help to decrease vascular thrombosis. By binding to the endothelium, platelets and red blood cells, dextrans impart an electronegative environment in the blood vessel resulting in a reduction of red blood cell aggregation and platelet adhesion to the vascular endothelium. *In vivo*, dextran solutions have also been used for blood volume expansion. Conversely, chitosan has the ability to induce clot formation. It is used in wound healing, particularly as a coating for bandages. Chitin may also aid in wound healing by accelerating collagen production. Chitosan is also used to enhance plant growth and may help plants resist fungal infection.

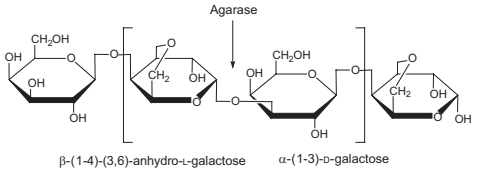
Chitin and starch are used as binders in the paper, dye, textiles and adhesives industries. Chitin and chitosan are also used as filtration aids, particularly in the waste water treatment industry. Chitosan aids in particulate aggregation as well as removal of phosphorus, metals, and grease from waste water. Modified agarose, chitin, starch and dextrans have been manipulated to produce media with controlled pore size for chemical separations. Beaded forms of cross-linked agarose and dextrans are the components of size exclusion, ion exchange and affinity chromatography media. Agarose and soluble starch are commonly used as electrophoresis media.

In the food industry, starches, aglinates, agarose, chitins, chitosans and pectins are used as gelling, thickening and encapsulating agents. Pectins and inulins are common components of dietary fiber supplements and may help to increase nutrient uptake. Pullulan is a common component of edible films.

For Hazard Information and other information please refer to the Sigma Biochemicals, Reagents and Kits for Life Science Research Catalog or sigma-aldrich.com

Agarase

Agarase Specificity



Agarose

Agarose is the principal neutral gelling component of agar extracted from algae. Agarose is a complex range of polysaccharide chains composed of alternating α-(1-3)-D-galactosyl-β-(1-4)-anhydro-L-galactosyl units.

Agarase

Agarase catalyzes the hydrolysis of 1,3-β-D-galactosidic linkages in agarose, giving the tetramer as the predominant product.

Agarase from *Pseudomonas atlantica*

Agarose 3-glycanohydrolase

[37288-57-6] E.C. 3.2.1.81

lyophilized powder, activity: 1,000-3,000 units/mg solid

Contains phosphate buffer salts. May contain bovine serum albumin to standardize protein content

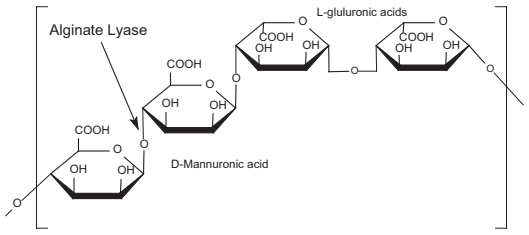
One unit will produce 1.0 µg of reducing sugar (measured as D-galactose) from agar per min at pH 6.0 at 40 °C.

2–8°C

A6306-1KU	**1,000 units**
A6306-5KU	**5,000 units**

Alginate Lyase

Alginate Lyase Specificity



Alginic Acid

Composed of blocks of β-D-(1-4) mannuronic acid homopolymeric regions (MMMM...), α-L-(1-4)-guluronic acid (GGGG...) homopolymeric regions, and alternating coplolymer regions of β-D-(1-4) mannuronic acid - α-L-(1-4)-guluronic acid (GMGMGM....). Bacterial alginic acid can be acetylated at the 2 or 3 positions on mannuronic acid.

Alginate lyase cleaves at the β-(1-4)-D-mannuronic bonds residues to yield oligosaccharides with 4-deoxy-α-L-erythro-hex-4-enopyranuronosyl groups at their non-reducing terminus.

Alginate Lyase from *Flavobacterium* sp.

E.C. 4.2.2.3

powder

activity: ≥10,000 units/g solid

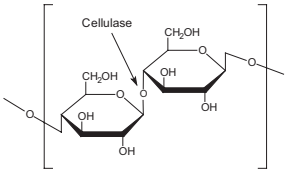
Add 0.15 mL of enzyme solution (1 un/mL) to 4.5 mL of 0.1% sodium alginate (pH 6.3). Incubate at 37 °C for 30 minutes. Terminate reaction by addition of 4.65 mL of 0.1 N NaOH.

One unit will produce an increase the A235 nm of 1.0 per minute per mL of sodium alginate solution at pH 6.3 at 37 °C

2–8°C

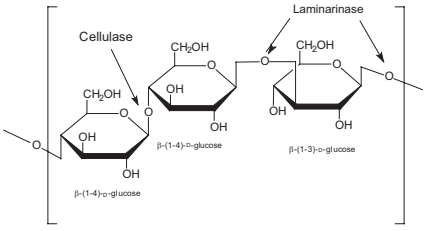
A1603-100MG	**100 mg**

Cellulose, Lichenan and Glucan Degrading Enzymes



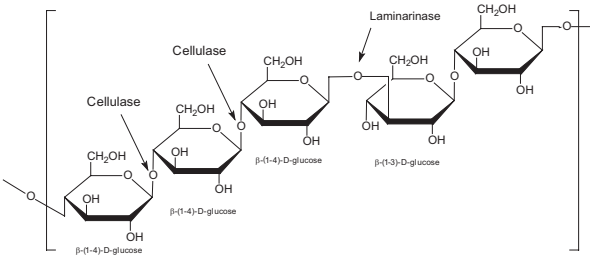
Cellulose

Polymer of β-(1-4)-D-glucopyranosyl units



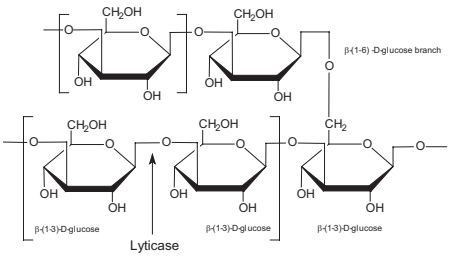
Lichenen

Repeating linear polymer of two β-(1-4)-D-glucopyranosyl and one β-(1-3)-D-glucopyranosyl unit.



Cerial β-Glucan

Polymer of β-(1-4)-D-glucopyranosyl units occuring as predominantly as cellotriose and cellotetraose separated by single β-(1-3)-D-glucopyranosyl units. Cross-linking can occur within the consecutive cellotriose regions.



Yeast β-Glucan

Polymer of β-(1-3)-D-glucopyranosyl units with branching at β-(1-6)-D-glucopyranosyl units.

Cellulase

Cellulase catalyzes the endohydrolysis of 1,4-β-D-glucosidic linkages in cellulose, lichenin and cereal β-D-glucans

Cellulase from *Aspergillus* sp.

Carezyme® 1000L

[9012-54-8] E.C. 3.2.1.4

activity: ≥1000 U/g

Produced by submerged fermentation of a genetically modified *Aspergillus* microorganism

A product of Novozyme Corp.

2–8°C

C2605-50ML	**50 mL**
C2605-250ML	**250 mL**

Cellulase from *Aspergillus niger*

1,4-(1,3:1,4)-β-D-Glucan 4-glucano-hydrolase
[9012-54-8] E.C. 3.2.1.4 EC No. 2327344

powder, activity: ≥0.3 units/mg solid

One unit will liberate 1.0 µmole of glucose from cellulose in 1 hr at pH 5.0 at 37 °C (2 hr incubation time).

2–8°C

C1184-5KU	**5,000 units**
C1184-25KU	**25,000 units**
C1184-100KU	**100,000 units**

Cellulase from *Trichoderma reesei* ATCC 26921

1,4-(1,3:1,4)-β-D-Glucan 4-glucano-hydrolase
[9012-54-8] E.C. 3.2.1.4

Celluclast® 1.5L

aqueous solution, activity: ≥700 U/g

Produced by submerged fermentation of a selected strain of the fungus *Trichoderma reesei* and catalyzes the breakdown of cellulose into glucose, cellobiose, and higher glucose polymers.

density.....1.2 g/mL, 25 °C

A product of Novozyme Corp.

2–8°C

C2730-50ML	**50 mL**

lyophilized powder, activity: ≥1 unit/mg solid

One unit will liberate 1.0 µmole of glucose from cellulose in 1 hr at pH 5.0 at 37 °C (2 hr incubation time).

2–8°C

C8546-2.5KU	**2,500 units**
C8546-5KU	**5,000 units**
C8546-10KU	**10,000 units**

Cellulase from *Trichoderma viride*

1,4-(1,3:1,4)-β-D-Glucan 4-glucano-hydrolase
[9012-54-8] E.C. 3.2.1.4 EC No. 2327344

plant cell culture tested, activity: 3-10 units/mg solid

Composition: protein ~50% (biuret); contains lactose and glucose

One unit will liberate 1.0 µmole of glucose from cellulose in 1 hr at pH 5.0 at 37 °C (2 hr incubation time).

2–8°C

C1794-5KU	**5,000 units**
C1794-10KU	**10,000 units**

crude powder, activity: 3-10 units/mg solid

Composition: protein ~50% (biuret)

One unit will liberate 1.0 µmole of glucose from cellulose in 1 hr at pH 5.0 at 37 °C (2 hr incubation time).

2–8°C

C9422-5KU	**5,000 units**
C9422-10KU	**10,000 units**

Onozuka RS, powder, activity: ≥5,000 units/g solid

Manufactured by Yakult
One unit will liberate 1.0 µmole of glucose from cellulose in 1 hr at pH 5.0 at 37 °C (2 hr incubation time).

2–8°C

C0615-1G	**1 g**

Driselase

Driselase from *Basidiomycetes* sp.

[85186-71-6]

powder, Protein: ~15%

Crude powder containing laminarinase, xylanase and cellulase.

–20°C

D9515-1G	**1 g**
D9515-5G	**5 g**
D9515-25G	**25 g**

Cellulose, Lichenan and Gluan Degradins Enzymes

β-Glucanase/Laminarinase

Laminarinase catalyzes the endohydrolysis of 1,3- or 1,4-linkages in β-D-glucans when the glucose residue whose reducing group is involved in the linkage to be hydrolyzed is itself substituted at C-3.

β-Glucanase from *Aspergillus niger*

[9074-98-0] E.C. 3.2.1.6 EC No. 2329802

BioChemika, powder, dark-brown, activity: ~1 unit/mg

One Unit corresponds to the amount of enzyme which will release 1 µmoL of reducing sugar equivalents (expressed as glucose) per minute at pH 5.0 and 55 °C, using β-D-glucan (Catalog No. 49102) as substrate

2-8°C

49101-100MG	**100 mg**
49101-500MG	**500 mg**

β-1,3-D-Glucanase from *Helix pomatia*

[9044-93-3] E.C. 3.2.1.39 EC No. 2329273

BioChemika, powder, light beige, activity: 0.5-1.5 units/mg

One Unit corresponds to the amount of enzyme which liberates 1 µmol glucose from laminarin (Catalog No. 61340) per minute at pH 5.0 and 37 °C.

Improved filterability of wines by enzymic decomposition of carbohydrate-containing colloids[1]; Induction of hydrolases as a defense reaction against pathogens, review[2]

Lit. cited: 1. Wucherpfennig, K., and Dietrich, H. , Weinwirtschaft **118**, 598 (1982)
2. Boller, T. , UCLA Symp. Mol. Cell Biol., New Ser. **22**, 247 (1985)

–20°C WET ICE

49103-10MG	**10 mg**
49103-50MG	**50 mg**

Laminarinase from *Penicillium* sp.

endo-1,3(4)-β-glucanase; 1,3-(1,3:1,4)-β-D-Glucan 3(4)-glucanohydrolase [62213-14-3] E.C. 3.2.1.6

lyophilized powder, activity: 5-10 units/mg protein

Lyophilized powder containing acetate buffer salts

composition
Protein ~70% (biuret)

One unit will liberate 1.0 mg of reducing sugar (measured as glucose) from laminarin per min at pH 5.0 at 37 °C.

Contains cellulase and α-amylase

2-8°C

L9259-25UN	**25 units**

Laminarinase from *Trichoderma* sp.

endo-1,3(4)-β-glucanase; 1,3-[1,3;1,4]-β-D-Glucan 3(4)-glucanohydrolase [62213-14-3] E.C. 3.2.1.6

powder, activity: 100-400 units/g solid

Contains chitinase activity.

One unit will liberate 1.0 mg of reducing sugar (measured as glucose) from laminarin per min at pH 5.0 at 37 °C.

Contains cellulase and α-amylase

2-8°C

L5272-5UN	**5 units**
L5272-25UN	**25 units**

Lyticase

Lyticase hydrolyzes poly-β-(1-3)-glucose such as yeast cell wall β-glucan.

Lyticase from *Arthrobacter luteus*

[37340-57-1]

Yeast cells are difficult to disrupt because the cell walls may form capsules or resistant spores. DNA can be extracted from yeast by using lysing enzymes such as lyticase, chitinase, zymolase, and gluculase to induce partial spheroplast formation; spheroplasts are subsequently lysed to release DNA. Lyticase is preferred to digest cell walls of yeast and generate spheroplasts from fungi for transformation. Reported to be useful for lysis of *Ashbya, Candida, Debaryomyces, Eremothecium, Endomyces, Hansenula, Hanseniaspora, Kloeckera, Kluyveromyces, Lipomyces, Metschikowia, Pichia, Pullularia, Torulopsis, Saccharomyces, Saccharomycopsis, Saccharomycodes, and Schwanniomyces* species.

One unit will produce a ΔA800 of 0.001 per min at pH 7.5 at 25 °C, using a suspension of yeast as substrate in a 3 mL reaction mixture.

