

# Where's the Beef?

Traditional hamburger patties are facing competition from alternatives made of plant-based raw materials or cultivated animal stem cells. This is how they are produced:

## PLANT-BASED MEAT

Companies such as Impossible Foods and Beyond Meat are booming. That's because it's nearly impossible to tell the difference between their plant-based meat substitutes and real meat. The recipes are varied and generally secret. However, we do know a few facts about them.

## MEAT FROM THE LAB

Producing meat without slaughtering animals—that's the promise of the scientists developing in vitro meat. A number of companies are trying to grow real meat based on cell samples taken from animals, mainly chickens, pigs, cows, and fish.

**€250,000**  
That's the approximate cost of the first hamburger cultivated in a laboratory. A University of Maastricht research team headed by Mark Post sampled this delicacy in front of TV cameras in 2013. According to Post, burger patties like this one can soon be produced at a cost of about €10.

The basic elements are **plant proteins**, for example legumes such as **soybeans** and **peas**. The addition of **potatoes** or **rice** adds crispness and roast aromas when the patties are fried.

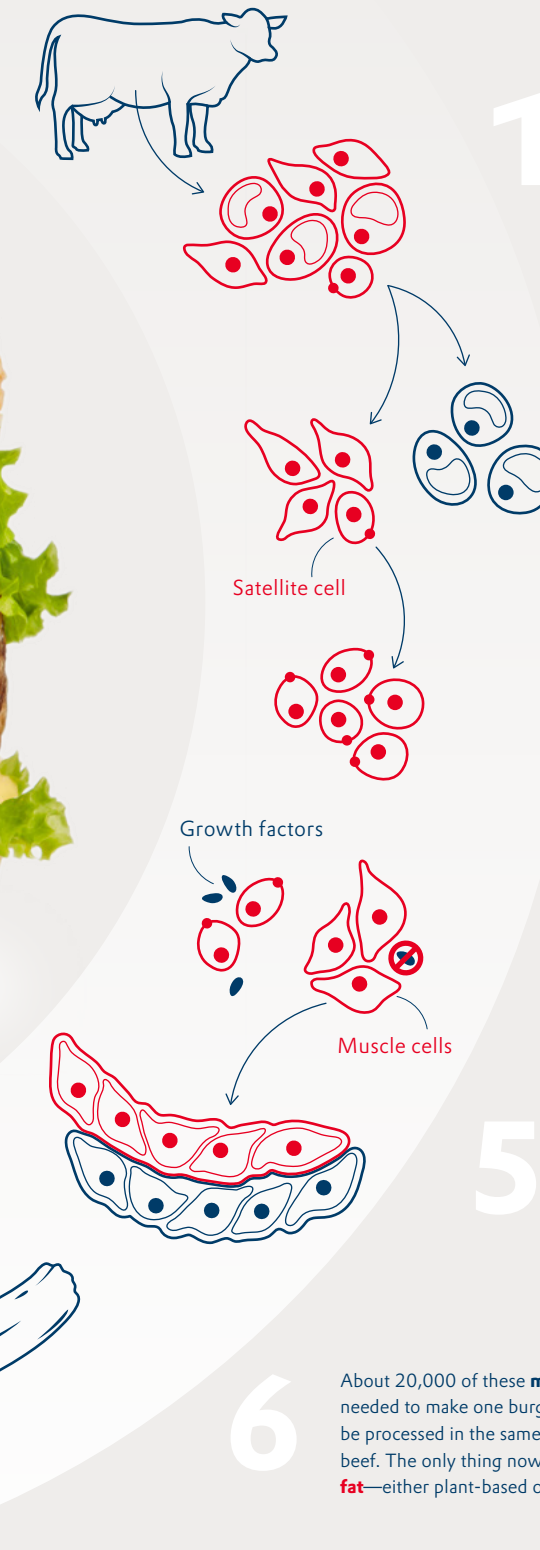
Modern processing technology gives the protein a **meaty structure**. For example, in the wet extrusion process, the raw mass is pressed through a **nozzle** and simultaneously cooked.

The iron compound called heme is an important component of the blood of all vertebrates. Soybean plants produce small amounts of it in their **roots**. If the corresponding **DNA** is implanted in **yeast cells**, heme can be produced in a bioreactor.

**Heme** gives the protein mass its red color and meaty taste. Other ingredients include **spices, flavorings, vitamins, and minerals**.

Plant-based oil makes the burgers juicy. **Coconut oil** has the advantage of remaining solid until it is **heated**. It only melts in the pan—just like animal fats.

To make the mass cohere, **methylcellulose** is added. It's the main component of wallpaper paste—but in the form of E 461 it also thickens many foods, ranging from ice cream to mayonnaise.



After administering local anesthesia, a small sample of muscle tissue is removed from a healthy animal. A few hundred **cells** are enough.

The **muscle cells** are separated from the **fat cells**. The **satellite cells** are isolated from the muscle cells. These are special stem cells that repair damaged muscle.

When placed in the right nutrient solution, **satellite cells** multiply almost endlessly. Theoretically, ten tons of tissue could be cultivated from a single cell. The nutrient solution required for this is often still based on calf serum. Companies are looking for plant-based alternatives.

If the amount of certain proteins known as **growth factors** in the nutrient solution is reduced, the satellite cells react by forming **muscle cells (myoblasts)**.

Myoblasts autonomously organize themselves into fibers called **myotubes**, which are only up to a third of a millimeter long. When they are correctly organized on a flexible carrier, they form tiny muscle fibers and begin to contract. The muscle "trains" itself and increases in mass.

About 20,000 of these **mini-muscles** are needed to make one burger patty. They can be processed in the same way as ground beef. The only thing now missing is **fat**—either plant-based or cultivated fat.