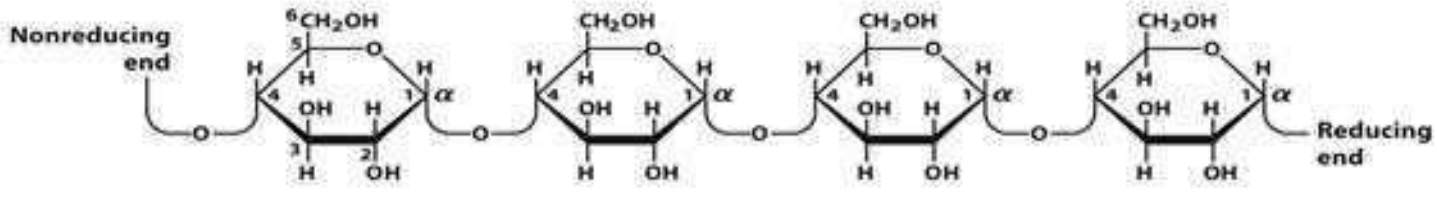
Polysaccharides

- Polysaccharides are polymers of monosaccharides.
- The number of monosaccharides is termed degree of polymerization (DP). Usually, DP>200.
- Polysaccharides can be:
    - Homopolysaccharides (one monosaccharide unit).
    - Heteropolysaccharides (multiple monosaccharide units).
    - Linear (one type of glycosidic bond).
    - Branched (multiple types of glycosidic bonds).

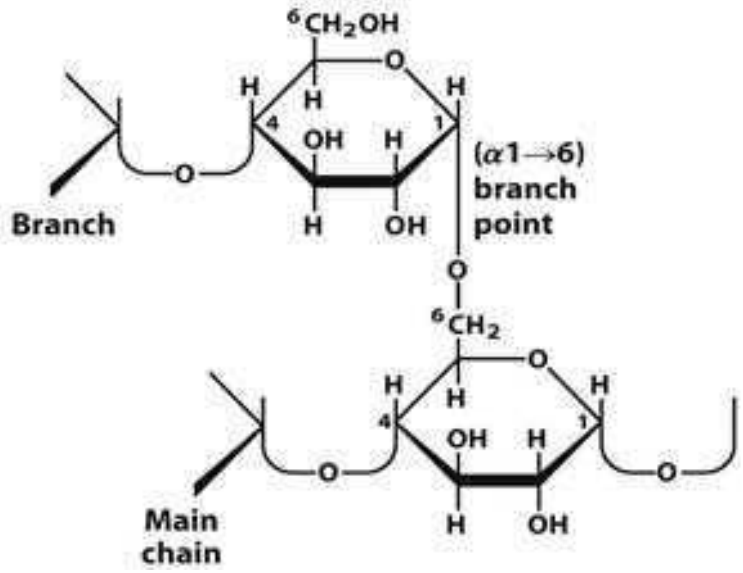
Starch

- Starch is the primary carbohydrate source for growing seeds and leaf tissue development and is found in leaves, tubers, fruits and seeds
- Widely used as a food ingredient for many purposes
- A very wide selection of starches, both **native** and **modified**.
- Starch gelatinization and pasting characteristics altered by other ingredients and by processing conditions.