▸ lyophilized powder, activity: ≥2,000 units/mg protein, Protein: ≥20%

Partially purified, lyophilized powder containing potassium phosphate buffer salts and stabilizers

–20°C

L2524-10KU	**10,000 units**
L2524-25KU	**25,000 units**
L2524-50KU	**50,000 units**
L2524-200KU	**200,000 units**

▸ lyophilized powder, activity: ≥200 units/mg solid

–20°C

L4025-25KU	**25,000 units**
L4025-50KU	**50,000 units**
L4025-100KU	**100,000 units**
L4025-250KU	**250,000 units**
L4025-1MU	**1,000,000 units**

▸ partially purified powder, activity: ≥2,000 units/mg protein

Partially purified powder containing ammonium sulfate and stabilizer

composition
Protein ~20% (biuret)

2-8°C

L5263-25KU	**25,000 units**
L5263-50KU	**50,000 units**
L5263-200KU	**200,000 units**

Lyticase from *Oerskovia xanthineolytica*

[37340-57-1]

recombinant, expressed in *Escherichia coli*, lyophilized powder

Purified recombinant β-(1,3)-glucanase preparation that is protease-free. Vial of ≥500 units.

One unit will produce a ΔA800 of 0.001 per min at pH 7.5 at 25 °C, using a suspension of yeast as substrate in a 3 mL reaction mixture.

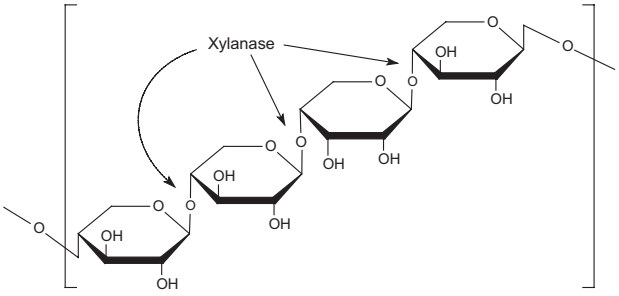
An exceptionally stable enzyme preparation with very low levels of nucleic acid and nuclease contamination.

–20°C

L4276-1VL	**1 vial**

Hemicellulose and Xylan Degrading Enzymes

Xylanase Specificity



Xylan Hemicellulose
Polymer of β-(1-4)-D-xylopyranosyl units

Xylan hemicelluloses are a group of plant-derived heteropolysaccharides associated with cellulose and lignin. The most common hemicelluloses are: xylan, glucuronoxylan, arabinoxylan, glucomannan and xyloglucan. In angiosperms, the principal hemicellulose component, xylan, is a polymer of β-(1-4)-D-xylopyranose. In arabinoxylan, branching occurs at the C2 & C3 positions with α-L-arabinofunaose. Glucuronoxylan, also found in angiosperms, has the xylan backbone with 4-0 methylglucuronic acid branching. In addition, arabinose branching as well as acetylation may be present. Gymnosperms contain glucomannans comprised primarily of D-mannosyl and D-glucosyl residues.

Hemicellulase

Hemicellulase from *Aspergillus niger*

[9025-56-3]

powder, activity: 0.3-3.0 units/mg solid (using a β-galactose dehydrogenase system and locust bean gum as substrate)

An undefined mixture of glycolytic enzymes usually containing xylanase, mananase and other activities.

Contains lactose as standardization of activity

One unit will produce a relative fluidity change of 1 per 5 minutes using locust bean gum as substrate at pH 4.5 at 40 °C

–20°C

H2125-150KU	**150,000 units**

Xylanase

Xylanase catalyzes the endohydrolysis of β-(1-4)-D-xylosidic linkages in xylans yielding various β-(1-4)-D-xylooligosaccharides.

Xylanase from *Thermomyces lanuginosus*

Pentopan Mono BG®

[37278-89-0]

powder, activity: ≥2500 units/g, recombinant, expressed in Aspergillus oryzae

Purified endo (1,4)-β-xylanase from *Thermomyces lanuginosus.* Produced by submerged fermentation of a genetically modified *Aspergillus oryzae* microorganism.

A product of Novozyme Corp.

2–8°C

X2753-10G	**10 g**
X2753-50G	**50 g**

Xylanase from *Trichoderma viride*

endo-1,4-β-Xylanase; 1,4-β-D-Xylanxylanohydrolase
[9025-57-4] E.C. 3.2.1.8 EC No. 2534397

lyophilized powder, activity: 100-300 units/mg protein

Contains sorbitol and sodium acetate buffer salts

composition

Protein ~50% (biuret)

One unit will liberate 1 µmole of reducing sugar measured as xylose equivalents from xylan (X0627) per min at pH 4.5 at 30 °C.

cellulase .... <0.2% β-xylosidase ..... <0.002%

β-glucosidase ..... <0.01%

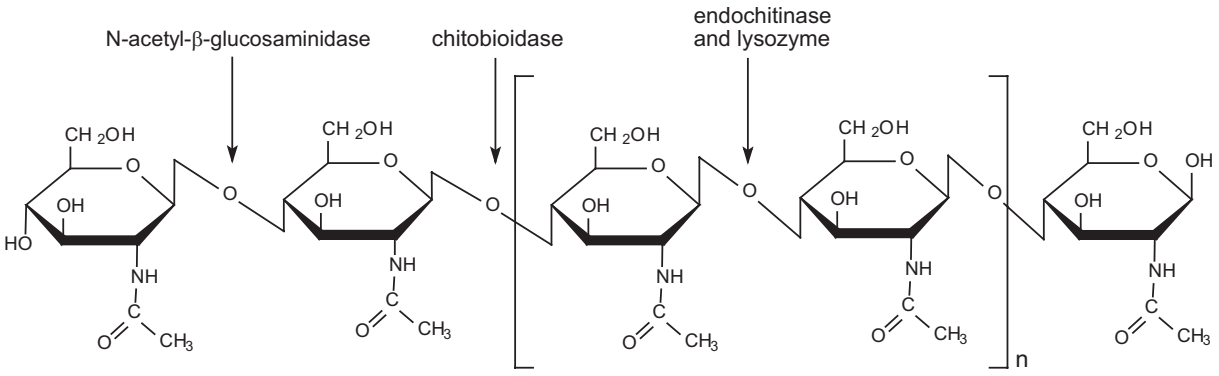
2–8°C

X3876-250UN	**250 units**
X3876-1KU	**1,000 units**

Chitin and Chitosan Degrading Enzymes

Chitinase

Chitinase Specificity



Chitin

Polymer of β-(1-4)-N-Acetyl-D-glucosamine units

Chitinases have been detected in many organisms, including bacteria, fungi, plants, invertebrates and vertebrates. Chitinases are broadly classified as endo- and exochitinases. The endochitinase activity is defined as the random cleavage at internal points in the chitin chain. The exochitinase activity is defined as the progressive action starting at the non reducing end of chitin with the release of chitobiose or N-acetylglucosamine units. Chitobiosidase and N-acetyl-β-glucosaminidase are considered exochitinases. The combination of endo- and exochitinases results in a synergistic increase in the chitinolytic activity.

Chitinase from *Serratia marcescens*

Chitodextrinase; Poly(1,4-β-[2-acetamido-2-deoxy-D-glucoside]) glycanohydrolase
[9001-06-3] E.C. 3.2.1.14

lyophilized powder, activity: 400-1,200 units/g solid

Lyophilized powder containing phosphate buffer salts

composition

Protein 20-40% (biuret)

One unit will liberate 1.0 mg of N-acetyl-D-glucosamine from chitin per hour at pH 6.0 at 25 °C in a 2 hour assay.

–20°C

C7809-1UN	**1 unit**
C7809-5UN	**5 units**
C7809-10UN	**10 units**

Chitinase from *Streptomyces griseus*

Chitodextrinase; Poly(1,4-β-[2-acetamido-2-deoxy-D-glucoside]) glycanohydrolase
[9001-06-3] E.C. 3.2.1.14 EC No. 2325787

lyophilized powder (Essentially salt free), activity: 200-800 units/g solid

One unit will liberate 1.0 mg of N-acetyl-D-glucosamine from chitin per hour at pH 6.0 at 25 °C in a 2 hour assay.

–20°C

C6137-5UN	**5 units**
C6137-25UN	**25 units**
C6137-50UN	**50 units**

Chitinase from *Trichoderma viride*

N-acetyl-β-glucosaminidase and chitodextrinase
E.C. 3.2.1.14 and 3.2.1.52

lyophilized powder, activity: ≥600 units/g solid

The chitinolytic enzymes from *T. viride* are a mixture of extracellular chitinolytic enzymes,which exhibit exo- and endochitinase activities including N-acetyl-β-glucosaminidase and chitobiosidase.

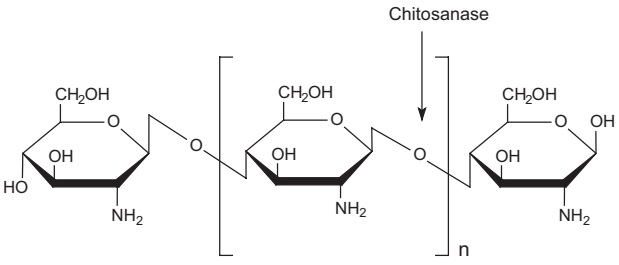
One unit will liberate 1.0 mg of N-acetyl-D-glucosamine from chitin per hour at pH 6.0 at 25 °C in a 2 hour assay.

–20°C WET ICE

C8241-25UN	**25 units**

Chitosanase

Chitosanase Specificity



Chitosan
Polymer of β-(1-4)-D-glucosamine units

Chitosanase catalyzes the endohydrolysis of β-(1-4)-linkages between D-glucosamine (GlcN-GlcN) residues in chitosan. The enzyme from Streptomyces has been reported to also hydrolyze the GlcNAc-GlcN linkage in partially acetylated chitosan.

Chitosanase from *Streptomyces* sp.

Chitosan N-acetylglucosaminohydrolase
[51570-20-8] E.C. 3.2.1.132

buffered aqueous glycerol solution, activity: ≥15 units/mg protein

Solution in 50% glycerol containing 100 mM sodium acetate, pH 5.0

One unit will liberate 1.0 µmole of reducing sugar (measured as D-glucosamine equivalents) from chitosan per minute at pH 5.5 at 37 °C.

–20°C

C0794-10UN	**10 units**

Chitosanase from *Streptomyces griseus*

Chitosan N-acetylglucosaminohydrolase
[51570-20-8] E.C. 3.2.1.132

lyophilized powder, activity: >50 units/mg protein (Bradford)

Lyophilized powder containing potassium phosphate buffer salts. Purified by chromatography

One unit will release 1 µmole of glucosamine from chitosan per min at pH 5.0 at 37 °C

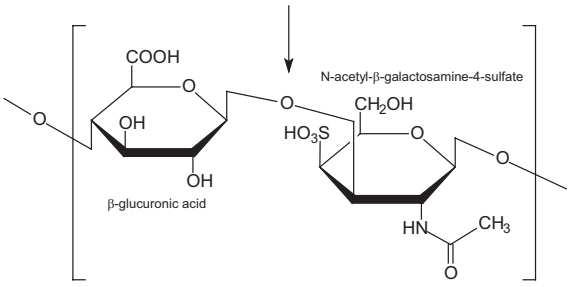
chitinase ..... <1.0 unit/mg protein

–20°C

C9830-10UN	**10 units**

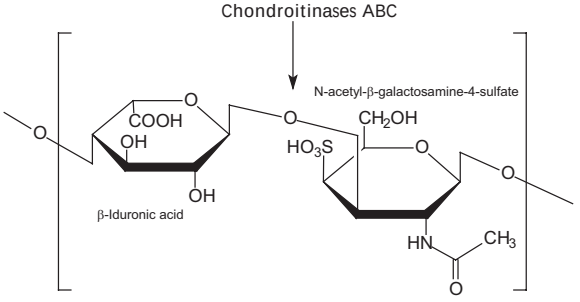
Chondroitinases

Chondroitinases ABC, AC & C



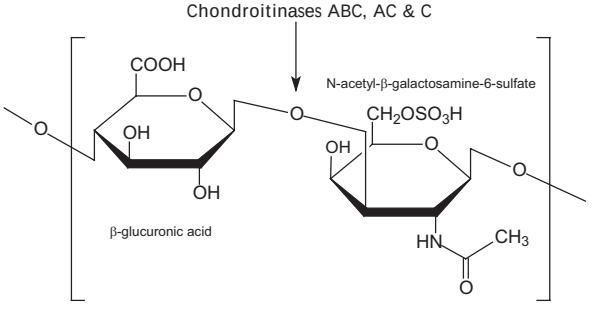
Chondroitin Sulfate A
Alternating copoly (β-glucuronic acid-(1-3))-N-acetyl-β-galactosamine-4-sulfate

Chondroitinases ABC



Chondroitin Sulfate B
Alternating copoly (β-Iduronic acid-(1-3))-N-acetyl-β-galactosamine-4-sulfate

Chondroitinases ABC, AC & C



Chondroitin Sulfate C
Alternating copoly (β-glucuronic acid-(1-3))-N-acetyl-β-galactosamine-6-sulfate

Chondroitinases

Chondroitinase ABC

Chondroitinase ABC catalyzes the eliminative degradation of polysaccharides containing β-(1-4)-D-hexosaminyl and β-(1-3)-D-glucuronosyl or α-(1-3)-L-iduronosyl linkages to disaccharides containing 4-deoxy-β-D-gluc-4-enuronosyl groups. It acts on chondroitin 4-sulfate, chondroitin 6-sulfate, dermatan sulfate, and acts slowly on hyaluronate. Initial rates of degradation of chondroitin sulfate B, chondroitin, and hyaluronic acid were 40%, 20%, and 2%, respectively, that of chondroitin sulfate A and chondroitin sulfate C.

Chondroitinase ABC from *Proteus vulgaris*

Chondroitin ABC Lyase
[9024-13-9] E.C. 4.2.2.4 EC No. 2327779

lyophilized powder, activity: 50-250 units/mg protein (usingchondroitin sulfate C as substrate)
Contains potassium phosphate buffer salts and stabilizer; BSA-free.
composition, protein ~10% (Lowry)
Affinity purified
Packages based on chondroitinase C

One unit will liberate 1.0 µmole of 2-acetamido-2-deoxy-3-O-(β-D-gluc-4-ene-pyranosyluronic acid)-4-O-sulfo-D-galactose from chondroitin sulfate A or 1.0 µmole of 2-acetamido-2-deoxy-3-O-(β-D-gluc-4-ene-pyranosyluronic acid)-6-O-sulfo-D-galactose from chondroitin sulfate C per min at pH 8.0 at 37 °C.

protease ..... essentially free

–20°C

C3667-5UN	**5 units**
C3667-10UN	**10 units**

Chondroitinase AC

Chondroitinase AC is an eliminase that degrades chondroitin sulfates A and C, but not chondroitin sulfate B. The enzyme cleaves, via an elimination mechanism, sulfated and non-sulfated polysaccharide chains containing β-(1-4) and β-(1-3) linkages between hexosamines and glucuronic acid residues. The reaction yields oligosaccharide products, mainly disaccharides, containing unsaturated uronic acids that can be detected by UV spectroscopy at 232 nm. The enzyme shows approximately equal activity with chondroitin sulfates A and C, while the activity observed with chondroitin sulfate B is approximately 7% of this value. This activity is most likely due to the presence of chondroitin sulfates A and C (10%) in the chondroitin sulfate B.

