

Way to Go, Indigo! *Biological Molecules and Denim Processing*

Denim jeans were designed in the 1840s to be tough outdoor clothing for farmers, miners, and cattle ranchers. These jeans were stiff and uncomfortable until they had been worn or washed many times. Eventually, jeans became fashionable, but consumers wanted to buy jeans that were already comfortable. Manufacturers had to develop methods to provide new jeans that felt and looked “worn in.”

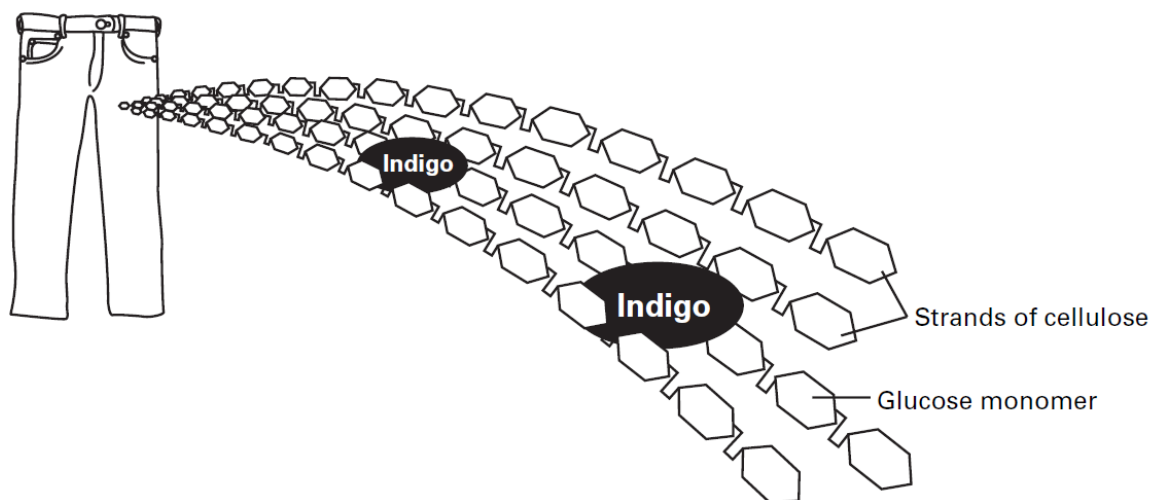
To understand denim you should be familiar with some properties of cotton. Cotton plant flowers mature into cotton bolls. When the boll (BOHL) is mature it opens showing the inner white fuzzy cotton fibers that are attached to the cotton plant’s seeds in the boll. Watch the video [Cotton boll popping open](https://www.youtube.com/watch?v=uQuXjj5ze6c) <https://www.youtube.com/watch?v=uQuXjj5ze6c>



The purpose of cotton fiber is to help the seed catch the wind and travel to land and grow in a new area of soil (see picture at left). The fiber can be spun into yarn or thread and used to make a soft, breathable cloth.

The cotton fibers are made of the carbohydrate cellulose. Cellulose is a long chain of beta glucose monomers. Multiple cellulose chains are linked together by hydrogen bonds. The chains wrap around each other, forming larger and larger strands.

Watch the first minute and a half of “Journey of Cotton from Farm to Fabric” <https://www.youtube.com/watch?v=orKBbm9Ij1s>



To make denim cloth, manufacturers spin the cotton fibers into threads. The naturally white threads are dyed blue. When the threads are dyed, molecules of the dye (called indigo) become trapped between the cellulose fibers, making the threads appear dark blue.

As denim is worn and washed several times, the cellulose fibers start to break and wear thin. As the fibers break, the indigo dye is released and the fabric softens, lightens, and becomes more flexible.

Manufacturers discovered that washing jeans with pumice stones sped up the softening process. To stone wash, rough pumice stones are added to the washing machine. During the wash, the stones scrape off dye particles from the surface of the yarn of the fabric. Stone washing makes the denim lighter in color and more flexible so that the clothes fit comfortably.

However, stonewashing (washing with pumice stones) caused several problems:

- The pumice stones took a toll on the industrial washing machines, which had to be replaced frequently.
- Additional employees were needed to pick the pumice stones out of the pockets of the jeans.
- Many jeans had to be destroyed because the pumice stones caused too much damage.
- The pumice stones wore down to a sandy sludge that clogged drains and sewer lines.
- Pumice has to be mined, which can have negative effects on the landscape and wildlife habitats in an area.

A better method of preparing denim was needed! Researchers have discovered that the enzyme cellulase could provide an alternative method of breaking down the cellulose fibers. As cellulase breaks down the fibers, the trapped indigo dye is released. The fabric surface becomes fuzzy as the threads fray softening the fabric.

After reading and watching the video links above,

1. What did you know about denim before reading this information and watching the video clips?
2. What did you learn from the information and video clips?