Amylose

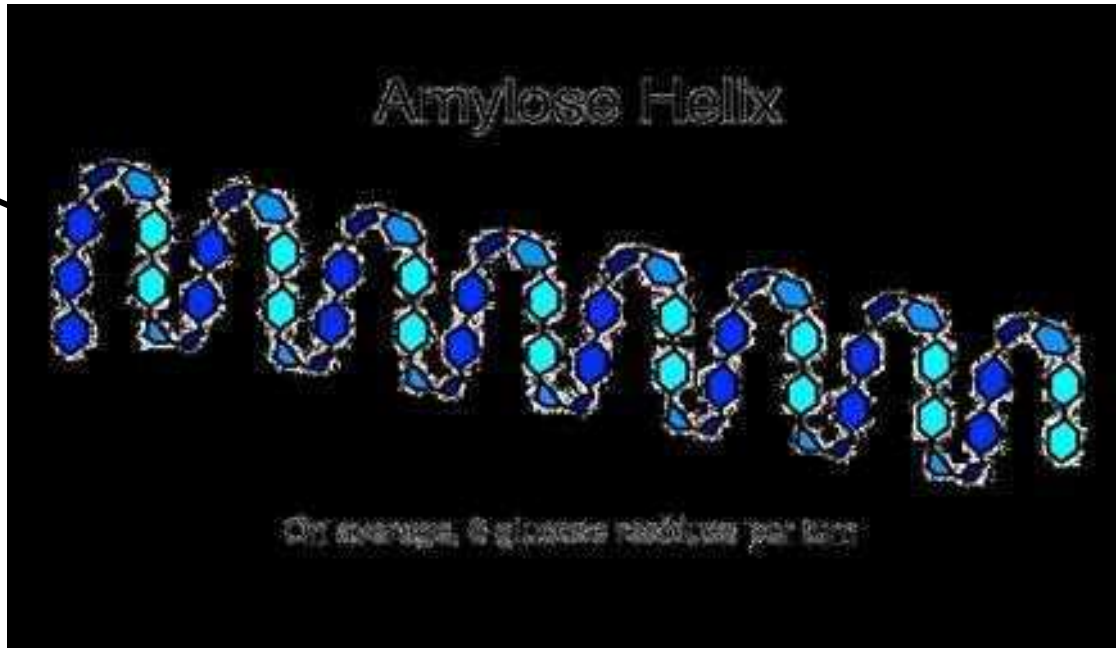


Amylopectin



Amylose helix

Hydrophobic Core



-Found in amorphous region, upon heating leached out allowing water to enter and swell starch granule in the crystalline region.

-Because of its tightly packed helical structure, amylose is more resistant to digestion than other starch molecules and is therefore an important form of resistant starch.

-Amylose can form complexes with hydrophobic molecules such as lipids or flavors. V-amylose shape. Iodine can also bind into the core that forms the basis of amylose determination in starches.

Amylopectin

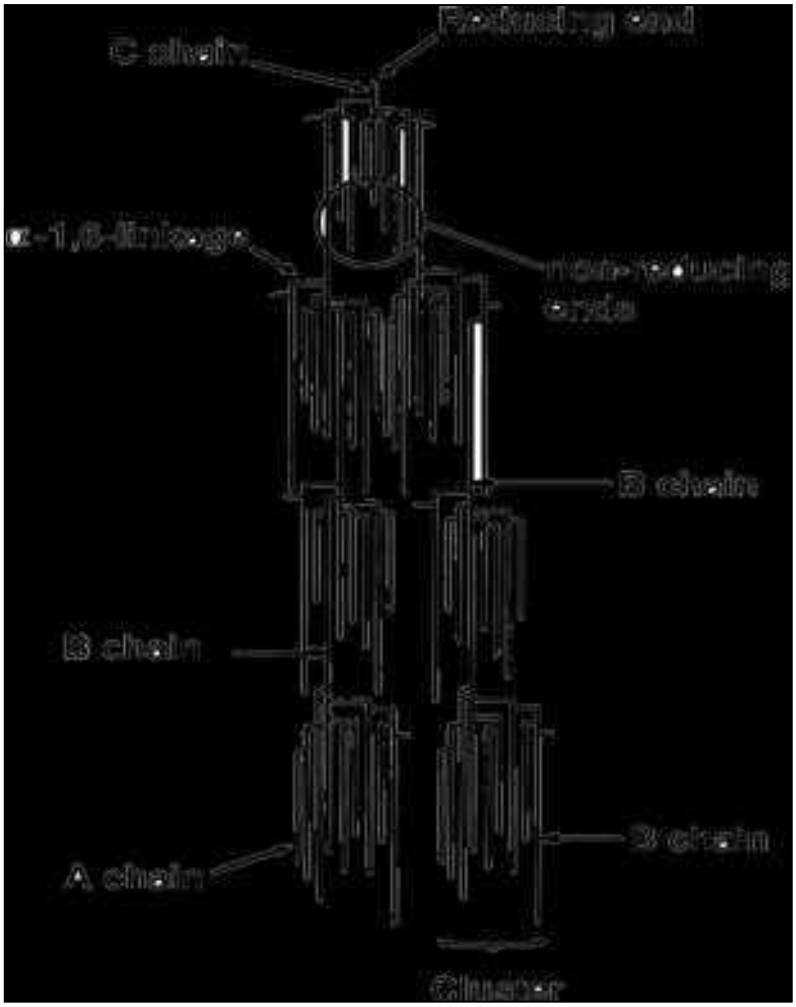
-Found in crystalline region

-Highly influences viscosity changes du to water and heating(geltinization)

