# Biodegradation of Cellulose

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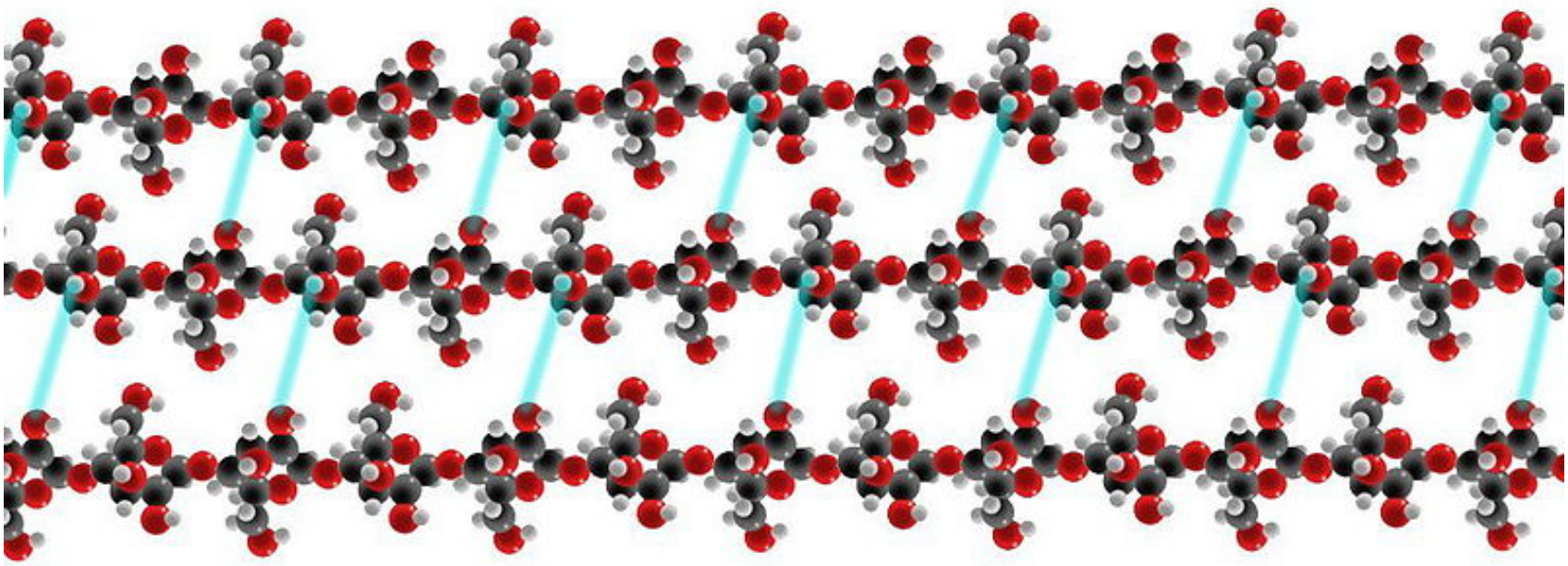
# Introduction

- Cellulose is a linear polymer of glucose joined together by $\beta$-1,4 glycosidic bonds.
- Primary component of plant cell walls.
- Most abundant component of plant biomass. Almost half of all photosynthesized carbon is in the form of cellulose.
- On average, 45% of wood fibre and 90% of cotton is cellulose.

# Salient Features of Cellulose

- It is a rigid linear polymer.
- H-bonds between adjacent molecules of cellulose result in the formation of a rigid crystalline structure.



# Biodegradation of Cellulose

- Cellulolytic microorganisms are usually eubacteria and fungi.
- Cellulose biodegradation requires a complex of several enzymes.

- Under aerobic conditions, cellulose is degraded completely to $CO_2$ and water.
- Under anaerobic conditions, it is degraded to $CO_2$, methane and water.
- About 5-10% of cellulose degraded in nature is through anaerobic metabolism.

# Biodegradation of Cellulose

The enzymes that degrade cellulose by hydrolysis the $\beta$-1,4 glycosidic bonds are known as Cellulases.

## Endoglucanases (EG)

- Formally known as endo-1,4-$\beta$-glucanases.
- Hydrolyse the internal bonds in cellulose.
- Prefer to act in amorphous regions.

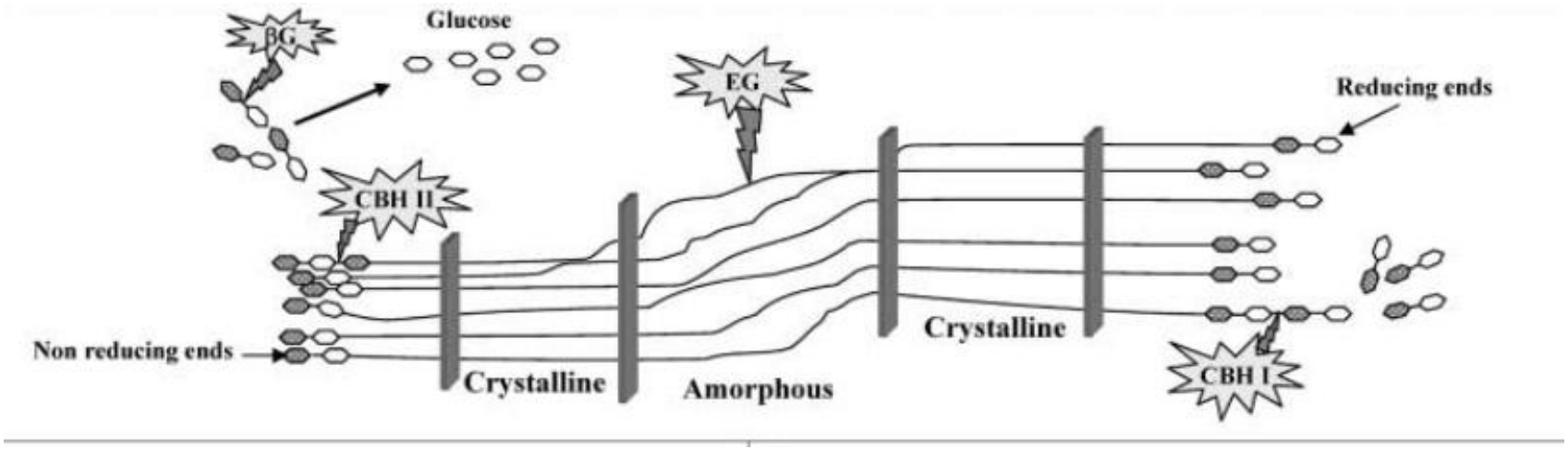
## Cellobiohydrolases (CBH)

- Formally known as exo-1,4-$\beta$-glucanases.
- Act on the ends of the cellulose molecule.
- Only enzyme that can degrade crystalline cellulose.

- The end product of these enzymes is cellobiose, a dimer of glucose.

# Biodegradation of Cellulose

- Additionally $\beta$-glucosidases are required to hydrolyse the cellobiose to glucose.



# Cellulose Degrading Fungi

- *Trichoderma reesei* and *Phaenochete chrysosporium* are most well studied.
- *Trichoderma* cellulase is used commercially.

# Cellulose Degrading Bacteria

## Aerobic degradation

- *Cellulomonas*, *Pseudomonas* and *Streptomyces* are well studied.

## Anaerobic degradation

- Rumen bacteria such as *Ruminococcus* sp.
- Thermophilic bacterium *Clostridium thermocellum* is the best studied.

# Cellose Degrading Protozoa

- Termite symbiont flagellated protozoa.