Chondroitinase AC from *Flavobacterium heparinum*

Chondroitin AC lyase
[9047-57-8] E.C. 4.2.2.5

lyophilized powder, activity: 0.5-1.5 units/mg solid
(using chondroitin sulfate A as substrate, also cleaves chondroitin sulfate C)
Contains potassium phosphate buffer salts and BSA as stabilizer.
composition, protein ~15% (Lowry)
One unit will cause a ΔA_{232} of 1.0 per minute due to the release of unsaturated disaccharide from chondroitin sulfate A at pH 7.3 at 37 °C. Reaction volume: 3.1 mL (light path 1 cm).

Glycosaminoglycan (GAG) degradation enzymes ..... may contain trace amount

–20°C

C2780-5UN	**5 units**

Chondroitinase C

Chondroitinase C cleaves chondroitin sulfate C producing tetrasaccharide plus an unsaturated 6-sulfated disaccharide (delta Di-6S). It also cleaves hyaluronic acid producing unsaturated nonsulfated disaccharide (Δ Di-OS). Chondroitin sulfate A is also degraded producing oligosaccharides and delta Di-6S, but not delta Di-4S. Chondroitinase C cleaves the GalNAc bond of the pentasaccharides or hexasaccharides derived from the linkage region of chondroitin sulfate chains and tolerates sulfation of the C-4 or C-6 of the GalNAc residue and C-6 of the Gal residues, as well as 2-O-phosphorylation of the Xyl residue. In contrast, it does not act on a GalNAc–GlcA linkage when attached to a 4-O-sulfated Gal residue.

Chondroitinase C from *Flavobacterium heparinum*

Chondroitin C lyase
[60184-91-0] E.C. 4.2.2.—

lyophilized powder, activity: ≥200 units/mg solid

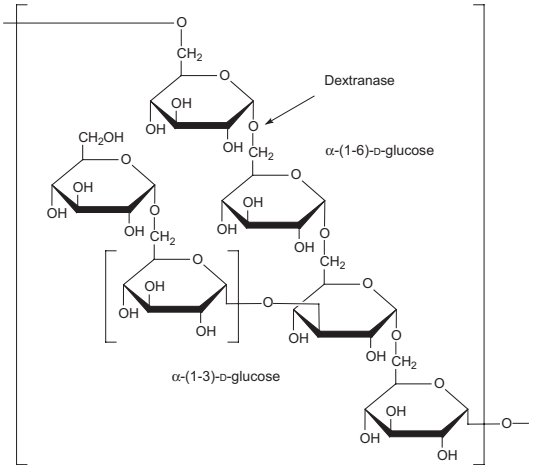
One unit will form 0.1 µmole of unsaturated uronic acid per hr at pH 8.0 at 25 °C using chondroitin sulfate C as substrate.

–20°C

C0954-75UN	**75 units**

Dextranases

Dextranase Specificity



Dextran is composed of approximately 95% α-(1-6)-D-linkages. The remaining α-(1-3) linkages account for the branching of dextran. Conflicting data on the branch lengths implies that the average branch length is less than three glucose units. However, other methods indicate branches of greater than 50 glucose units exist. Native dextran has been found to have a molecular weight (MW) in the range of 9 million to 500 million Da. Lower MW dextrans will exhibit slightly less branching and have a more narrow range of MW distribution. Dextrans with MW greater than 10,000 Da behave as if they are highly branched. As the MW increases, dextran molecules attain greater symmetry. Dextrans with MW of 2,000 to 10,000 Da exhibit the properties of an expandable coil. At MWs below 2,000 Da dextran is more rod-like.

Dextranase

Dextranase catalyzes the endohydrolysis of α-(1-6)-D-glucosidic linkages in dextran.

Dextranase from *Chaetomium erraticum*

1,6-α-D-Glucan 6-glucanohydrolase
E.C. 3.2.1.11

A product of Novozymes Corp.

solution

A fungal dextranase produced by submerged fermentation of *Chaetomium erraticum.*

Stable in the pH range of 3-7 and at temperatures up to approx. 70 °C. For most applications, the preferred conditions are pH 5-6 and a temperature of 50-60 °C.

2-8°C

D0443-50ML	**50 mL**
D0443-250ML	**250 mL**

Dextranase from *Penicillium* sp.

1,6-α-D-Glucan 6-glucanohydrolase
E.C. 3.2.1.11

One unit will liberate 1.0 µmole of isomaltose (measured as maltose) per min at pH 6.0 at 37 °C, using dextran as substrate.

▸ lyophilized powder, activity: 400-800 units/mg protein
composition, protein 35% (Lowry)

2-8°C

D8144-500UN	**500 units**
D8144-1KU	**1,000 units**

▸ lyophilized powder, activity: 100-250 units/mg protein

Partially purified, lyophilized powder
composition, protein ~25% (Lowry)

2-8°C

D4668-500UN	**500 units**
D4668-1KU	**1,000 units**

▸ lyophilized powder, activity: 10-25 units/mg solid

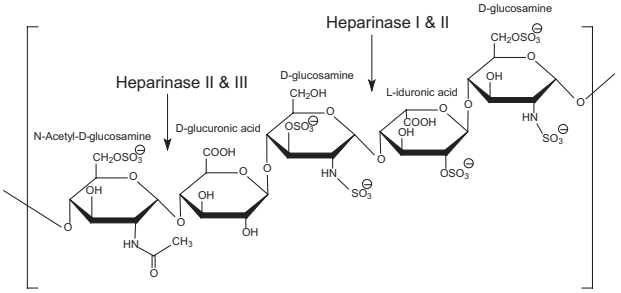
Crude

2-8°C

D5884-5KU	**5,000 units**

Heparinases

Heparinase Specificities



Heparan

Heparan and heparin glycosaminoglycans (GAGs) are complex heterogeneous mixtures of repeating disaccharide units consisting of a uronic acid (D-glucuronic or L-iduronic acid) and D-glucosamine or N-acetyl-D-glucosamine. Various degrees of sulfation occur (at O and/or N) on each monosacchiride unit, ranging from zero to tri-sulfation. In general, heparan is less sulfated than heparin.

Heparinase selectively cleaves sulfated glycans containing α-(1-4)-glycosidic linkages between the glucosamine and uronic acid residues in the heparin polymer. The cleavage proceeds via an elimination reaction, resulting in the formation of oligosaccharides containing unsaturated uronic acid residues (double bond between C4 and C5). These cleavage products can be detected by UV spectroscopy (232 nm). The three forms of heparinase (I, II, and III) have varying substrate specificities.

Heparinase I

Heparinase I cleaves heparin and heparan sulfate (relative activity about 3:1) at the linkages between hexosamines and O-sulfated iduronic acids, yielding mainly disaccharides. The enzyme also cleaves the antithrombin III binding pentasaccharide domain in the heparin molecule.

Heparinase I from *Flavobacterium heparinum*

Heparinase; Heparin lyase I
[9025-39-2] E.C. 4.2.2.7

Lyophilized powder stabilized with approx. 25% bovine serum albumin, activity: 200-600 units/mg solid

mol wt 42.8 kDa

One unit will form 0.1 µmole of unsaturated uronic acid per hr at pH 7.5 at 25 °C. One International Unit (I.U.) is equivalent to approx. 600 Sigma units.

-20°C

H2519-50UN	**50 units**
H2519-100UN	**100 units**
H2519-250UN	**250 units**

Heparinases

Heparinase II

Heparinase II cleaves heparan sulfate, and to a lesser extent heparin (relative activity about 2:1), at the α-(1-4) linkages between hexosamines and uronic acid residues (both glucuronic and iduronic), yielding mainly disaccharides.

Heparinase II from *Flavobacterium heparinum*

Heparin lyase II
[149371-12-0]

Lyophilized powder stabilized with approx. 25% bovine serum albumin, lyophilized powder, activity: 100-300 units/mg solid

mol wt 84.1 kDa

One unit will form 0.1 µmole of unsaturated uronic acid per hr at pH 7.0 at 25 °C. One International Unit (I.U.) is equivalent to approx. 600 Sigma units.

–20°C

H6512-10UN	**10 units**
H6512-25UN	**25 units**
H6512-100UN	**100 units**

Heparinase III

Heparinase III cleaves at the α-(1-4) linkages between hexosamine and glucuronic acid residues in heparan sulfate, yielding mainly disaccharides. The enzyme is not active towards heparin. Sulfation at the 6-position of glucosamine inhibits cleavage by heparinase III,

Heparinase III from *Flavobacterium heparinum*

Heparin Lyase III; Heparitinase from *Flavobacterium heparinum*; Heparitinase I
[37290-86-1] E.C. 4.2.2.8

Lyophilized powder stabilized with approx. 25% bovine serum albumin, activity: 200-600 unit/mg solid

Heparin-degrading lyase that recognizes heparin sulfate proteoglycan as its primary substrate.

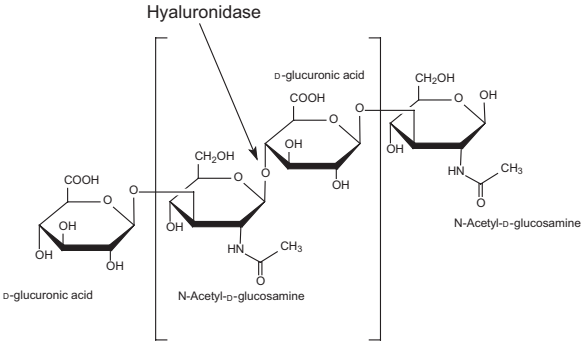
mol wt 70.8 kDa

One unit will form 0.1 µmole of unsaturated uronic acid per hr at pH 7.5 at 25 °C. One International Unit (I.U.) is equivalent to approx. 600 Sigma units.

–20°C

H8891-5UN	**5 units**
H8891-10UN	**10 units**
H8891-50UN	**50 units**

Hyaluronidases



Hyaluronic Acid
Composed of alternating residues of β-D-(1-3) glucuronic acid and β-D-(1-4)-N-acetylglucosamine

The mammalian hyaluronidases (EC 3.2.1.35) cleave hyaluronic acid and similar glycosaminoglycans by hydrolysis. The enzyme from *Streptomyces* (EC 4.2.2.1) is a lyase that catalyzes cleavage by an elimination reaction yielding a 4-deoxy-4,5-unsaturated oligosaccharides. Its specificity towards chondroitins and other glycosaminoglycans is unclear.

Mammalian Hyaluronidase

The mammalian glycolytic hyaluronidase (EC 3.2.1.35) catalyzes the random hydrolysis of the 1-4 bond between N-acetyl-D-glucosamine and D-glucuronic acid in hyaluronic acid. It also hydrolyzes β-(1-4)-D-glycosidic linkages between N-acetyl-galactosamine or N-acetylgalactosamine sulfate and glucuronic acid in chondroitin sulfates A and C, and dermatan.

Hyaluronidase from bovine testes

Hyaluronate 4-glycanohydrolase; Hyaluronoglucosaminidase
[37326-33-3] E.C. 3.2.1.35 EC No. 2534643

mol wt ~55 kDa (four subunits of 14 kDa each)

One unit is based on the change in absorbance at 600 nm (change in turbidity) of a USP reference standard hyaluronidase which is assayed concurrently with each lot.

▸ Type I-S, lyophilized powder, activity: 400-1000 units/mg solid

–20°C

H3506-100MG	**100 mg**
H3506-500MG	**500 mg**
H3506-1G	**1 g**
H3506-5G	**5 g**

▸ Type IV-S, lyophilized powder (essentially salt-free), activity: 750-1500 units/mg solid

–20°C

H3884-50MG	**50 mg**
H3884-100MG	**100 mg**
H3884-500MG	**500 mg**
H3884-1G	**1 g**

Type VIII, lyophilized powder, activity: ~300 units/mg

Prepared from sterile filtered solution of Type I-S.

–20°C

H3757-100MG	**100 mg**

Type VI-S, lyophilized powder, activity: 3,000-15,000 units/mg solid

Chromatographically purified

–20°C

H3631-3KU	**3,000 units**
H3631-15KU	**15,000 units**
H3631-30KU	**30,000 units**

Hyaluronidase from sheep testes

Hyaluronate 4-glycanohydrolase; Hyaluronoglucosaminidase [37326-33-3]
E.C. 3.2.1.35 EC No. 2534643

mol wt 55 kDa

One unit is based on the change in absorbance at 600 nm (change in turbidity) of a USP reference standard hyaluronidase which is assayed concurrently with each lot.