A-chains
side chains linked via their reducing end to B-chains

B-chains
side chains linked to C-chains. A-chains are attached to them

C-chains
chains that carry the only reducing group of the molecule

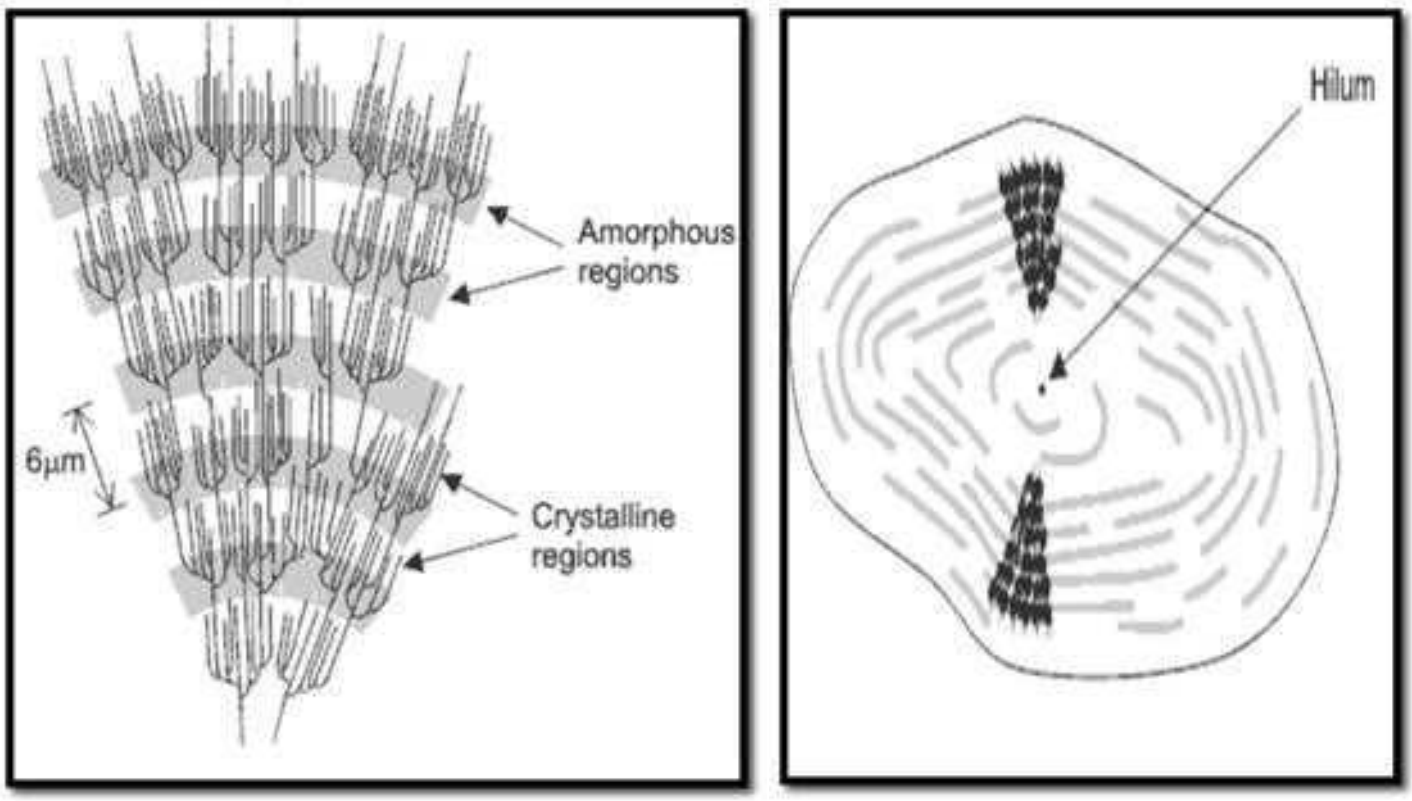


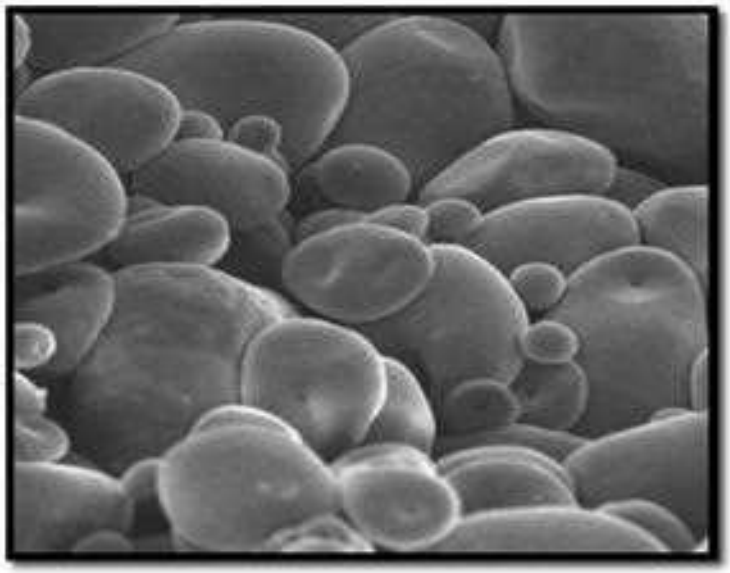
Starch granule

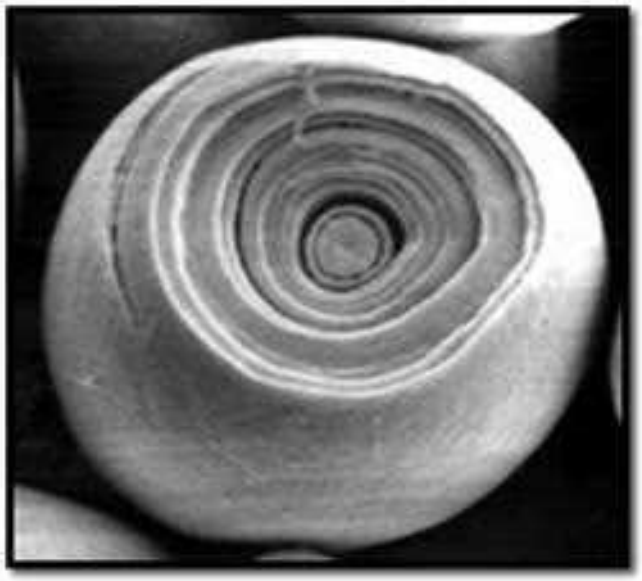
Amylopectin is **ordered** in the starch granule

