IUPUI DEPARTMENT OF BIOLOGY

What is Biology Good For?
"Stone" Washing Jeans: Cellulases

(This assignment is optional and is due on Friday, January 31, 2003 by noon. Read this essay and answer the questions at the bottom for 3 extra credit points. It is not necessary to visit the links in the text unless you are interested in more information.)

[Good For 1] [Good For 2] [Good For 3] [Good For 4] [Good For 5] [Good For 6] [Good For 7] [Good For 8] [Good For 9] [Good For 10] [Good For 11] [Good For 12] [Good For 13] [Good For 14] [Good For 15]

Ahh...there's nothing like lounging around in your favorite pair of jeans, reading up on some biology. It's hard to believe that annual sales of jeans like yours make up part of a **$700 Billion** global industry! Yup, jeans are **BIG** business these days. In 1999, over 200 million pairs were sold in Europe alone. In the US, jeans are an even hotter commodity, with about a dozen pairs flying off the shelves **every second** *Image*.

Regardless of the color or style, chances are your jeans were subjected to some sort of wash treatment to give the fabric a softer, smoother feel. Most of us are familiar with "stone washed" jeans. As the name implies, freshly dyed jeans are loaded into large washing machines and tumbled with stones. Adding pumice stones gives the additional effect of a faded or worn look. The pumice abrades the surface of the jeans like sandpaper, removing some dye particles from the surfaces of the yarn. Pumice has been used since the introduction of stone washed jeans in the early 1980s. However, stone washing with pumice has some severe drawbacks. The quality of the abrasion process is difficult to control: Too little will not give the desired look. Too much can damage the fabric, particularly at the hems and waistbands. The outcome of a load of jeans is never uniform, with a significant percentage always getting ruined by too much abrasion. The process is also non-selective. Everything in the washing machines gets abraded, including the metal buttons and rivets on the jeans as well as the drum of the washing machine. This substantially reduces the quality of the products and the life of the equipment, and increases production costs. Acid washing jeans avoided some of these problems, but came with added dangers, expenses, and pollution. Environmental regulations have put intense pressure on the textiles industry to generate less pollution. Treating the wastewater and disposing of the sludge (i.e. used pumice or neutralized

acid) represents a growing portion of the production costs for a pair of jeans. So what are we to do? Will we have to give up our comfortable jeans? Will prices skyrocket? Will we have to choose between fashion and the environment? *[Image]*

Never fear! Biology is here! A technique known as "biostoning" was introduced in Europe in 1989 and then quickly adopted in the US the following year. Biostoning relies on the action of enzymes to selectively modify the fabric surface. Enzymes have been used in the textiles industry since the turn of the century to remove starchy and waxy residues from raw materials and to give fabric a uniform finish. Global sales of enzymes used in the textiles industry reached $164.2 million in 1998 and are expected to reach $182.7 million by 2002. Genencor is one of the major producers of industrial enzymes. The enzymes used in biostoning are known as "cellulases." (***Note on scientific lingo:*** The ending "-ase" at the and of a word usually means that the molecule is an enzyme).

The gene for the cellulase enzyme was first isolated from the **fungus** *Trichoderma reesei* and then put into bacteria for mass production. Cellulases digest cellulose -- the main component of cotton and other natural plant fibers. [Remember from lecture that cellulose is a long, **glucose polymer** used as structural support in plant cell walls. We can't digest cellulase, but organisms like fungi and some bacteria can!]. Cellulases bind to the exposed cellulose on the exterior of each cotton fiber and break some of the molecular bonds. The process can be stringently controlled so that only the dye particles are loosened from the denim surface while the interior of the cotton fibers are left intact. *[Image]*

In the early days, one problem with biostoning was "back staining." Back staining happens when loosened dye particles redeposit onto the back surface of the fabric, causing discoloration. A reddening of the dyes sometimes occurred too. But maintaining the pH of the wash load between 6-8 has successfully controlled both problems. Today, biostoning can achieve the same effect as traditional stone washing, but without the damaging abrasion of the fabric and equipment.

Biostoning is by far the most economical and environmentally friendly way to treat denim.

- Waste, pollution, quality variability, and imperfections are all reduced. And unlike pumice or acid, which get used up during the wash, enzymes can be recycled.
- A small dose of enzymes can replace several dozen pounds of pumice stones. So productivity can be increased by 30-50% because the room formerly taken up by the pumice stones in the washing machines can now be filled with more jeans.
- And there is no need for the time-consuming and expensive task of removing stone fragments from the jeans once the wash is done.

- There is also no pumice dust to endanger employee health or gritty sediment to clog drains.

Does this all sound too good to be true? Well believe it! Nearly all jeans made today are finished by biostoning.

But wait, there's more! Cellulases and other enzymes used in the textile industry are available in a number of different varieties, each with its own special properties. This added dimension gives fashion designers the flexibility to create a wider range of shades and finishing effects. By selectively modifying the surface of the denim without damaging the fabric integrity, designers have a more liberal pallet to create new fashions possibilities. For example, colorful logos can be printed onto metal buttons or leather labels without the fear of them being abraded away by pumice. And intricate designer accents made of non-cellulose fibers such as nylon or polyester will remain vibrant even after cellulase treatment.

So next time you sit down in your favorite pair of jeans to enjoy reading some biology, just remember: Even though the label **says** *stone* washed, stones aren't really used at all. Instead, when you see "stone washed," think of those industrious little enzymes made possible through the wonders of modern biology. And think about where else biology abounds in your life. It's not just used for making medicines and food anymore. It is revolutionizing the face of one industry after another. We should not fear or loath this, but embrace it. So, if anybody asks you what biology is good for, you can point to their jeans and tell them *exactly* what biology is good for.

This Good For assignment was researched and written by IUPUI graduate student Elbert T. Chen, who can often be spotted lounging around campus in a pair of jeans, reading up on some Biotechnology.

References and More Information

Biozyme International Pvt.Ltd , enzymes.co.uk, Canada's Business and Consumer Site , David Rigby Associates, Genencor, EnzyTex , Business Communications Company , Research Reporter , Dyadic International, Inc., UNX, Inc. Flo-Jeans System., Copyright Elbert T. Chen, 2001

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