Type V, lyophilized powder, activity: ≥1,500 units/mg solid

–20°C

H6254-500MG	**500 mg**
H6254-1G	**1 g**

Type II, lyophilized powder, activity: ≥300 units/mg

Lyophilized powder containing lactose

–20°C

H2126-100MG	**100 mg**
H2126-500MG	**500 mg**
H2126-1G	**1 g**
H2126-5G	**5 g**

Type III, lyophilized powder, activity: ≥500 units/mg

Lyophilized powder containing 20-50% lactose

–20°C

H2251-100MG	**100 mg**
H2251-500MG	**500 mg**
H2251-1G	**1 g**
H2251-5G	**5 g**

Hyaluronate Lyase (*Streptomyces Hyaluronidase*)

Hyaluronidase from *Streptomyces hyalurolyticus*

Hyaluronate Lyase from *Streptomyces hyalurolyticus*
[9001-54-1] E.C. 4.2.2.1 EC No. 2326141

lyophilized powder

Hyaluronate lyase cleaves hyaluronic acid at the β-D-GalNAc-(1-4)-β-D-GlcA bond, yielding 3-(4-deoxy-β-D-gluc-4-enuronosyl)-N-acetyl-D-glucosamine tetra- and hexasaccharides. Unlike other hyaluronidases, this enzyme is specific for hyaluronic acid and is inactive with chondroitin and chondroitin sulfate.[1]

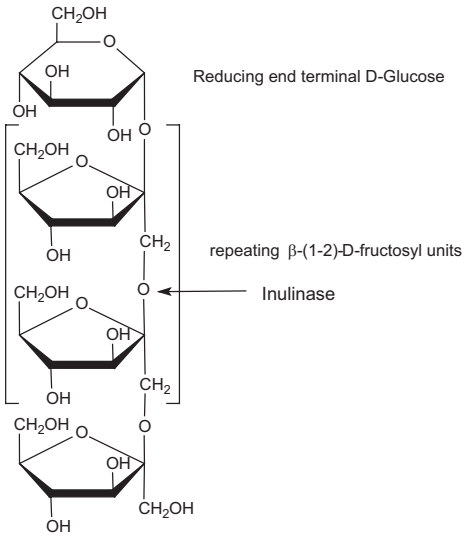
Lit. cited: 1. Ohya, T., and Kaneko, Y., Biochim. Biophys. Acta **198**, 607 (1970)

–20°C

H1136-1AMP	**1 amp**

Inulinase

Inulinase Specificity



Inulin

Inulins are fructan oligosaccharides composed α-D-glucopyranosyl-[β-(2-1) D-fructofuranosyl-D-fructofuranosides. Inulins can generally contain 2 to 140 fructose units.

Inulinase from *Aspergillus niger*

Fructozyme L™; Inulase
E.C. 3.2.1.7

Inulinase catalyzes endohydrolysis of β-(2-1)-D-fructosidic linkages in inulin.

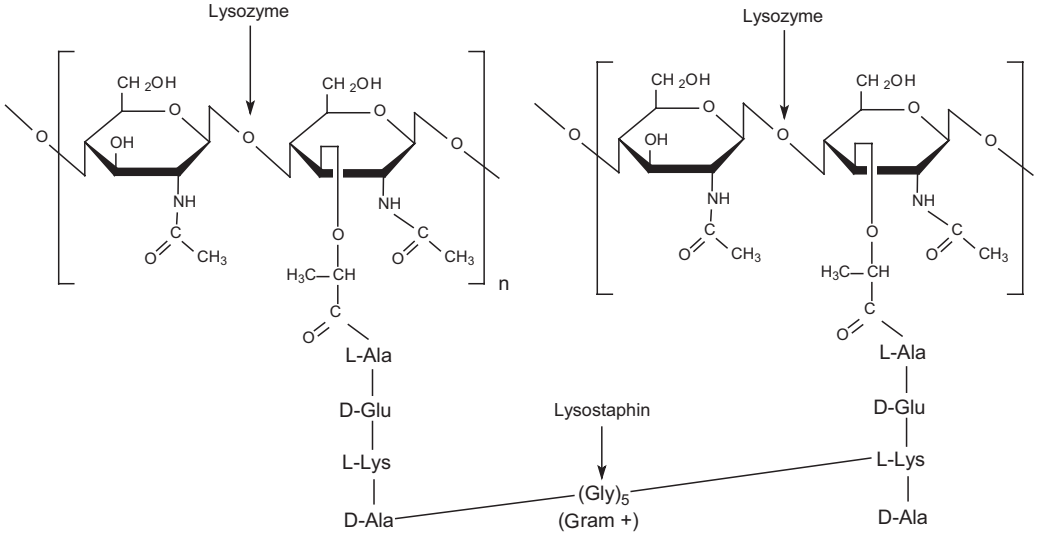
A product of Novozyme Corp.

2–8°C

I2017-50ML	**50 mL**
I2017-250ML	**250 mL**

Peptidoglycan Degrading Enzymes

Lysozyme and Mutanolysin Specificity



Peptidoglycan
Polymer of β-(1-4)-N-Acetyl-D-glucosamine units. Alternating residues are modified to form N-acetylmuramic acid with the addition of lactate to form branching links to the tetrapeptide.

Lysozyme

Lysozyme from chicken egg white

Mucopeptide N-acetylmuramoylhydrolase; Muramidase
[12650-88-3] E.C. 3.2.1.17

Lysozyme hydrolyzes β-(1-4) linkages between N-acetylmuramic acid and N-acetyl-D-glucosamine residues in peptidoglycan and between Nacetyl-D-glucosamine residues in chitodextrin. Gram-positive cells are quite susceptible to this hydrolysis as their cell walls have a high proportion of peptidoglycan. Gram-negative bacteria are less susceptible due to the presence of an outer membrane and a lower proportion of peptidoglycan. However, these cells may be hydrolyzed in the presence of EDTA that chelates metal ions in the outer bacterial membrane.

The enzyme is active over a broad pH range (6.0 to 9.0). At pH 6.2, maximal activity is observed over a wider range of ionic strengths (0.02 to 0.100 M) than at pH 9.2 (0.01 to 0.06 M).

Used to prepare spheroplasts.

Single-chain mol wt 14.7 kDa

One unit will produce a ΔA_{450} of 0.001 per min at pH 6.24 at 25 °C, using a suspension of *Micrococcus lysodeikticus* as substrate, in a 2.6 mL reaction mixture (1 cm light path).

▸ lyophilized powder, Protein: ~95%, activity: ~50,000 units/mg protein

Dialyzed and lyophilized, containing buffer salts as sodium acetate and sodium chloride

3× crystallized

–20°C

L6876-1G	**1 g**
L6876-5G	**5 g**
L6876-10G	**10 g**
L6876-25G	**25 g**
L6876-100G	**100 g**

▸ lyophilized powder, Protein: ~95%, activity: ~50,000 units/mg protein (E1%282)

Features and Benefits

- Highly purified by repeated crystallization and dialysis
- Each lot is use-tested for isolation of plasmid DNA from *E. coli* essentially salt-free

3× crystallized

–20°C

L7651-1G	**1 g**
L7651-5G	**5 g**
L7651-10G	**10 g**
L7651-25G	**25 g**
L7651-100G	**100 g**

▸ aseptically filled, Lyophilized powder

Prepared from L6876

–20°C

L7773-50MG	**50 mg**

Lysozyme chloride form from chicken egg white

Mucopeptide N-acetylmuramoylhydrolase; Muramidase
[9066-59-5] E.C. 3.2.1.17

Grade VI, activity: ~60,000 units/mg protein

Enzyme which breaks down the cell walls of bacteria; used to prepare spheroplasts.

Lyophilized powder containing sodium chloride and sodium acetate

mol wt ~14.3 kDa

Composition protein ~90%

3× Crystallized

One unit will produce a ΔA_{450} of 0.001 per min at pH 6.24 at 25 °C, using a suspension of *Micrococcus lysodeikticus* as substrate, in a 2.6 mL reaction mixture (1 cm light path).

-20°C

L2879-1G	**1 g**
L2879-5G	**5 g**
L2879-25G	**25 g**

Lysozyme from human milk

Mucopeptide N-acetylmuramoylhydrolase; Muramidase
[12671-19-1] E.C. 3.2.1.17

lyophilized powder, activity: ≥100,000 units/mg protein

Lyophilized powder containing sodium phosphate and sodium chloride

composition protein ~10%

One unit will produce a ΔA_{450} of 0.001 per min at pH 6.24 at 25 °C, using a suspension of *Micrococcus lysodeikticus* as substrate, in a 2.6 mL reaction mixture (1 cm light path).

-20°C

L6394-25KU	**25,000 units**
L6394-100KU	**100,000 units**

Lysozyme from human neutrophils

Mucopeptide N-acetylmuramoylhydrolase; Muramidase
[9001-63-2] E.C. 3.2.1.17

≥95% (SDS-PAGE), lyophilized powder, activity: ≥100,000 units/mg protein

Lyophilized from 50 mM sodium acetate, pH 6.0, with 100 mM NaCl

One unit will produce a ΔA_{450} of 0.001 per min at pH 6.24 at 25 °C, using a suspension of *Micrococcus lysodeikticus* as substrate, in a 2.6 mL reaction mixture (1 cm light path).

-20°C

L8402-.1MG	**0.1 mg**

Mutanolysin

Mutanolysin from *Streptomyces globisporus* ATCC 21553

[55466-22-3]

Mutanolysin is an N-acetylmuramidase. Like lysozyme, it is a muralytic enzyme that cleaves the β-N-acetylmuramyl-(1–4)-N-acetylglucosamine linkage of the bacterial cell wall polymer peptidoglycanpolysaccharide. Its carboxy terminal moieties are involved in the recognition and binding of unique cell wall polymers. Mutanolysin lyses *Listeria* and other Gram-positive bacteria such as *Lactobacillus* and *Lactococcus*.

Provides gentle cell lysis for the isolation of easily degradable biomolecules and RNA from bacteria. It has been used in the formation of spheroplasts for isolation of DNA.

mol wt 23 kDa

One unit will produce a ΔA_{600} of 0.01 per minute at pH 6.0 at 37 °C in a 1 mL volume using a suspension of *Streptococcus faecalis* cell wall as substrate.

lyophilized powder, activity: ≥4000 units/mg protein (biuret),

Chromatographically purified

Lyophilized powder containing Ficoll® and sodium succinate buffer salts

-20°C

M9901-1KU	**1,000 units**
M9901-5KU	**5,000 units**
M9901-10KU	**10,000 units**
M9901-50KU	**50,000 units**

aseptically filled, lyophilized powder, activity: ≥4000 units/mg protein (biuret)

Lyophilized powder containing Ficoll® and sodium succinate buffer salts

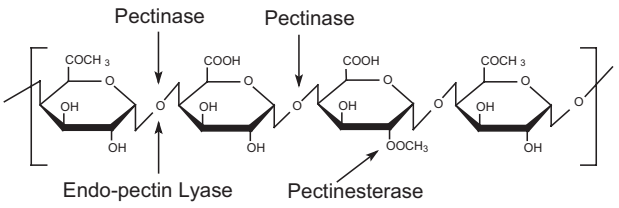
Prepared from M9901

-20°C

M4782-5KU	**5,000 units**

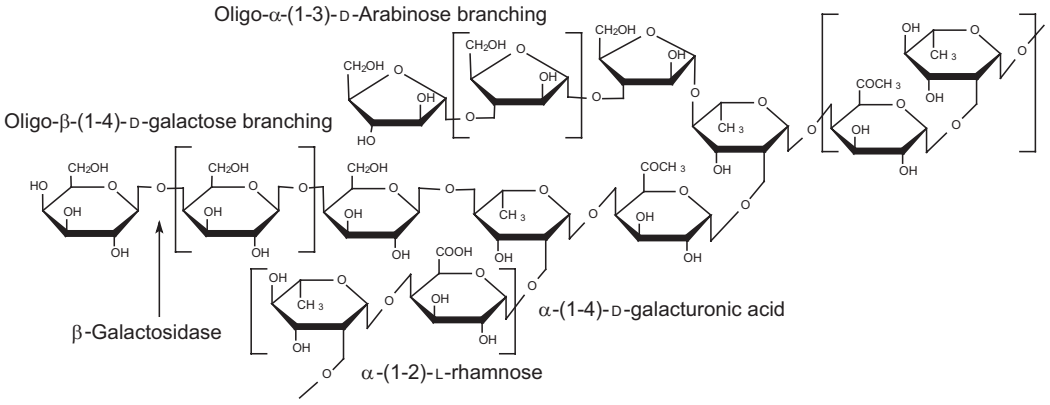
Pectin Degrading Enzymes

Pectinase and Pectinesterase Specificities



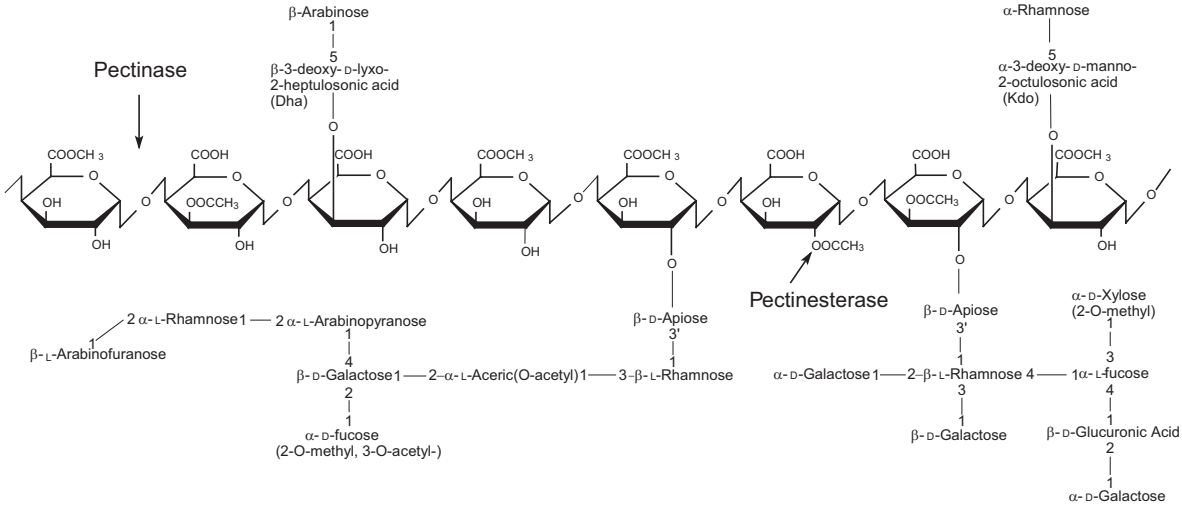
Homogalacturonan

Poly-α-(1-4)-D-galacturonic acid backbone with random-partial methylation and acetylation



Rhamnogalacturonan I

Alternating α-(1-2)-L-rhamnosyl-α-(1-4)-D-galacturonosyl backbone
with two types of branching composed of arabinofuranose or galactose oligomers



Rhamnogalacturonan II

Poly-α-(1-4)-D-galacturonic acid backbone with random-partial methylation, acetylation
and four different types of branching

Pectins are complex branched heteropolysaccharides primarily containing an α-(1-4) polygalacturonic acid backbone which can be randomly acetylated and methylated. Three different pectins have been isolated from plant cell walls. Homogalacturonans are composed of the simple α-(1-4) polygalacturonic acid backbone. Substituted homogalacturonans are modifications of this backbone with β-D-xylose branching at C3, or apiofuranose substitutions in the backbone with β-D-Apiosyl-(1,3')-β-D-Apiose branching. Rhamnogalacturonan I contains alternating α-(1-4) galacturonosyl and α-(1-2) rhamnosyl residues, with primarily oligo α-(1-3) arabinose and oligo β-(1-4) galactose branching. Rhamnogalacturonan II is composed of the simple α-(1-4) polygalacturonic acid backbone with complex branching composed of up to 11 different monosaccharide types.