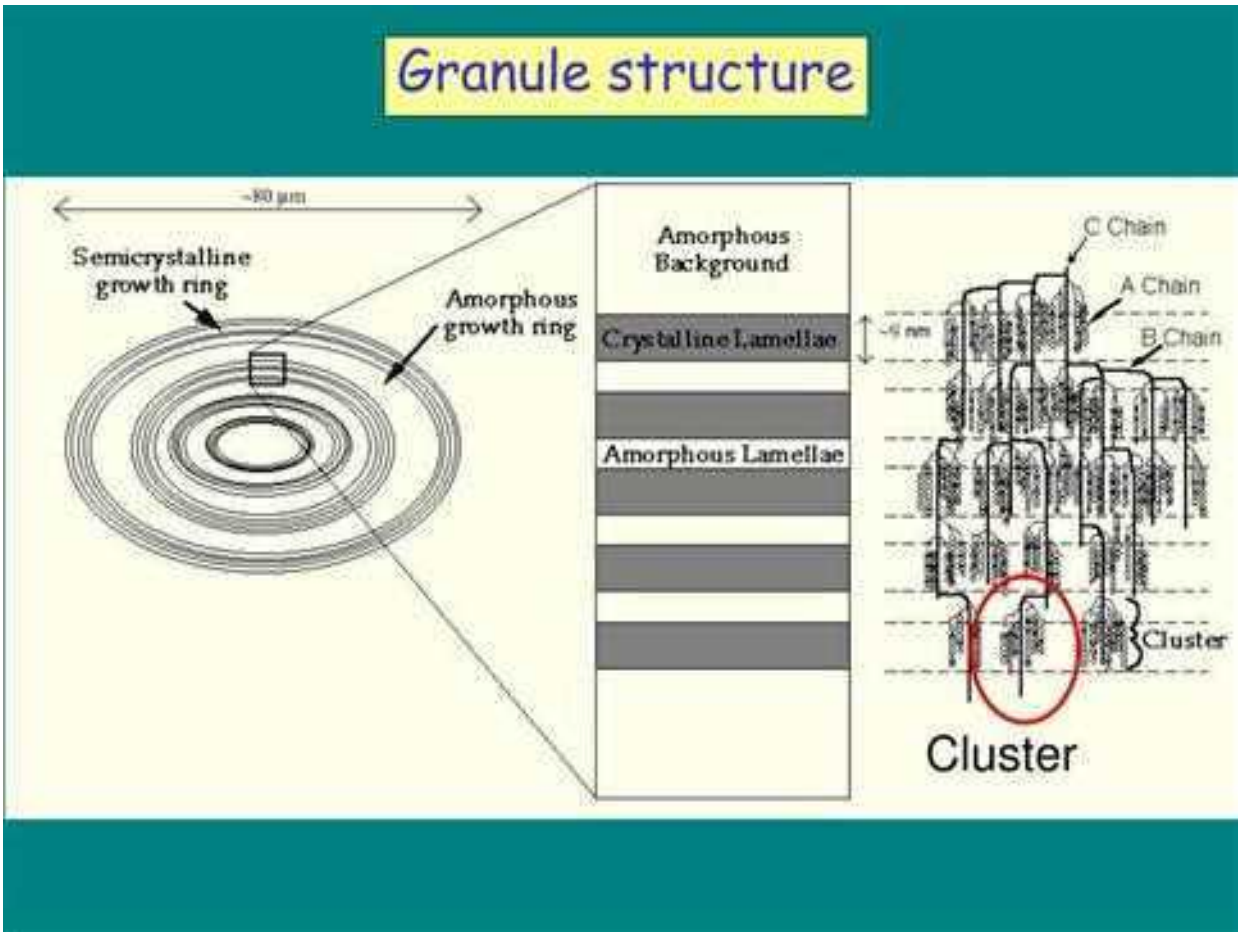
Amylopectin molecules are arranged radially

Crystallinity comes mostly from amylopectin









Types of food starches

- Native starches: corn, wheat, potato, tapioca.
- Pre-gelatinized starches
- Modified starches
    - Acid thinned - hydrolyzed to reduce molecular weight
    - Cross-linked - Chemically linking OH- from two adjacent molecules. Adds acid and heat stability.
    - Derivatized - Add bulky groups to starch to reduce retrogradation. Changes hydrophobicity.
    - Cross-linked-Derivatized - Does both.
    - Oxidized - reduces retrogradation.

