



GREENER JEANS

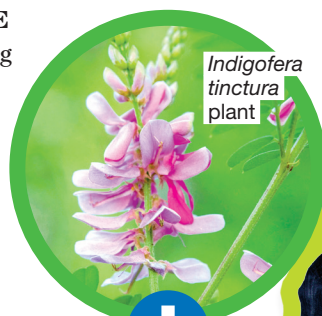
Can researchers find a way to make jeans blue without using toxic chemicals?

ESSENTIAL QUESTION: How might clothing production affect the environment?

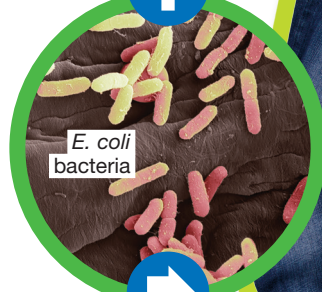
BLUE JEANS ARE SOME of the most popular clothing items of all time. But manufacturing them comes with a hidden cost: Many of the chemicals used to produce jeans' characteristic blue color are toxic and can end up polluting the environment. Now scientists are working on a greener way to make jeans blue with help from an unusual source—bacteria.

TOXIC DYE

Blue jeans were originally colored with natural *indigo*, a blue dye derived from several tropical plants, including *Indigofera tinctora*. Eventually, chemists developed a *synthetic*, or artificial, version of indigo to keep up with the high demand for the dye. “Synthetic indigo is very useful for industry, but it’s made in an unsustainable way,” says Tammy Hsu, a biochemist at the University of California, Berkeley.



Indigofera tinctora plant



E. coli bacteria



Researchers added traits of indigo-producing plants to bacteria and used it to dye jeans blue.



Synthetic indigo is not *soluble*—able to dissolve—in water. To make synthetic indigo soluble so it can attach to fabric, jean manufacturers must mix it with harsh chemicals (see *Making Jeans Blue*, right). Unfortunately, jean factories overseas sometimes release water tainted by these chemicals into lakes and streams during the dyeing process. The pollution puts people and wildlife at risk.

BACTERIAL BLUE

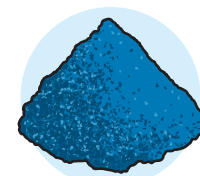
Recently, Hsu and her colleagues found a way to *bioengineer* a less toxic substitute for synthetic indigo. They tweaked the *DNA*, or hereditary material, of *E. coli* bacteria to produce a chemical found

in *I. tinctora* plants. This chemical can dye cloth blue when mixed with an *enzyme*—a substance that helps speed up chemical reactions.

It’s too soon to tell whether this indigo alternative could someday replace the synthetic version. “The next step is to see if we can make a pair of jeans using our method,” says Hsu. Until then, your blue jeans will still be blue—just not entirely green. ✨ —Jacob Batchelor

MAKING JEANS BLUE

Getting your jeans that perfect blue color is far from an eco-friendly process. Check out the color chemistry behind your favorite pair of pants.



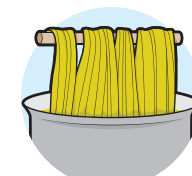
1

Chemists produce synthetic indigo in a lab using petroleum products.



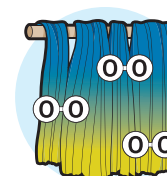
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The synthetic indigo is mixed with a base (opposite of an acid) and harsh chemicals like sodium dithionite.



3

The chemicals react with the indigo to make it water soluble, allowing the indigo to stick to the yarn. After dyeing, the yarn has a yellowish color.



4

The indigo oxidizes—combines with oxygen (O₂)—in the air, causing another chemical reaction that turns the yarn blue.



5

The blue yarn is woven into denim that’s cut and sewn into blue jeans.

TOXIC WATER

Water contaminated with chemicals from dyeing blue jeans spills into a river in Lesotho, a small nation in Africa.



CORE QUESTION

Using what you learned in the article, explain in your own words what bioengineering is.