Pectinase

Pectinase catalyzes the random hydrolysis of α-(1-4)-D-galactosiduronic linkages in pectin and other galacturonans.

Pectinase from *Aspergillus aculeatus*

Pectinex Ultra SPL®

aqueous solution, activity: ≥26,000 units/mL

Highly active pectolytic enzyme preparation produced by a selected strain of *Aspergillus aculeatus*

A product of Novozyme Corp.

2–8°C

P2611-50ML	**50 mL**
P2611-250ML	**250 mL**

Pectinase from *Aspergillus niger*

Pectinex® 3XL
aqueous solution

Pectolytic enzyme preparation produced from a selected strain of *Aspergillus niger*: contains mainly pectintranseliminase, polygalacturonase, and pectinesterase and small amounts of hemicellulases and cellulases.

A product of Novozyme Corp.

2–8°C

P2736-50ML	**50 mL**
P2736-250ML	**250 mL**

Pectinase solution from *Aspergillus niger*

Polygalacturonase solution from *Aspergillus niger*; Poly-(1,4-α-D-galacturonide) glycanohydrolase
[9032-75-1] E.C. 3.2.1.15

Used in plant protoplast preparation to digest cell wall prior to organelle isolation.

Solution in 40% glycerol

One unit will liberate 1.0 µmole of galacturonic acid from polygalacturonic acid per min at pH 4.0 at 25 °C.

▸ aqueous glycerol solution, activity: ≥5 units/mg protein (Lowry)

2–8°C

P4716-5KU	**5,000 units**
P4716-10KU	**10,000 units**
P4716-25KU	**25,000 units**
P4716-100KU	**100,000 units**

▸ plant cell culture tested, aqueous glycerol solution, activity: ≥5 units/mg protein (Lowry)

2–8°C

P0690-10KU	**10,000 units**
P0690-25KU	**25,000 units**

Pectinase from *Rhizopus* sp.

Macerozyme R-10; Polygalacturonase; Poly-(1,4-α-D-galacturonide) glycanohydrolase
[9032-75-1] E.C. 3.2.1.15 EC No. 2328856

Used in plant protoplast preparation to digest cell wall prior to organelle isolation.

One unit will liberate 1.0 µmole of galacturonic acid from polygalacturonic acid per min at pH 4.0 at 25 °C.

▸ powder, activity: 400-800 units/g solid

Crude source of pectinase activity, also containing cellulase and hemicellulase activities.

–20°C

P2401-500UN	**500 units**
P2401-1KU	**1,000 units**
P2401-5KU	**5,000 units**

▸ plant cell culture tested, crude powder activity: 400-800 units/g solid

–20°C

P4300-1KU	**1,000 units**
P4300-5KU	**5,000 units**

Pectin Degrading Enzymes

Pectinesterase

Pectinesterase catalyzes the hydrolysis of the methyl esters of pectin to yield pectate and methanol.

Pectinesterase from orange peel

Pectin methylesterase; Pectin pectylhydrolase
[9025-98-3] E.C. 3.1.1.11 EC No. 2328070

lyophilized powder, activity: ≥150 units/mg protein

Contains $(NH_4)_2SO_4$ and sodium chloride

Composition protein 20-50% (biuret)

One unit will release 1.0 microequivalent of acid from pectin per min at pH 7.5 at 30 °C.

Protein determined by biuret.

2-8°C

P5400-1KU	**1,000 units**

Pectolyase

Pectolyase catalyzes the eliminative cleavage of α-(1- 4)-D-galacturonan methyl ester to give oligosaccharides with 4-deoxy-6-O-methyl-α-D-galact-4-enuronosyl groups at their non-reducing ends.

Pectolyase from *Aspergillus japonicus*

E.C. 3.2.1.15

Reported to contain two types of pectinase, endopolygalacturonase (EC 3.2.1.15), endo-pectin lyase (EC 4.2.2.10) and a maceration stimulating factor.

Used in plant protoplast preparation to digest cell wall prior to organelle isolation.

Lyophilized powder containing lactose

One unit will liberate 1.0 µmole of galacturonic acid from polygalacturonic acid per min at pH 5.5 at 25 °C.

lyophilized powder, activity: ≥0.3 units/mg solid

2-8°C

P3026-100MG	**100 mg**
P3026-250MG	**250 mg**
P3026-1G	**1 g**

plant cell culture tested, lyophilized powder activity: ≥0.3 unit/mg solid

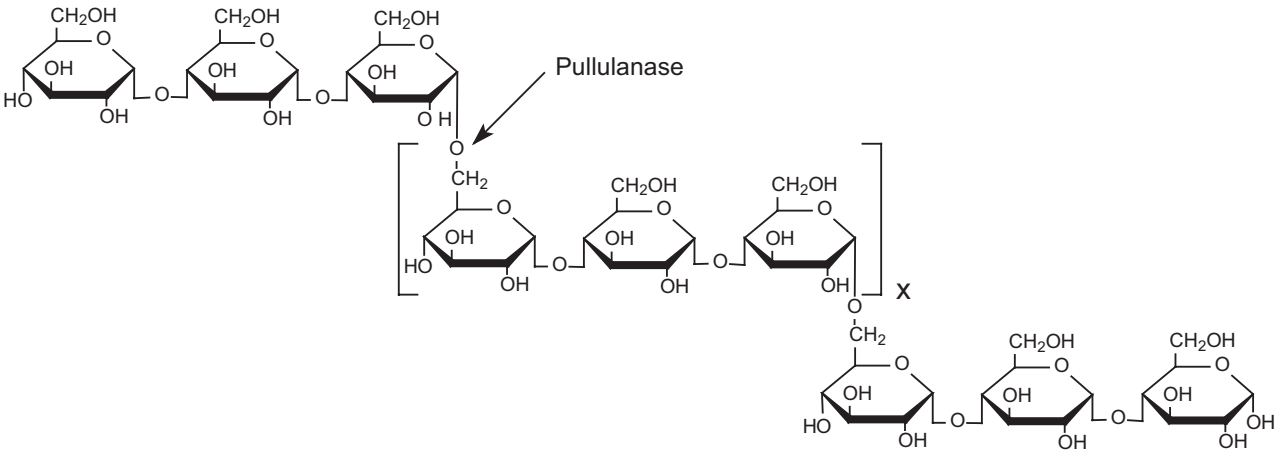
Composition protein ~60% (Lowry)

2-8°C

P5936-100MG	**100 mg**
P5936-250MG	**250 mg**
P5936-1G	**1 g**

Pullulanase

Pullulanase Specificity



Pullulan
Linear polymer of α-(1-6)-linked maltotriose units

Pullulanase catalyzes the hydrolysis of α-(1-6)-D-glucosidic linkages in pullulan (a linear polymer of α-(1-6)-linked maltotriose units), and, similar to isoamylase, in amylopectin and glycogen, and the α- and β- limit dextrins of amylopectin and glycogen.

Pullulanase from *Bacillus acidopullulyticus*

Pullulan 6-glucano-hydrolase
[9075-68-7] E.C. 3.2.1.41

Promozyme® 400 L
aqueous solution, ≥400 units/mL

Heat-stable debranching enzyme obtained from a selected strain of *Bacillus acidopullulyticus*, and belongs to the group of debranching enzymes known as pullulanases.

One unit is defined as the amount of enzyme which hydrolyzes pullulan, liberating reducing carbohydrate with a reducing power equivalent to 1.0 µmole glucose per minute at pH 5.0 and 40 °C.

density ..... 1.25 g/mL, 25 °C

A product of Novozymes Corp.

2–8°C

P2986-50ML	**50 mL**
P2986-250ML	**250 mL**

Pullulanase from *Klebsiella pneumoniae*

Amylopectin 6-gluconohydrolase; Limit dextrinase
[9075-68-7] E.C. 3.2.1.41

One unit will liberate 1.0 µmole of maltotriose (measured as glucose) from pullulan per min at pH 5.0 at 25 °C.

lyophilized powder, activity: 10-30 units/mg protein

Lyophilized powder containing potassium phosphate buffer salts and stabilizer

Composition protein ~10% (Lowry)

-20°C

P1067-100UN	**100 units**
P1067-250UN	**250 units**

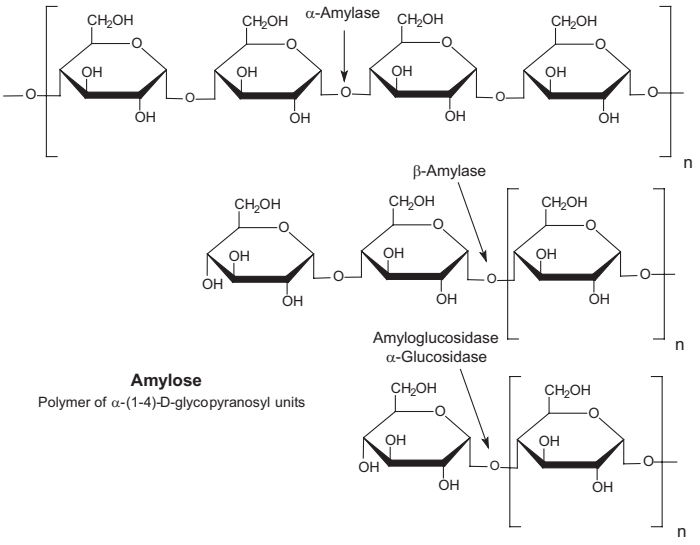
ammonium sulfate suspension, activity: ≥5 units/mg protein (biuret)

Suspension in 3.2 M $(NH_4)_2SO_4$ solution, pH 6.2
Highly purified by a modification of ion exchange chromatography.

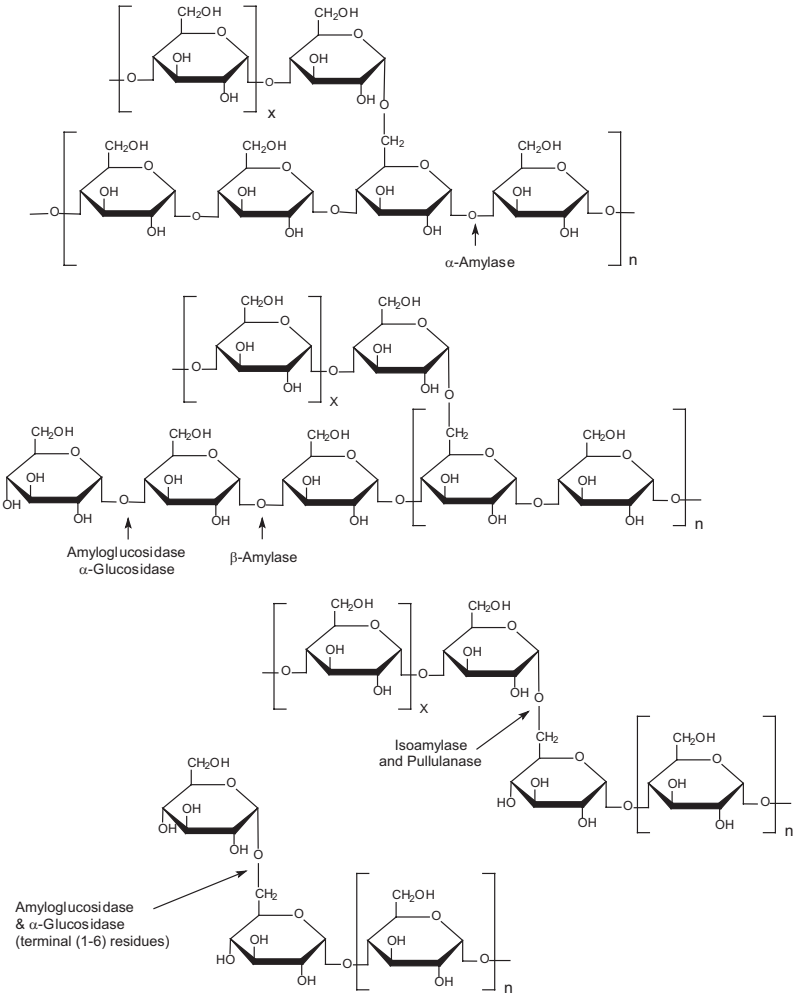
2–8°C

P5420-100UN	**100 units**
P5420-250UN	**250 units**

Starch and Glycogen Degrading Enzymes



Amylose
Polymer of α-(1-4)-D-glycopyranosyl units



Amylopectin and Glycogen
Polymers of α-(1-4)-D-glucopyranosyl units. Amylopectin has approximately 4% α-(1-6)-D-glucopyranosyl branching. Glycogen tends to have a higher frequency of branches of shorter length than amylopectin.

α-Amylase

α-Amylase catalyzes the endohydrolysis of α-(1-4)-D-glucosidic linkages in polysaccharides containing three or more α-(1-4)-linked D-glucose units.

α-Amylase from *Bacillus licheniformis*

1,4-α-D-Glucan-glucanohydrolase
[9000-85-5] E.C. 3.2.1.1

lyophilized powder, activity: 500-1,500 units/mg protein, ~95% (SDS-PAGE)

Lyophilized powder containing potassium

Composition protein ~70% (BCA)

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

heat ..... (Stable)

2–8°C

A4551-100MG	**100 mg**
A4551-1G	**1 g**

α-Amylase from *Aspergillus oryzae*

1,4-α-d-Glucan-glucanohydrolase
[9001-19-8] E.C. 3.2.1.1 EC No. 2325881

lyophilized powder, activity: 150-250 units/mg protein (biuret) Crude

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

–20°C

A6211-250KU	**250,000 units**
A6211-1MU	**1,000,000 units**
A6211-5MU	**5,000,000 units**

Fungamyl® 800L aqueous solution, activity: ≥0.8 units/g

A product of Novozyme Corp.

