Why your skin is so tough: Revolting experiment reveals how collagen straightens and stretches when pulled

- **Researchers at the Lawrence Berkeley National Laboratory used real skin samples to study microscopic changes that resist tears when pulled apart**
- **They found collagen fibres in dermis change structure when under strain**
- **The fibres go from being a disorganised tangle to straighten and stretch**
- **Scientists hope their findings can help develop new tear-resistant materials**

By Richard Gray for MailOnline

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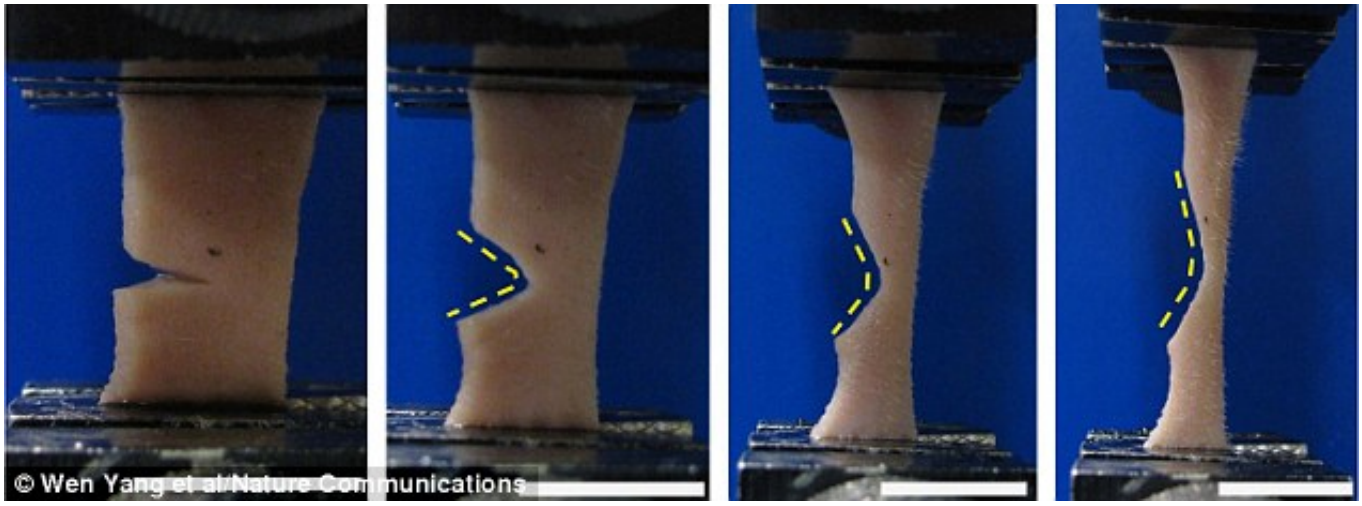
It is probably the most unpleasant experiment you will read about today: what happens when your skin starts to tear.

Researchers have uncovered the reason why skin is so difficult to tear even when put under extreme pressures, by cutting samples of real skin and attempting to pull them apart.

They found that rather than simply tearing, mammalian skin actually has sophisticated stress resistance properties that prevent holes and cuts from expanding.



The researchers cut real skin samples and then attempted to rip them by pulling them apart (shown above)

Using X-ray beams they were able to directly observe the microscopic changes that take place in skin to help it resist tearing during their stomach churning experiments.

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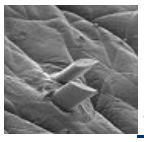
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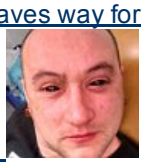
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They discovered that the curly fibers of collagen that make up dermis of the skin straighten and stretch in response to a tear to share the load and prevent further damage.

HOW TO GET THE PERFECT SHAVE

Scientists at Gillette have spent nine years studying how to get the perfect shave.