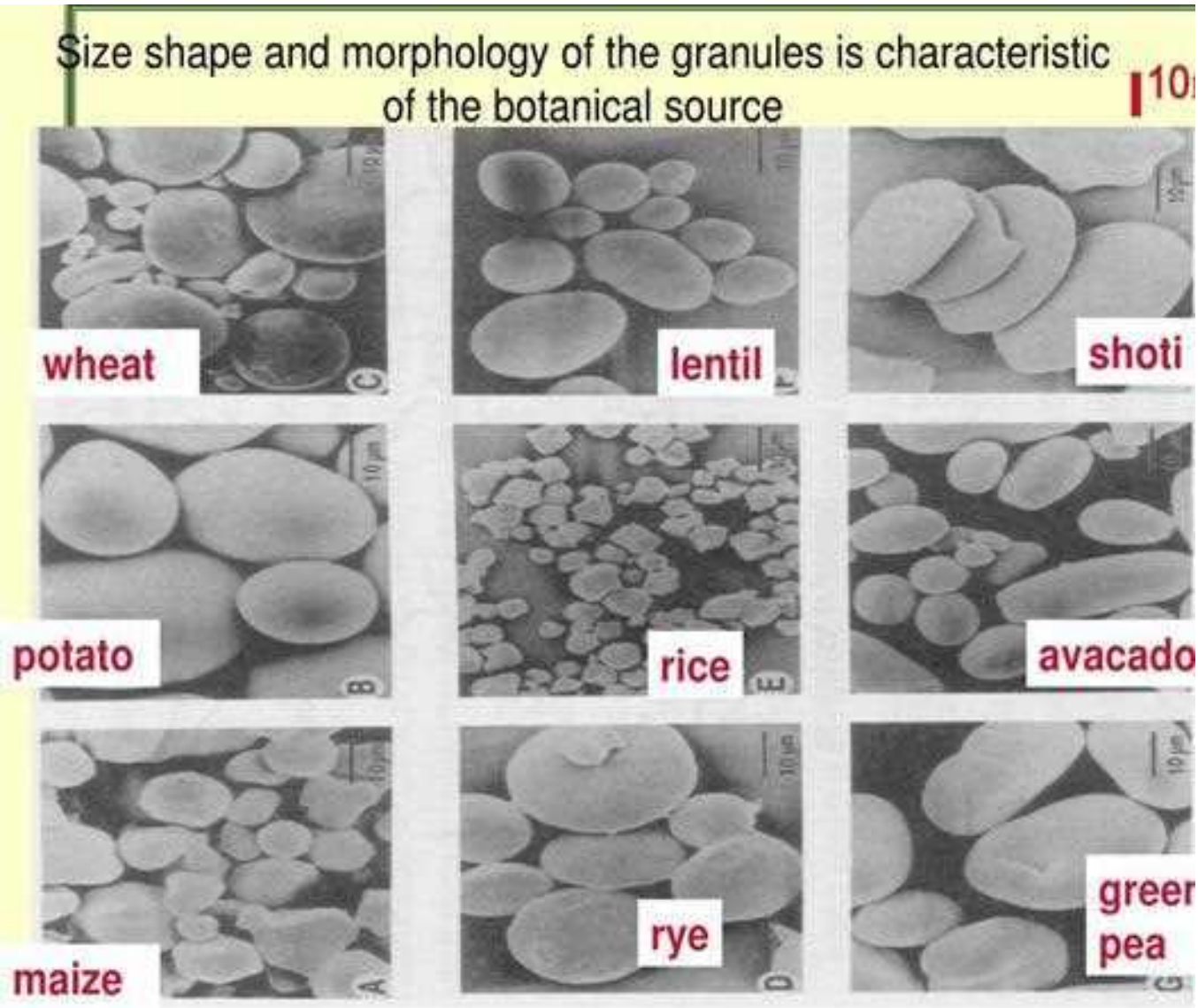
Native Starches

- The most common native starches are corn (maize), rice, wheat, potato, and waxy maize.
- Except for waxy maize, these starches generally contain from 15-27% amylose.
- Waxy maize and other waxy native starches generally contain less than 2% amylose.
- High amylose starches contain more than 30% amylose and have quite different properties**.**

Differences in native starches

- Vary in amylose and amylopectin content
- Vary in crystal structure

- Vary in gelation and pasting characteristics
- Vary in minor components that can be incorporated within the structure of amylose and amylopectin
    - Phosphate esters
    - Phospholipids
    - Proteins



Because of the variation and in\

nature of native starches it is difficult to use them. Therefore, it has become need to modify the starch.

Modified Starches

Modified starches are typically made from regular plant starches and are commonly used as

-thickeners, stabilizers, emulsifiers, and binders in various food products, including soups, sauces, dressings, and baked goods.

-They can also act as a fat replacer or calorie reducer in low-fat and reduced-calorie products.

-The modification process can involve various techniques, such as heat treatment, acid or enzyme hydrolysis, or cross-linking, which can alter the structure and properties of the starch.

-Modified starches play a crucial role in the food industry by improving the quality, stability, and functionality of many processed foods.