2–8°C

A8220-50ML	**50 mL**
A8220-250ML	**250 mL**

Taka-Diastase from *Aspergillus oryzae*

α-Amylase; 1,4-α-D-Glucan-glucanohydrolase; Taka-Amylase A
[9001-19-8] E.C. 3.2.1.1 EC No. 2325881

BioChemika, powder, activity: ~100 units/mg

One unit corresponds to the amount of enzyme which liberates 1 µmol maltose per minute at pH 6.0 and 25 °C (starch according to Zulkowsky, Catalog No. 85642, as substrate).

2–8°C

86247-25G	**25 g**
86247-100G	**100 g**

α-Amylase from *Bacillus* sp.

1,4-α-D-Glucan-glucanohydrolase from *Bacillus* sp.
[9000-90-2] E.C. 3.2.1.1

powder, activity: ≥400 units/mg protein (Lowry)

Contains starch as an extender.

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

–20°C

A6814-1MU	**1,000,000 units**
A6814-5MU	**5,000,000 units**
A6814-25MU	**25,000,000 units**

Duramyl®, liquid, activity: ≥300 units/g

Protein-engineered α-amylase produced by submerged fermentation of a genetically modified species of *Bacillus*.

A product of Novozyme Corp.

2–8°C

A7720-50ML	**50 mL**
A7720-250ML	**250 mL**

Type II-A, lyophilized powder, activity: 1,500-3,000 units/mg protein (biuret)

mol wt 50-55 kDa by SDS-PAGE
4× crystallized

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

–20°C

A6380-25MG	**25 mg**
A6380-100MG	**100 mg**
A6380-250MG	**250 mg**
A6380-500MG	**500 mg**
A6380-1G	**1 g**

α-Amylase from *Bacillus amyloliquefaciens*

BAN™ 240L; 1,4-α-D-Glucan glucanohydrolase
[9000-85-5] E.C. 3.2.1.1. EC No. 2325656

liquid, activity: ≥250 units/g

This enzyme is active at high temperatures (70-90 °C).

mol wt 55 kDa

One unit is the amount of enzyme which dextrinizes 5.26 g dry starch per hour under standard conditions.

A product of Novozyme Corp.

2–8°C

A7595-50ML	**50 mL**
A7595-250ML	**250 mL**

Starch and Glycogen Degrading Enzymes

α-Amylase from Bacillus licheniformis

1,4-α-D-Glucan-glucanohydrolase
[9000-85-5] E.C. 3.2.1.1
Termamyl® 120

Type XII-A, saline solution, activity: 500-1,000 units/mg protein (biuret)

Aqueous solution containing approx. 15% sodium chloride and 25% sucrose.

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

Reported to be heat stable at temperatures as high as ~90 °C.

A product of Novozyme Corp.

2-8°C

A3403-500KU	**500,000 units**
A3403-1MU	**1,000,000 units**
A3403-5MU	**5,000,000 units**

suitable for determination of starch (Kit STA-20)

2-8°C

A4582-.5ML	**0.5 mL**

α-Amylase, heat-stable

α-Amylase; 1,4-αD-Glucan-glucanohydrolase
[9000-85-5] E.C. 3.2.1.1

solution, For use in Total Dietary Fiber Assay, TDF-100A

2-8°C

A3306-10ML	**10 mL**

α-Amylase from barley malt

1,4-α-D-Glucan-glucanohydrolase
[9000-90-2] E.C. 3.2.1.1

Type VIII-A, powder

α-amylase activity: ≥1 unit/mg solid
β-amylase activity: ≥1 unit/mg solid
contains lactose as standardization of activity
Package size based on α-amylase activity

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

2-8°C

A2771-10KU	**10 KU**
A2771-50KU	**50 KU**

α-Amylase from human pancreas

[9000-90-2] E.C. 3.2.1.1 EC No. 2325656

lyophilized powder, activity: ≥100 units/mg protein

Lyophilized from Tris buffer containing NaCl and $CaCl_2$.
purified by 3× crystallization
Prepared by modified method of Levitzki et al.

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

–20°C

A9972-100UG	**100 µg**

α-Amylase from human saliva

1,4-α-D-Glucan-glucanohydrolase
[9000-90-2] E.C. 3.2.1.1 EC No. 2325656

composition
Protein ~10% (biuret)

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

Type XIII-A, lyophilized powder, activity: 300-1,000 units/mg protein

Lyophilized powder containing $(NH_4)_2SO_4$ and sodium citrate.

–20°C

A1031-1KU	**1,000 units**
A1031-5KU	**5,000 units**

Type IX-A, lyophilized powder, activity: 1,000-3,000 units/mg protein

Lyophilized powder containing $(NH_4)_2SO_4$ and sodium citrate
Chromatographically purified

–20°C

A0521-100UN	**100 units**
A0521-500UN	**500 units**
A0521-2.5KU	**2,500 units**

α-Amylase from porcine pancreas

E.C. 3.2.1.1

Molecular Weight: 51-54 kDa.

α-Amylase isolated from porcine pancreas is a glycoprotein. It is a single polypeptide chain of approximately 475 residues containing two SH groups and four disulfide bridges and a tightly bound Ca^{2+} necessary for stability. Chloride ions are necessary for activity and stability. The pH range for activity is 5.5 to 8.0, with the pH optimum at 7.

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 6.9 at 20 °C.

Type VI-B, activity: 10-30 units/mg solid

Contains lactose
Package size based on α-amylase activity

2-8°C

A3176-500KU	**500,000 units**
A3176-1MU	**1,000,000 units**
A3176-2.5MU	**2,500,000 units**
A3176-5MU	**5,000,000 units**
A3176-10MU	**10,000,000 units**

Type I-A, DFP Treated, saline suspension, activity: 700-1400 units/mg protein

Suspension in 2.9 M NaCl solution containing 3 mM $CaCl_2$

DFP treated. 2× crystallized

2-8°C

A6255-10MG	**10 mg**
A6255-25MG	**25 mg**
A6255-100MG	**100 mg**

Type VII-A, DFP treated, ammonium sulfate suspension, activity: ≥500 units/mg protein

Suspension in 3.2 M $(NH_4)_2SO_4$, pH 6.1

2–8°C

A2643-10MG	**10 mg**
A2643-50MG	**50 mg**

Type I-A, PMSF treated, saline suspension, activity: 700-1400 units/mg protein

Suspension in 2.9 M NaCl solution containing 3 mM $CaCl_2$.

2× crystallized

2–8°C

A4268-25MG	**25 mg**
A4268-100MG	**100 mg**

β-Amylase

β-Amylase catalyzes the exo-hydrolysis of α-(1-4)-D-glucosidic linkages in polysaccharides resulting in the successive liberation of maltose units from the non-reducing ends of the chains.

β-Amylase from barley

1,4-α-D-Glucan maltohydrolase
[9000-91-3] E.C. 3.2.1.2 EC No. 2325661

Type II-B, activity: 20-80 units/mg protein (biuret)

Crude

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 4.8 at 20 °C.

2–8°C

A7130-10KU	**10,000 units**
A7130-50KU	**50,000 units**
A7130-250KU	**250,000 units**

β-Amylase from sweet potato

1,4-α-D-Glucan maltohydrolase
[9000-91-3] E.C. 3.2.1.2 EC No. 2325661

Type I-B, ammonium sulfate suspension, activity: 750-1,000 units/mg protein

Crystalline suspension in 2.3 M $(NH_4)_2SO_4$

One unit will liberate 1.0 mg of maltose from starch in 3 min at pH 4.8 at 20 °C.

2–8°C

A7005-10KU	**10,000 units**
A7005-25KU	**25,000 units**
A7005-50KU	**50,000 units**
A7005-100KU	**100,000 units**

Amyloglucosidase

Amyloglucosidase catalyzes the hydrolysis of terminal α-(1-4)-linked D-glucose residues successively from the non-reducing ends of maltooligo-and polysaccharides with release of β-D-glucose. Most forms of the enzyme can rapidly hydrolyze α-(1-6)-D-glucosidic bonds when the next bond in the sequence is 1,4- and some preparations of this enzyme hydrolyze 1,6- and α-(1-3)-D-glucosidic bonds in other polysaccharides.

Amyloglucosidase from *Aspergillus niger*

Exo-1,4-α-glucosidase; 1,4-α-D-Glucan glucohydrolase; Glucoamylase
[9032-08-0] E.C. 3.2.1.3 EC No. 2328772

lyophilized powder, activity: ≥80 units/mg protein (biuret)

Lyophilized powder containing less than 0.02% glucose

One unit will liberate 1.0 mg of glucose from starch in 3 min at pH 4.5 at 55 °C.

–20°C

A7420-5MG	**5 mg**
A7420-25MG	**25 mg**
A7420-100MG	**100 mg**

AMG™ 300L, ≥300 units/mL

Stabilized with glucose
aqueous solution
density ..... ~1.2 g/mL, 25 °C

A product of Novozymes Corp.

2–8°C

A7095-50ML	**50 mL**

aqueous glucose solution activity: ≥5000 units/mL

Solution in 1 M glucose containing 0.5% sodium benzoate as preservative

One unit will liberate 1.0 mg of glucose from starch in 3 min at pH 4.5 at 55 °C.

2–8°C

A3042-50ML	**50 mL**

ammonium sulfate suspension, activity: ≥40 units/mg protein Suspension in 3.2 M $(NH_4)_2SO_4$ solution, pH approx. 6.0

One unit will liberate 1.0 mg of glucose from starch in 3 min at pH 4.5 at 55 °C.

2–8°C

A1602-25MG	**25 mg**
A1602-100MG	**100 mg**

Starch and Glycogen Degrading Enzymes

Amyloglucosidase from *Candida tsukubaensis*

Exo-1,4-α-glucosidase; 1,4-α-D-Glucan glucohydrolase; Glucoamylase
[9032-08-0] E.C. 3.2.1.3

ammonium sulfate suspension, activity: 50-150 units/mg protein

An acid-stable amyloglucosidase, maintaining high activity at pH values down to 2.5.

Suspension in 3.2 M $(NH_4)_2SO_4$, pH approx. 5.5.

One unit will liberate 1.0 mg of glucose from starch in 3 min at pH 4.5 at 55 °C.

2-8°C

A2330-25UN	**25 units**
A2330-100UN	**100 units**

Amyloglucosidase from *Rhizopus* sp.

Exo-1,4-α-glucosidase; 1,4-α-D-Glucan glucohydrolase; Glucoamylase [9032-08-0] E.C. 3.2.1.3 EC No. 2328772

activity: ≥40,000 units/g solid

Lyophilized salt-free powder

Composition protein ~35% (biuret)

One unit will liberate 1.0 mg of glucose from starch in 3 min at pH 4.5 at 55 °C.

2-8°C

A9228-1G	**1 g**

α-Glucosidase

α-Glucosidase catalyzes the hydrolysis of terminal α-(1-4)-linked D-glucose residues successively from the non-reducing ends of maltooligo-and to a lesser extent polysaccharides with release of β-D-glucose. Most forms of the enzyme can slowly hydrolyze α-(1-6)-D-glucosidic bonds.

α-Glucosidase from *Bacillus stearothermophilus*

α-D-Glucoside glucohydrolase; Maltase
[9001-42-7] E.C. 3.2.1.20

lyophilized powder, activity: ≥50 units/mg protein

Lyophilized powder containing potassium phosphate buffer salt

One unit will liberate 1.0 µmole of D-glucose from p-nitrophenyl α-D-glucoside per min at pH 6.8 at 37 °C.

Protein determined by biuret.

β-Glucosidase, α-galactosidase and β-galactosidase ..... ≤0.1%

2-8°C

G3651-250UN	**250 units**

α-Glucosidase from rice

α-D-Glucoside glucohydrolase; Maltase
[9001-42-7] E.C. 3.2.1.20

Type V, ammonium sulfate suspension, activity: 40-80 units/mg protein

Suspension in 2.8 M $(NH_4)_2SO_4$ solution

One unit will convert 1.0 µmole of maltose to 2.0 µmoles of D-glucose per min at pH 4.0 at 37 °C.

Protein determined by biuret.

2-8°C

G9259-100UN	**100 units**

α-Glucosidase from *Saccharomyces cerevisiae*

α-D-Glucosidase; α-D-Glucoside glucohydrolase; Maltase from yeast
[9001-42-7] E.C. 3.2.1.20 EC No. 2326047

For the determination of α-amylase and the synthesis of various 1'-osucrose and 1-O-fructose esters

Protein determined by biuret.

▸ recombinant, expressed in unspecified host, lyophilized powder, activity: ≥125 units/mg protein

Lyophilized powder containing potassium phosphate buffer salt pH 7.15 and approx. 70% lactose

One unit will liberate 1.0 µmole of D-glucose from p-nitrophenyl α-Dglucoside

per min at pH 6.8 at 37 °C.

2-8°C

G0660-750UN	**750 units**

▸ Type I, lyophilized powder, activity: ≥10 units/mg protein (using p-nitrophenyl α-D-glucoside as substrate.)

contains phosphate buffer salts and EDTA as balance

composition

Protein ~50%

Sold on basis of p-nitrophenyl α-D-glucoside units.

One unit will liberate 1.0 µmole of D-glucose from p-nitrophenyl α-D-glucoside per min at pH 6.8 at 37 °C.

β-Glucosidase, α-galactosidase and β-galactosidase ..... ≤0.1%

–20°C

G5003-100UN	**100 units**
G5003-1KU	**1,000 units**

Kits for Carbohydrate Analysis

Sigma manufactures several unique enzymatic-based kits for the quantitation of important carbohydrates. These kits utilize spectrophotometric, and gravimetric detection making them easy-to-use, yielding high sensitivity, and consistent results.