Their work has shown why washing the skin is so vital and why you should never, ever tap your razor on the sink, and also settles the debate about whether you should go with, or against the grain

Here are their main findings:

Before the shave, hydrate the hair by washing the skin with a gentle cleanser: This softens the hair and significantly reduces the force needed to cut it.

Apply plenty of shave gel: This provides a protective anti-friction layer and improves razor glide for a smoother, more comfortable shave.

Shave with a multi-blade razor using light strokes: Gillette said the razor should do the work, not the person shaving.

Change direction: Begin by shaving with the grain of the hair before switching and going against this grain.

Make sure blades are not old or dull: The lifespan of razors can vary depending on how often they are used and how hard. As a general rule if the razor begins to drag or doesn't cut as closely as before, replace the blades.

Use aftershave: This can be any product containing moisturiser to rehydrate and comfort the skin.

Many aftershaves contain alcohol that acts as an astringent to sterilise the skin and provide a barrier against

infection.

The findings help to explain why the thin layer of cells that cover our bodies is able to provide such an effective barrier to the outside world.

Scientists behind the research also hope their findings could eventually lead to stronger new materials that do not easily tear that could be used in aircraft, for example.

Professor Robert Ritchie, a materials scientist at the Lawrence Berkeley National Laboratory in Berkeley, California, who was one of the co-authors of the research, said: 'Our study is the first to model and directly observe in real time the micro-scale behavior of the collagen fibrils associated with the skin's remarkable tear resistance.

'Collagen fibrils and fibers rotate, straighten, stretch and slide to carry load and reduce the stresses at the tip of any tear in the skin.

'The movement of the collagen acts to effectively diminish stress concentrations associated with any hole, notch or tear.'

To conduct the experiment the researchers used the skin taken from dead rabbits, carefully removed the hair and placed it in equipment designed to pull the skin apart.

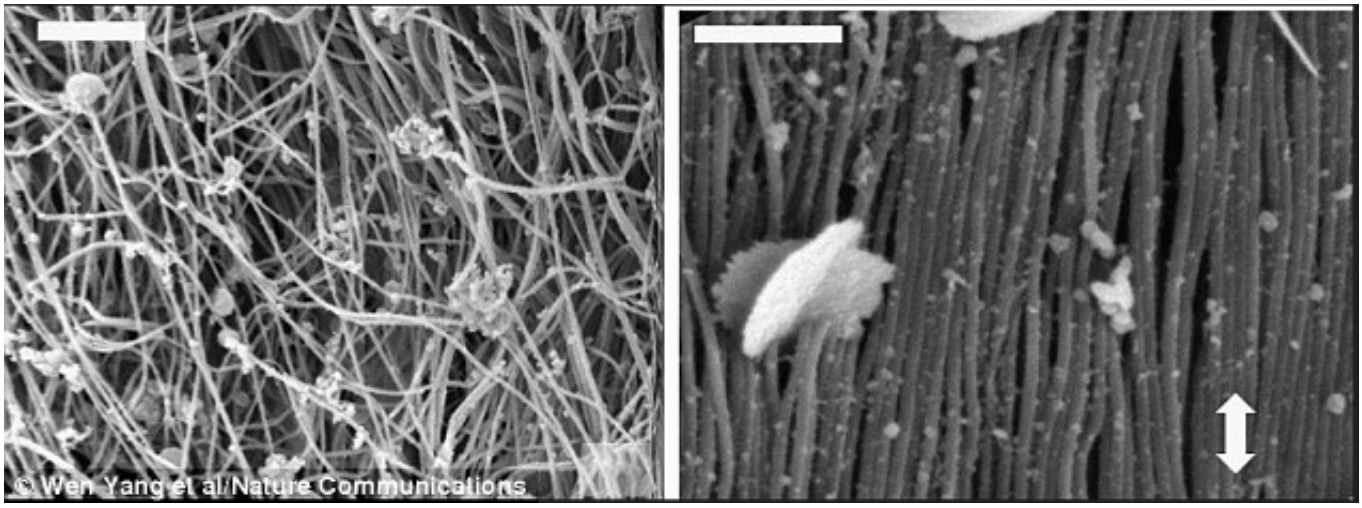
They then cut a small notch or hole in the skin and watched how it changed shape as the skin was stretched in a way intended to cause the tear to increase.