-Changing the composition of a starch achieved to allows food producers to overcome the weaknesses of native starches including:

-clumping, excessive retrogradation, low water holding capacity, unwanted flavors, prolonged cooking, high gelatinization temperatures, high temperatures, freeze-thaw cycles, low hydrophobic groups which imparts emulsification properties and low paste clarity properties.

-The modification can also improve their solubility, viscosity, and stability, making them suitable for a wider range of applications.

In the food industry, the starches are typically classified based on the degree and type of change, such as cross-linked, hydrolyzed, and esterified starches. Each variety of modified starch has its own unique properties and functionality, making them suitable for different applications.

Modified Starches Include

- Starch esters (Substituted or derivatized)
    - Acetate starch
    - Starch phosphate
    - Succinylated
- Starch ethers
    - Carboxy methyl starch
    - Hydroxyl propyl starch
- Cross linked
- Cross linked and derivatized

Pregelatinized starch

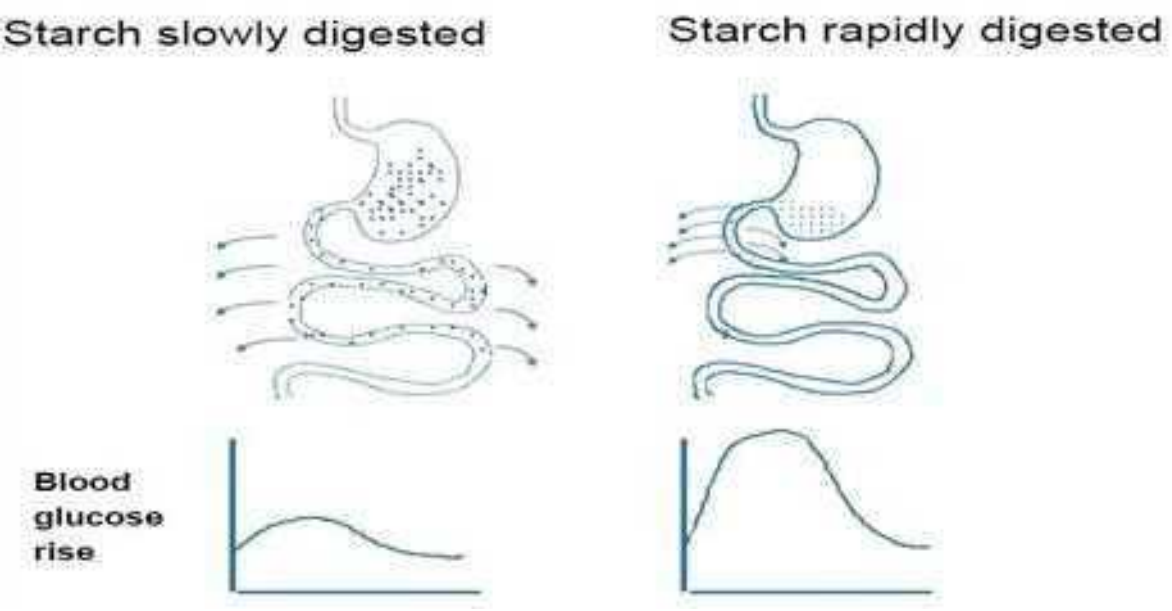
Native starch does not form a paste in cold water and therefore requires heating if it is to be used as a food ingredient.

Pregelatinized starch has been heated in water to complete gelatinization, dried, and ground to fine powder. Therefore, it can form a paste in cold water (1-5%).

Used in instant puddings, pie fillings, soup mixes, salad dressings, sugar confectionery, and as a binder in meat products. Nutritional value is the same as that of the original starch.

Resistant starch (RS)

Starch that cannot be digested in the small intestine of healthy individuals.



Intact wholegrain cereals/seeds/nuts (unprocessed) e.g. oats, rye, wheat, barley, semolina, corn, linseed, sesame. Processed starchy foods e.g. some breakfast cereals (like cornflakes), white bread, rice, pasta ,Legumes e.g., lentils, baked beans (legumes have the highest content of RS), unripe fruit, especially banana. Cooking and cooling food can also increase the RS content, cooked cold rice (e.g. sushi rice), cold pasta salad, cold boiled potato salad.