Total Dietary Fiber Assay Kit, Cat. No. TDF100A-1KT

sufficient for ~100 assays

For the determination of total dietary fiber. Uses a combination of enzymatic and gravimetric methods to analyze samples of dried, defatted foods to determine soluble fiber, protein, and ash content. This procedure is based on the method published by AOAC.[1]

Reference:

[1]Official Methods of Analysis, 16th ed., AOAC, Arlington, VA, Vol. II, Sec. 45.4.07, Method 985.29, 1105 (1997).

Total Dietary Fiber Assay Procedure

Heat stable α-Amylase, incubation at pH 6.0, 15 min., 95 °C

↓

Protease incubation at pH 7.5, 30 min., 60 °C

↓

Amyloglucosidase incubation at pH 4.5, 30 min., 60 °C

↓

Ethanol precipitation of Soluble Dietary Fiber

↓

Alcohol and acetone washes

↓

Drying

↙ ↘

Kjeldahl Protein → Determination

Ash Determination 5 hours, 525 °C

↘ ↙

Calculation of Total Dietary Fiber

Dietary Fiber, Total, Assay Control Kit, Cat. No. TDFC10-1KT

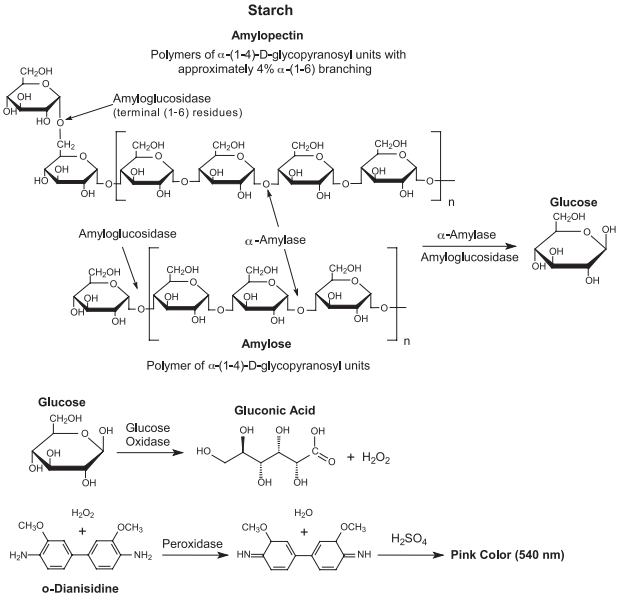
sufficient for ~10 assays

Set of 6 standards for use as internal controls in conjunction with the Total Dietary Fiber Assay Kit (TDF100A)

Starch (GO/P) Assay Kit, Cat. No. STA20-1KT

sufficient for 20 assays

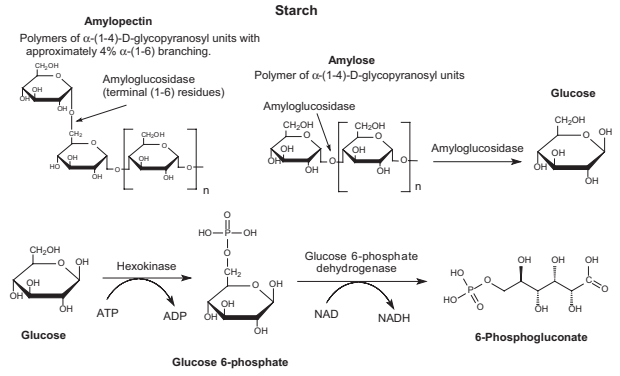
For the quantitative, enzymatic determination of starch in food and other materials. The hydrolysis of starch to glucose is catalyzed by α-amylase and amyloglucosidase. Glucose is oxidized to gluconic acid and hydrogen peroxide by glucose oxidase. Hydrogen peroxide reacts with *o*-dianisidine in the presence of peroxidase to form a colored product. Oxidized *o*-dianisidine reacts with sulfuric acid to form a more stable colored product. The intensity of the pink color measured at 540 nm is proportional to the original glucose concentration.



Starch (HK) Assay Kit, Cat. No. SA20-1KT

sufficient for 20 assays

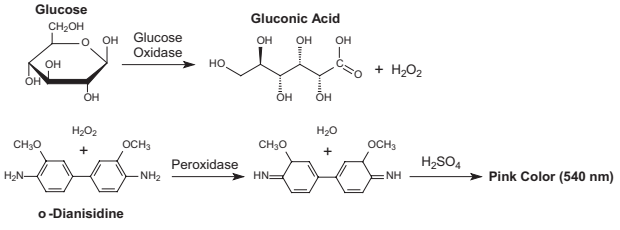
For the quantitative, enzymatic determination of native starch in food and other materials. The hydrolysis of starch to glucose is catalyzed by amyloglucosidase. Glucose is phosphorylated by hexokinase. Glucose-6-phosphate is then oxidized to 6-phosphogluconate in the presence of NAD in a reaction catalyzed by glucose 6-phosphate dehydrogenase. The increase in absorbance at 340 nm is directly proportional to the glucose concentration.



Glucose (GO) Assay Kit, Cat. No. GAGO20-1KT

sufficient for 20 assays

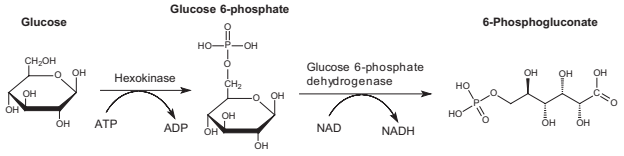
For the quantitative, enzymatic determination of glucose in food and other materials. Glucose is oxidized to gluconic acid and hydrogen peroxide by glucose oxidase. Hydrogen peroxide reacts with *o*-dianisidine in the presence of peroxidase to form a colored product. Oxidized *o*-dianisidine reacts with sulfuric acid to form a more stable colored product. The intensity of the pink color measured at 540 nm is proportional to the original glucose concentration.



Glucose (HK) Assay Kit, Cat. No. GAHK20-1KT

sufficient for 20 assays

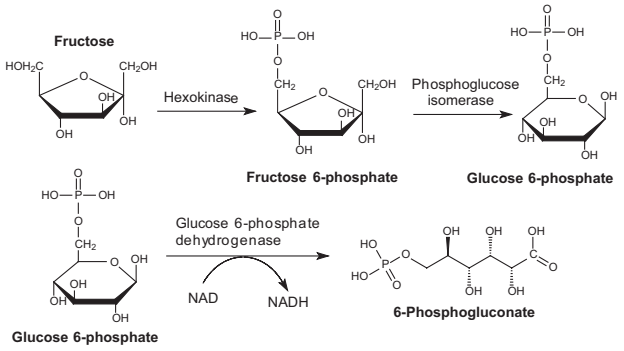
For the quantitative, enzymatic determination of glucose in food and other materials. Glucose is phosphorylated by hexokinase to form glucose 6-phosphate. Glucose 6-phosphate is then oxidized to 6-phospho gluconate in the presence of NAD by glucose 6-phosphate dehydrogenase. During this oxidation, an equimolar amount of NAD is reduced to NADH. The consequent increase in absorbance at 340 nm is directly proportional to glucose concentration.



Fructose Assay Kit, Cat. No. FA20-1KT

sufficient for 20 assays

For the quantitative, enzymatic determination of fructose in food and other materials. Fructose is phosphorylated by ATP using hexokinase. Fructose 6-phosphate is then converted to glucose 6-phosphate by phosphoglucose isomerase. Glucose 6-phosphate is then oxidized to 6-phosphogluconate in the presence of NAD by glucose 6-phosphate dehydrogenase. During this oxidation, an equimolar amount of NAD is reduced to NADH. The consequent increase in absorbance at 340 nm is directly proportional to fructose concentration.



Complex Carbohydrates

The following table contains selected polysaccharides, glycosaminoglycans, and related reagents for use as standards, glycan detection and measurement of enzymatic activity.

Product Name	Description	Cat. No.
Alginic acid ammonium calcium salt *Macrocystis pyrifera* (kelp)	-	**A7253-100G**
Alginic acid from brown algae	-	**A7003-100G**
		A7003-250G
		A7003-500G
		A7003-1KG
Alginic acid sodium from salt brown algae	for immobilization of microorganisms	**71238-50G**
		71238-250G
		71238-1KG
Alginic acid sodium from salt brown algae	Low viscosity	**A2158-100G**
		A2158-250G
		A2158-500G
		A2158-1KG
Alginic acid sodium from salt brown algae	Medium viscosity	**A2033-100G**
		A2033-250G
		A2033-500G
		A2033-1KG
Alginic acid sodium from salt brown algae	Low viscosity, plant cell culture tested, powder	**A0682-100G**
Amylopectin potato starch	-	**A8515-25G**
		A8515-100G
Amylopectin Azure	Amylase Substrate	**A4640-1G**
		A4640-5G
		A4640-25G
		A4640-50G
Amylose from potato	Essentially Free of Amylopectin	**A0512-250MG**
		A0512-1G
		A0512-5G
		A0512-25G
Amylose–Remazol Brilliant Blue R	Amylase Substrates	**A3508-1G**
		A3508-5G
Chitin from crab shells	suitable for analysis of chitinase, purified powder	**C9752-250MG**
		C9752-1G
		C9752-5G
Chitin from crab shells	practical grade, powder	**C7170-100G**
		C7170-1KG
Chitin from crab shells	practical grade, coarse flakes	**C9213-500G**
		C9213-1KG
Chitin azure	Chitinase Substrate	**C3020-100MG**
		C3020-1G
Chitosan from crab shells	≥75% deacetylated	**C3646-10G**
		C3646-25G
		C3646-100G
		C3646-500G
Chondroitin disaccharide Δdi-0S sodium salt	-	**C3920-5MG**
		C3920-10MG
Chondroitin disaccharide Δdi-4S sodium salt	-	**C4045-5MG**
		C4045-10MG
Chondroitin disaccharide Δdi-6S sodium salt	-	**C4170-5MG**
		C4170-25MG
Chondroitin disaccharide Δdi-UA-2S sodium salt	-	**C5820-1MG**
Chondroitin 6-sulfate sodium salt from shark cartilage	~90%, balance is chondroitin sulfate A	**C4384-250MG**
		C4384-1G
		C4384-5G
		C4384-25G
Chondroitin sulfate B sodium salt	from porcine intestinal mucosa, ≥90%, lyophilized powder	**C3788-25MG**
		C3788-100MG
Monoclonal Anti-Chondroitin Sulfate antibody produced in mouse	clone CS-56, ascites fluid	**C8035-.2ML**
		C8035-.5ML
Chondroitin sulfate A sodium salt from bovine trachea	cell culture tested	**C9819-5G**
		C9819-25G

Complex Carbohydrates

Product Name	Description	Cat. No.
Curdlan from *Alcaligenes faecalis*	-	**C7821-5G**
Dammar Resin	-	**30424-250G**
		30424-1KG
Dextran from *Leuconostoc mesenteroides*	average mol wt 9,000-11,000	**D9260-10G**
		D9260-50G
		D9260-100G
		D9260-500G
Dextran from *Leuconostoc mesenteroides*	average mol wt 64,000-76,000	**D4751-10G**
		D4751-50G
		D4751-100G
		D4751-500G
		D4751-1KG
Dextran from *Leuconostoc mesenteroides*	average mol wt 35,000-45,000	**D1662-10G**
		D1662-50G
		D1662-100G
		D1662-500G
Dextran from *Leuconostoc mesenteroides*	average mol wt 425,000-575,000	**D1037-50G**
		D1037-100G
		D1037-500G
Dextran *Leuconostoc mesenteroides*	average mol wt 100,000-200,000	**D4876-50G**
		D4876-100G
		D4876-500G
		D4876-1KG
Dextran from *Leuconostoc mesenteroides*	industrial grade, average mol wt 5,000,000-40,000,000	**D5501-100G**
		D5501-500G
		D5501-1KG
Dextran from *Leuconostoc mesenteroides*	average mol wt ~2,000,000	**D5376-100G**
		D5376-500G
Dextran solution from *Leuconostoc mesenteroides*	20 % (w/w) (Autoclaved)	**D8802-25ML**
		D8802-50ML
β-D-Glucan from barley	powder	**G6513-50MG**
		G6513-100MG
		G6513-500MG
		G6513-1G
		G6513-5G
Glucan from baker's yeast *(S. cerevisiae)*	-	**G5011-25MG**
		G5011-100MG
Glycogen from bovine liver	-	**G0885-1G**
		G0885-5G
		G0885-10G
		G0885-25G
Glycogen *Crepidula fornicata* (slipper limpet)	-	**G1633-5G**
Glycogen from *Mytilus edulis* (Blue mussel)	-	**G1508-5G**
		G1508-25G
Glycogen from oyster	-	**G1765-5MG**
		G1765-10MG
		G1765-25MG
Glycogen from oyster	-	**G8751-5G**
		G8751-25G
		G8751-100G
Glycogen from rabbit liver	-	**G8876-500MG**
		G8876-1G
		G8876-5G
		G8876-10G
Glycogen azure	from rabbit liver, suitable for substrate for α-amylase	**G5510-1G**
Glycol chitosan	≥60% (colloidal titration), crystalline	**G7753-500MG**
		G7753-1G
		G7753-5G