However, rather than getting bigger as the skin tore, the notches simply yawned open.

The researchers, whose work is published in the journal **Nature Communications**, then used the x-ray beams produced by the Advanced Light Source at the Lawrence Berkeley National Laboratory, to study the structural changes that took place in the skin.

They found the collagen in the dermis, the thickest of the three main layers that make up skin, changed its alignment at the edge of the tear.

The collagen, which is normally in a disordered tangle, straightened and began to slide against each other to absorb the stress and provide extra strength.

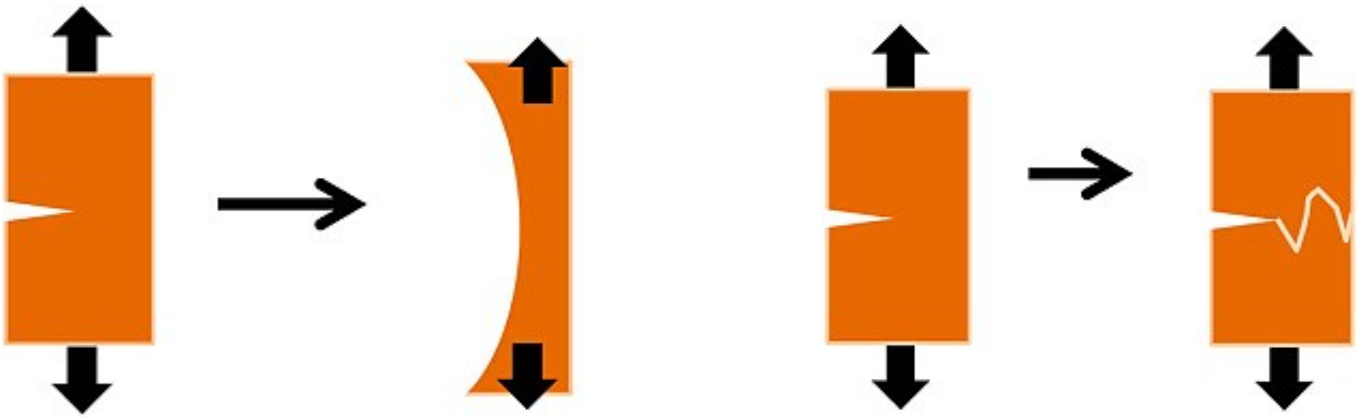


The researchers found the collagen in the skin dermis changes from being a disordered tangle (shown left) to line up in straight parallel rows (shown right) when skin is damaged to provide strength and tear resistance

Dr Marc Meyers, a materials scientist at the University of California San Diego who also took part in the research, said: 'Straightening and stretching allow the uptake of strain without much stress increase, and sliding allows more energy dissipation during inelastic deformation.

'This reorganization of the fibrils is responsible for blunting the stress at the tips of tears and notches.'

Research on skin's mechanical properties dates back nearly 200 years, when physicians began examining stab wounds.



The graphic above shows what happens to a notch in skin when it is stretched (left) compared to bone (right)

Unlike bone and teeth, which are also made of collagen fibres but tear and crack when under stress, the collagen in the skin appears to change its structure when placed under stress.

The researchers behind the latest study are working with the US Air Force Office of Scientific Research.

Professor Ritchie added: 'Natural inspiration is a powerful motivation to develop new synthetic materials with unique properties.

'For example, the mechanistic understanding we've identified in skin could be applied to the improvement of artificial skin, or to the development of thin film polymers for applications such as flexible electronics.'

Read more:

- Tear resistance of skin in comparison to bone materials. : On the tear resistance of skin : Nature Communications : Nature Publishing Group

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