Type	Properties
RS1	Physically inaccessible, digestive enzymes cannot come into contact
RS2	Indigestible, digestible enzymes cannot break it
RS3	Resistant starch that is formed when starch-containing foods are cooked and

	cooled again
RS4	Starches that have been chemically modified to resist digestion.

Applications of starches

Functionality	Examples
Thickener	**Puddings, sauces, pie fillings**
Binder	**Formed meats; breaded items; pasta**
Gelling agent	**Confections**
Encapsulation, Emulsion stabiliser	**Flavours, bottlers emulsions**
Coating	**Candies, glazes, icings and toppings**
Water Binder	**Cakes**
Bulking Agent	**Baking powder**
Texture modifier	**Processed cheese, meat products**

Fat Replacer	**Salad dressings, dairy products, baked goods**

Maltodextrins and syrups

Maltodextrins (up to 20 glucose units linked with α-(1,4) glycosidic bonds) and syrups are starch hydrolysates with quite different properties**.**

Dextrose equivalent (DE)

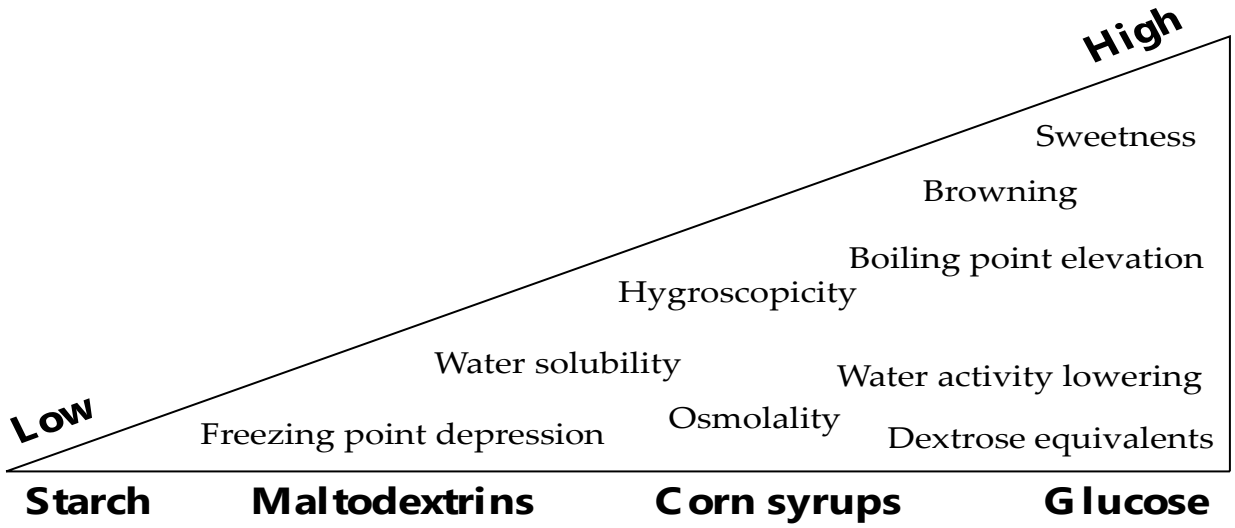
- Dextrose is another name for glucose
- DE is a measure of the reducing groups in a syrup
- It ranges from 0-100%
- Maltodextrin with DE of 10 would have 10% of the reducing power of glucose. Glucose has DE of 100.
- The DE value is important as it affects the functional properties of the resulting maltodextrins or syrups.

Dextrose equivalent of some carbohydrates

Carbohydrate	Dextrose Equivalent
Starch	**~0**
Maltodextrins	**2-20**
Corn syrup solids	**20-36**
Corn syrup low DE	**<36**

Corn syrup normal DE	**42**
Corn syrup high DE	**68**
Glucose	**92-100**
Sucrose	**0**

Functionality changes with DE



Applications

Maltodextrins

- Bulking
- Viscosity
- Sugar crystallization (hard candies)
- Turn oil into powder
- Matrix for drying
- Energy Source

Corn syrups

- Sweetener
- Texture modification
- Browning
- Inhibitor of sugar crystallization
- Source of fermentable carbohydrates