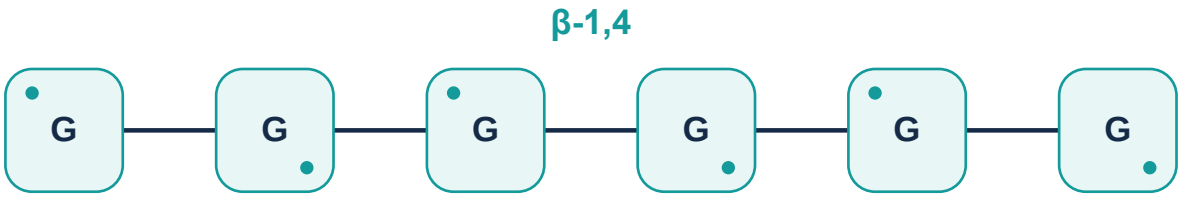
Beta linkages make a straight chain

Cellulose is a structural polysaccharide in plant cell walls. It contains beta-glucose residues joined by beta-1,4 glycosidic linkages, rather than the alpha linkages of starch.

ALTERNATING ORIENTATION ALONG ONE CHAIN



G = one glucose residue; dots mark alternating orientation.

Block model only: atoms, ring shapes and OH groups are omitted.

1. READ THE BOND NAME

Beta-1,4 means carbon 1 of one glucose unit is linked through an oxygen atom to carbon 4 of the next, with the beta arrangement at carbon 1. Glycosidic linkages are covalent bonds within the polymer.

2. ROTATE ALTERNATE UNITS, NOT THE ANOMER

Successive glucose residues have alternating orientations, often described as a 180-degree rotation of every other unit. Rotation does not turn beta-glucose into alpha-glucose; the beta linkage geometry remains.

3. FOLLOW ONE UNBRANCHED PATH

The chain is long, straight and unbranched. It has no alpha-1,6 branch points and does not form the storage helix characteristic of amylose.

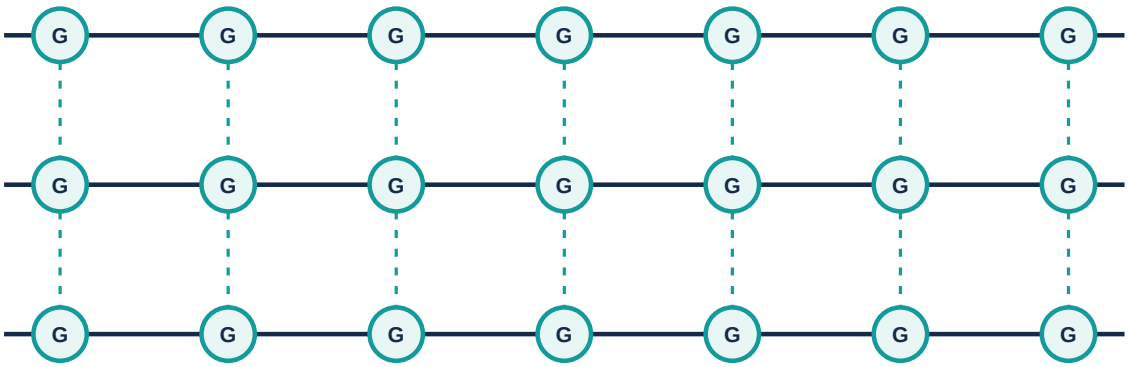
Supporting reading: OpenStax Biology 2e, 3.2 Carbohydrates.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 8, p. 18.

Many chains form a microfibril

Straight cellulose molecules can lie side by side. Interactions between neighbouring chains hold them together in strong microfibrils: each microfibril contains many polymer molecules.

A SMALL PART OF A MUCH LARGER BUNDLE



Solid horizontal lines: chain links. Dashed lines: hydrogen bonds.

G represents a residue, not an atom. Only three chains and a few interactions are shown; the dashed lines do not specify exact atomic attachment sites.

1. KEEP THE TWO BOND TYPES SEPARATE

Covalent glycosidic bonds join residues along a cellulose chain. Hydrogen bonds form between suitable polar groups on neighbouring chains; hydrogen bonding also occurs within chains. Do not label the interchain attractions as glycosidic bonds.

2. MANY INTERACTIONS WORK TOGETHER

An individual hydrogen bond is weaker than a covalent bond, but numerous interactions collectively stabilise the bundle. Together with the strong chain backbones, this gives microfibrils high tensile strength: resistance to pulling and stretching.

Scale check: glucose residue → cellulose molecule → microfibril → cell wall. A whole cell wall is not one giant cellulose molecule.

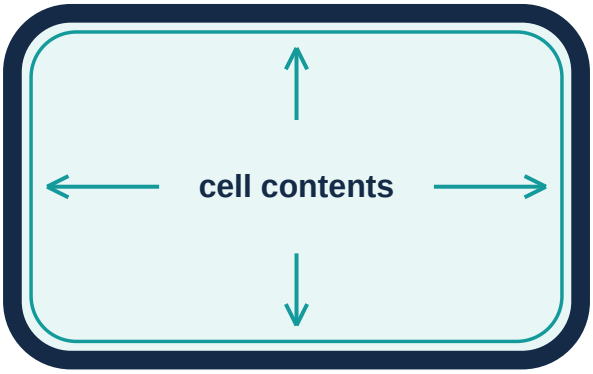
Supporting reading: OpenStax Biology 2e, 4.3 Eukaryotic cells.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 8, p. 18.

A wall that resists stretching

Cellulose microfibrils reinforce the wall outside the plasma membrane. Their arrangement helps maintain cell shape and allows the wall to withstand forces from the cell contents.

WHEN WATER ENTERS A PLANT CELL



Thick outer line: cell wall.

Thin inner line: plasma membrane.

Arrows: outward pressure, not water movement.

The wall resists expansion as turgor pressure develops.

1. WATER ENTRY MEETS MECHANICAL RESISTANCE

If water enters by osmosis, the cell contents press against the wall. The wall resists stretching, helping prevent bursting. A turgid cell supports soft plant tissues; if water is lost, reduced turgor can contribute to wilting.

2. A WALL IS A REINFORCED NETWORK

Microfibrils are embedded in a matrix containing other wall polysaccharides, including hemicelluloses and pectins. Their orientations help determine the directions in which the wall resists extension. The primary wall can be remodelled during growth.

3. STRENGTH DOES NOT MEAN WATERPROOF

The wall is porous to water and many small solutes. The plasma membrane is the selectively permeable boundary. Cellulose reinforces the wall; it does not stop all water from entering.

Supporting reading: OpenStax Biology 2e, 5.2 Passive transport.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 8, p. 18.