

**2.6g 329m/s: the name of this project,
the performance standard for bulletproof vests.**

Bulletproof skin: 2.6g 329m/s are the maximum weight and velocity of a .22 calibre Long Rifle bullet from which a Type 1 bulletproof vest should protect you. Spider silk thread is relatively much stronger than steel and can even be made by a living being. Woven it would be capable to resist the impact of a bullet, much like a bee on the spider's web. If human skin would be able to produce this thread, would we be protected from bullets? Together with the [Forensic Genomics Consortium Netherlands](#) Jalila Essaïdi takes the acid test: by implanting transgenic spider silk in the human skin and letting a bullet do its work.

By implementing this bulletproof matrix of spider silk produced by transgenic goats in human skin Essaïdi wants to explore the social, political, ethical and cultural issues surrounding safety in a world with access to new biotechnologies. Issues which arise on the basis of ancient human desire for invulnerability. It is legend that Achilles, the central character of Homer's Iliad was invulnerable in all of his body except for his heel. Will we in the near future due to biotechnology no longer need to descend from a godly bloodline in order to have traits like invulnerability?

With this work Jalila Essaïdi wants to show that safety in its broadest sense is a relative concept, and hence the term bulletproof. The work did stop some partially slowed bullets but not the one at full speed. But even with the skin pierced by the bullet the experiment leads to the conversation about how which form of safety would benefit society.

2.6g 329m/s is made possible through the [Designers & Artist 4 Genomics Awards](#) and partly through sponsorship from [Fisher Scientific](#). The project suggests interesting materials research that goes beyond the expertise of the [Forensic Genomics Consortium Netherlands](#) and which utilises expertise of the [Utah State University](#), [Leiden University Medical Center](#), the [Netherlands Forensic Institute](#) and other Dutch institutions.

Bulletproofing: silk is a natural protein fibre, some forms of which can be woven into textiles. Genghis Khan was once said to have issued all his horsemen with silk vests, as an arrow hitting silk does not break it but ends up embedded in the flesh wrapped in silk.

Silkworms are known for their silk production, but silks are produced by several other insects, ranging from bees & ants to spiders. It's the spider whose silk is the strongest natural protein fibre known to man, multiple times stronger than steel. Evolved to make an ever stronger web the spider uses his silk to catch fast flying insects.

Imagine a spider silk vest, capable of catching bullets, the modern day equivalent of Genghis Khan's arrows. Now, let's take this one step further, why bother with a vest: imagine replacing keratin, the protein responsible for the toughness of the human skin, with this spider silk protein. This is possible by adding the silk producing genes of a spider to the genome of a human: creating a bulletproof human.

Science-fiction? Maybe, but we can get a feeling of what this transhumanistic idea would be like by letting a bulletproof matrix of spider silk merge with an in vitro human skin. A process which takes five weeks, during these weeks a bulletproof spider silk matrix is grown in-between the two layers that make up our skin. The use of different human skin cells which result in the dermis and epidermis make this the closest possible representation of a normal human skin in vitro.

Spider silk: How to get enough spider silk for this project? An article in Science about Dr. Randy Lewis from Utah State University caught Essaïdi's attention. Dr. Randy Lewis isolated the silk producing genes of a spider and [added them to the genome of a goat](#) and more recently to the genome of a silkworm. Resulting in spider silk producing transgenic- goats and silkworms. For this project Dr. Randy Lewis donated a batch of spider silk produced by these transgenic goats and silkworms. In order to process this spider silk into a bulletproof matrix capable of supporting cell growth Essaïdi had to travel all over Western

Europe and the silk itself has been all over the globe. Strangely enough you can't find any people with spider silk weaving expertise when you need them ;-)

'Bulletproof'-skin: With the bulletproof spider silk matrix made, Essaïdi rushed to Dr. Abdoel El Ghalbzouri at the LUMC who agreed to help her embed the spider silk matrix in-between the dermis and epidermis of his 'Alternatives to Animal Use' skin model. Resulting in a beautiful piece of 'bulletproof'-skin: The skin is made up of multiple types of cells that form the usual dermis and epidermis. The spider silk was designed to function as a carrier for these cells and merged during a period of five weeks in-between the two layers. Resulting in a really sturdy patch of human skin which is with the use of Dr. Abdoel El Ghalbzouri's model the closest we can get to normal human skin.

Execution: "Five weeks does not only mark the moment when the skin is at its most beautiful, it also is the point where it slowly starts to die; making me feel a slightly bit better while I am securing the skin in front of a block ballistic gel, in order for it [to be executed](#) by a 2.6gram bullet at the shooting range of the Netherlands Forensic Institute. I'm calling it execution because it will die even if it succeeds in its purpose, even if it would resist the impact it would still die because of contamination, physical abuse and because of its age."

All this effort for a brief moment of invulnerability.