Complex Carbohydrates

Product Name	Description	Cat. No.
Guar	-	**G4129-250G**
		G4129-500G
		G4129-1KG
Gum accroides	-	**G9627-500G**
Gum arabic from acacia tree	reagent grade	**G9752-500G**
		G9752-1KG
Heparan sulfate sodium salt from bovine kidney	-	**H7640-1MG**
		H7640-5MG
		H7640-10MG
Heparan sulfate fast-moving fraction sodium salt from porcine intestinal mucosa	≥90% (electrophoresis)	**H9902-1MG**
		H9902-5MG
Heparan sulfate proteoglycan	≥400 µg/mL glycosaminoglycan, sterile-filtered	**H4777-.1MG**
Heparin sodium salt from porcine intestinal mucosa	mol wt 4,000-6,000 Da	**H8537-50MG**
		H8537-100MG
		H8537-250MG
		H8537-1G
Heparin sodium salt from porcine intestinal mucosa	average mol wt ~3,000	**H3400-50MG**
		H3400-100MG
		H3400-250MG
		H3400-1G
Heparin sodium salt from porcine intestinal mucosa	Grade I-A, activity: ~170 USP units/mg	**H3393-10KU**
		H3393-25KU
		H3393-50KU
		H3393-100KU
		H3393-250KU
		H3393-500KU
		H3393-1MU
Heparin-benzalkonium	activity: ~60 USP units/mg	**H7280-1G**
Heparin, deaminated sodium salt from porcine intestinal mucosa	Low molecular weight mono-aldehyde, heparin activity: >75 USP units/mg	**H7405-250MG**
		H7405-1G
Heparin disaccharide I-A sodium salt	α-δUA-2S-[1→4]-GlcNAc-6S	**H9517-1MG**
Heparin disaccharide I-H sodium salt	α-δUA-2S-[1→4]-Glc-6S	**H8892-1MG**
Heparin disaccharide I-S sodium salt	(α-ΔUA-2S-[1→4]-GlcNS-6S)	**H9267-1MG**
Heparin disaccharide II-H sodium salt	(α-δUA-[1→4]-GlcN-6S)	**H9017-1MG**
Heparin disaccharide III-H sodium salt	(α-δUA-S2-[1→4]-GlcN)	**H9142-1MG**
Heparin disaccharide III-S sodium salt	(α-ΔUA-2S-[1→4]-GlcNS)	**H9392-1MG**
Heparin disaccharide IV-A sodium salt	(α-ΔUA-[1→4]-GlcNAc)	**H0895-.5MG**
Heparin disaccharide IV-H ≥95%	α-ΔUA-[1→4]-GlcN	**H9276-1MG**
Hyaluronan biotin sodium salt	>97%, soluble powder	**B1557-5MG**
Hyaluronic acid potassium salt from human umbilical cord	suitable as substrate for hyaluronidase	**H1504-50MG**
		H1504-100MG
		H1504-500MG
		H1504-1G
Hyaluronic acid potassium salt from human umbilical cord	Highly polymerized	**H1751-500MG**
Hyaluronic acid sodium salt from bovine vitreous humor	-	**H7630-10MG**
		H7630-50MG
Hyaluronic acid sodium salt from rooster comb	-	**H5388-100MG**
		H5388-250MG
		H5388-1G
Hyaluronic acid sodium salt from *Streptococcus equi*	-	**53747-1G**
		53747-10G
Hyaluronic acid sodium salt from *Streptococcus zooepidemicus*	-	**H9390-1G**
Hyaluronic acid disaccharide δDiHA sodium salt	≥95%	**H9649-1MG**
Inulin from chicory	-	**I2255-10G**
		I2255-25G
		I2255-100G
		I2255-1KG

Complex Carbohydrates

Product Name	Description	Cat. No.
Inulin from dahlia tubers	Mr^2 5000	**I3754-25G**
		I3754-100G
		I3754-1KG
Inulin–FITC	from dahlia tuber	**F3272-1G**
Lichenan from Cetraria islandica	practical grade, powder	**L6133-250MG**
		L6133-1G
Pectin from apple	meets USP testing specifications	**P8471-100G**
		P8471-500G
Pectin from citrus peel	Galacturonic acid: ≥74.0%	**P9135-100G**
		P9135-500G
		P9135-1KG
Pectin, esterified from citrus fruit	extent of labeling: ~90% esterified	**P9561-5G**
		P9561-25G
Pectin, esterified potassium salt from citrus fruit	extent of labeling: ~60% esterified	**P9436-5G**
		P9436-25G
		P9436-50G
Pectin, esterified potassium salt from citrus fruit	extent of labeling: ~30% esterified	**P9311-5G**
		P9311-25G
Peptidoglycan from *Bacillus subtilis*	-	**69554-10MG-F**
Peptidoglycan from *Micrococcus luteus*	-	**53243-10MG-F**
Peptidoglycan from *Saccharomyces cerevisiae*	-	**72789-10MG-F**
Peptidoglycan from *Staphylococcus aureus*	-	**77140-10MG**
		77140-25MG
Peptidoglycan from *Streptomyces* sp.	-	**79682-10MG-F**
Pullulan from *Aureobasidium pullulans*	suitable for substrate for pullulanase	**P4516-1G**
		P4516-5G
		P4516-25G
Stachyose hydrate from *Stachys tuberifera*	≥98%	**S4001-10MG**
		S4001-100MG
		S4001-500MG
		S4001-1G
		S4001-5G
Starch	from potatoes, for electrophoresis	**85645-100G**
		85645-1KG
Starch	from potatoes	**85650-1KG**
Starch from corn	Standard for Starch Assay Kits SA-20 and STA-20	**S5296-5G**
Starch from corn	practical grade	**S4180-100G**
		S4180-500G
		S4180-1KG
Starch from corn	Unmodified regular corn starch containing approx. 73% amylopectin and 27% amylose	**S4126-2KG**
		S4126-5KG
Starch from potato	for electrophoresis	**S5651-100G**
		S5651-500G
		S5651-1KG
		S5651-2KG
		S5651-5KG
Starch from potato	Soluble	**S2630-100G**
		S2630-500G
		S2630-1KG
Starch from potato	Soluble	**S2004-500G**
		S2004-1KG
Starch from potato	Powder	**S4251-2KG**
		S4251-5KG
Starch from rice	-	**S7260-100G**
		S7260-500G
		S7260-1KG
Starch from wheat	Unmodified S	**5127-100G**
		S5127-500G
		S5127-5KG

Complex Carbohydrates

Product Name	Description	Cat. No.
Starch from wheat	Purified	**S2760-500G**
Starch from Azure	Potato starch covalently linked with Remazol Brilliant Blue	**S7629-1G**
		S7629-5G
		S7629-25G
Starch from Azure	Insoluble corn starch covalently linked with Remazol Brilliant Blue	**S7776-1G**
		S7776-5G
Starch, from soluble	ACS reagent	**S9765-100G**
		S9765-250G
		S9765-500G
		S9765-1KG
Xylan from beechwood	-	**X4252-10G**
		X4252-25G
		X4252-100G
Xylan from birch wood	Xylose residues: ≥90%	**X0502-10G**
		X0502-25G
		X0502-100G
Xylan from birch wood	-	**95588-10G**
		95588-25G
		95588-100G
Xylan from oat spelts	Xylose: ≥70%	**X0627-10G**
		X0627-25G
		X0627-100G
Xylan from oat spelts	-	**95590-10G**
		95590-50G

Argentina
SIGMA-ALDRICH DE ARGENTINA S.A.
Free Tel: 0810 888 7446
Tel: (+54) 11 4556 1472
Fax: (+54) 11 4552 1698

Australia
SIGMA-ALDRICH PTY LTD.
Free Tel: 1800 800 097
Free Fax: 1800 800 096
Tel: (+61) 2 9841 0555
Fax: (+61) 2 9841 0500

Austria
SIGMA-ALDRICH HANDELS GmbH
Tel: (+43) 1 605 81 10
Fax: (+43) 1 605 81 20

Belgium
SIGMA-ALDRICH NV/SA.
Free Tel: 0800 14747
Free Fax: 0800 14745
Tel: (+32) 3 899 13 01
Fax: (+32) 3 899 13 11

Brazil
SIGMA-ALDRICH BRASIL LTDA.
Free Tel: 0800 701 7425
Tel: (+55) 11 3732 3100
Fax: (+55) 11 5522 9895

Canada
SIGMA-ALDRICH CANADA LTD.
Free Tel: 1800 565 1400
Free Fax: 1800 265 3858
Tel: (+1) 905 829 9500
Fax: (+1) 905 829 9292

China
SIGMA-ALDRICH (SHANGHAI)
TRADING CO. LTD.
Free Tel: 800 819 3336
Tel: (+86) 21 6141 5566
Fax: (+86) 21 6141 5567

Czech Republic
SIGMA-ALDRICH S.R.O.
Tel: (+420) 246 003 200
Fax: (+420) 246 003 291

Denmark
SIGMA-ALDRICH DENMARK A/S
Tel: (+45) 43 56 59 10
Fax: (+45) 43 56 59 05

Finland
SIGMA-ALDRICH FINLAND OY
Tel: (+358) 9 350 9250
Fax: (+358) 9 350 92555

France
SIGMA-ALDRICH CHIMIE S.à.r.l.
Free Tel: 0800 211 408
Free Fax: 0800 031 052
Tel: (+33) 474 82 28 00
Fax: (+33) 474 95 68 08

Germany
SIGMA-ALDRICH CHEMIE GmbH
Free Tel: 0800 51 55 000
Free Fax: 0800 64 90 000
Tel: (+49) 89 6513 0
Fax: (+49) 89 6513 1160

Greece
SIGMA-ALDRICH (O.M.) LTD.
Tel: (+30) 210 994 8010
Fax: (+30) 210 994 3831

Hungary
SIGMA-ALDRICH Kft
Ingyenes zöld telefon: 06 80 355 355
Ingyenes zöld fax: 06 80 344 344
Tel: (+36) 1 235 9055
Fax: (+36) 1 235 9050

India
SIGMA-ALDRICH CHEMICALS
PRIVATE LIMITED
Telephone
Bangalore: (+91) 80 6621 9600
New Delhi: (+91) 11 4165 4255
Mumbai: (+91) 22 2570 2364
Hyderabad: (+91) 40 6684 5488
Fax
Bangalore: (+91) 80 6621 9650
New Delhi: (+91) 11 4165 4266
Mumbai: (+91) 22 2579 7589
Hyderabad: (+91) 40 6684 5466

Ireland
SIGMA-ALDRICH IRELAND LTD.
Free Tel: 1800 200 888
Free Fax: 1800 600 222
Tel: (+353) 1 404 1900
Fax: (+353) 1 404 1910

Israel
SIGMA-ALDRICH ISRAEL LTD.
Free Tel: 1 800 70 2222
Tel: (+972) 8 948 4100
Fax: (+972) 8 948 4200

Italy
SIGMA-ALDRICH S.r.l.
Numero Verde: 800 827018
Tel: (+39) 02 3341 7310
Fax: (+39) 02 3801 0737

Japan
SIGMA-ALDRICH JAPAN K.K.
Tokyo Tel: (+81) 3 5796 7300
Tokyo Fax: (+81) 3 5796 7315

Korea
SIGMA-ALDRICH KOREA
Free Tel: (+82) 80 023 7111
Free Fax: (+82) 80 023 8111
Tel: (+82) 31 329 9000
Fax: (+82) 31 329 9090

Malaysia
SIGMA-ALDRICH (M) SDN. BHD
Tel: (+60) 3 5635 3321
Fax: (+60) 3 5635 4116

Mexico
SIGMA-ALDRICH QUÍMICA, S.A. de C.V.
Free Tel: 01 800 007 5300
Free Fax: 01 800 712 9920
Tel: 52 722 276 1600
Fax: 52 722 276 1601

The Netherlands
SIGMA-ALDRICH CHEMIE BV
Free Tel: 0800 022 9088
Free Fax: 0800 022 9089
Tel: (+31) 78 620 5411
Fax: (+31) 78 620 5421

New Zealand
SIGMA-ALDRICH NEW ZEALAND LTD.
Free Tel: 0800 936 666
Free Fax: 0800 937 777
Tel: (+61) 2 9841 0555
Fax: (+61) 2 9841 0500

Norway
SIGMA-ALDRICH NORWAY AS
Tel: (+47) 23 17 60 60
Fax: (+47) 23 17 60 50

Poland
SIGMA-ALDRICH Sp. z o.o.
Tel: (+48) 61 829 01 00
Fax: (+48) 61 829 01 20

Portugal
SIGMA-ALDRICH QUÍMICA, S.A.
Free Tel: 800 202 180
Free Fax: 800 202 178
Tel: (+351) 21 924 2555
Fax: (+351) 21 924 2610

Russia
SIGMA-ALDRICH RUS, LLC
Tel: +7 (495) 621 6037
Fax: +7 (495) 621 5923

Singapore
SIGMA-ALDRICH PTE. LTD.
Tel: (+65) 6779 1200
Fax: (+65) 6779 1822

South Africa
SIGMA-ALDRICH
SOUTH AFRICA (PTY) LTD.
Free Tel: 0800 1100 75
Free Fax: 0800 1100 79
Tel: (+27) 11 979 1188
Fax: (+27) 11 979 1119

Spain
SIGMA-ALDRICH QUÍMICA, S.A.
Free Tel: 900 101 376
Free Fax: 900 102 028
Tel: (+34) 91 661 99 77
Fax: (+34) 91 661 96 42

Sweden
SIGMA-ALDRICH SWEDEN AB
Tel: (+46) 8 742 4200
Fax: (+46) 8 742 4243

Switzerland
SIGMA-ALDRICH CHEMIE GmbH
Free Tel: 0800 80 00 80
Free Fax: 0800 80 00 81
Tel: (+41) 81 755 2828
Fax: (+41) 81 755 2815

United Kingdom
SIGMA-ALDRICH COMPANY LTD.
Free Tel: 0800 717 181
Free Fax: 0800 378 785
Tel: (+44) 1747 833 000
Fax: (+44) 1747 833 313
SAFC (UK) Free Tel: 0800 71 71 17

United States
SIGMA-ALDRICH
P.O. Box 14508
St. Louis, Missouri 63178
Toll-Free: 800 325 3010
Toll-Free Fax: 800 325 5052
Call Collect: (+1) 314 771 5750
Tel: (+1) 314 771 5765
Fax: (+1) 314 771 5757

Internet
sigma-aldrich.com

World Headquarters
3050 Spruce St., St. Louis, MO 63103
(314) 771-5765
sigma-aldrich.com

Order/Customer Service (800) 325-3010 • Fax (800) 325-5052
Technical Service (800) 325-5832 • sigma-aldrich.com/techservice
Development/Bulk Manufacturing Inquiries SAFC™ (800) 244-1173

SIGMA-ALDRICH

*Accelerating Customers' Success through Leadership in **Life Science**, **High Technology** and **Service***

The SIGMA-ALDRICH Group

SIGMA® ALDRICH® Fluka® Riedel-de Haën® SAFC™ SUPELCO® ISOTEC™

JFK
01948-504141
0037

SIGMA-ALDRICH™

3050 Spruce Street • St. Louis, MO 63103 USA