



# Artificial intelligence, lab meat, bleeding plant burger, ...



**Innovations to replace meat, eggs and dairy. Global  
overview of leading technologies and researchers**

*This presentation: [futurefood.org/futurefood\\_english.ppt](http://futurefood.org/futurefood_english.ppt)*

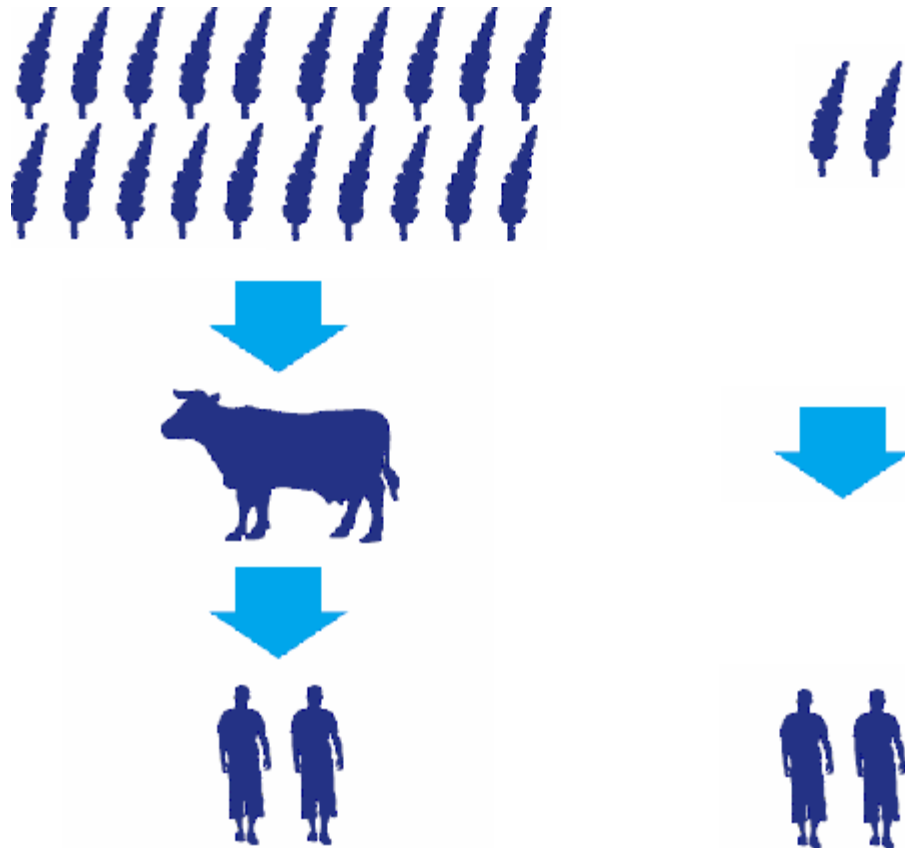


[www.futurefood.org](http://www.futurefood.org) - alternatives to animals products

## 🌱 The reasons

- 🌱 Environment (climate)
- 🌱 Health
- 🌱 Animal welfare
- 🌱 World nutrition / hunger

# World hunger / environment



Meat = lengthened  
food chain =>  
requires 5-15 times  
more areas, plants,  
water etc. to feed  
humans

(Exception: Pure pasture  
management of ruminants, which  
on the other hand requires huge  
areas, causes much of the  
methane-issues, furthermore only  
small share of global production).

# World hunger / environment



Input / Output: 1 out of 7 calories converted to meat, what happens with the rest?

Metabolic losses inevitable (compare humans), Bread example, livestock first of all an efficient production of excrements, meat as „side product“, by far biggest waste of food globally, 1/3 of world harvest (cereals+soya) converted to excrements!

# ***Livestock / consumption of animal products***

**is the biggest ... on earth !!**

- **land consumer**
- **water consumer**
- **water contaminator**
- **contributor to rainforest destruction**
- **food-waster**
- **cause of billionfold suffering of animals**
- **risk factor for food poisonings**
- **risk factor for global pandemics**

**one of the biggest or the biggest ... on earth!!**

- **factor in loss of biodiversity**
- **cause for soil erosion**
- **risk factor for lifestyle diseases**
- **risk factor for antibiotic resistances**

**is one of the biggest ... on earth!!**

- **climate killers**
- **air polluter**

***„With each meal the earth is at stake“***

**If too much meat is  
a big part of the  
problems, we  
should modernise  
our nutrition as  
part of the  
solutions**





Artificial intelligence, lab meat, bleeding plant burger, ...

**Kurt Schmidinger** – [www.futurefood.org](http://www.futurefood.org)  
Geophysicist & Food Scientist



What could lead to a collapse of the „factory farming“ practices?

- Human reason / ethics ?????
- Top-products as alternatives to animal products ?
- Food shortages (climate?) / concurrency of non-food croplands (plastic alternatives made of maize, biofuels) ??
- Antibiotic-resistances from intensive livestock facilities ?
- Serious new pandemics from intensive livestock facilities ?





## [www.futurefood.org](http://www.futurefood.org) Alternatives to animal products

- 1) “Vegetarian meat”: All raw materials to replace meat
- 2) “Non dairy milk products”: All raw materials to replace dairy milk, cheese, yoghurt etc.
- 3) “Replace egg (products)”: All raw materials to replace egg (products)
- 4) New approaches like “bleeding plant burgers”, use of artificial intelligence for (1), (2) and (3)
- 5) Futuristic: Cultured meat, milk, eggs. Biofermenter.

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## Vegetarian meat

- Wheat: Wheat gluten (seitan)
- Soy: Soya meat (TVP), tofu, tempeh, sprouted soybeans
- Sweet lupines
- Fresh mushrooms
- Fermented fungi, e.g. Quorn
- Algae
- Rice, peas
- Vegetable fibres (e.g. Proviand)



## Some top brands veget. meat

### 🌿 Tofurky (Turtle Islands Foods):

Oregon, USA

Sausages, roasts and others, based on tofu and wheat gluten, but also te



### 🌿 Gardein (Garden Protein Int.):

British Columbia, Canada

"Chicken"-wings,-filets,-breasts und-stripes, skewers and more,

Based on soy protein and wheat gluten.





# Some top brands veget. meat

## Impossible Foods

California, USA  
Breaking new grounds with their mission to create the perfect plant based "beef burger" with heme (haem) from plants as "bloody juice". Another US\$114 million funding in April 2018.



## Beyond Meat

California, USA.  
Funded by Leo DiCaprio, Bill Gates, Tyson Foods(!), ...

and many other companies

**VEGETARIAN MEAT**

Remarkable intermediate products for the production of vegetarian meats:

- Meatless, vegetable fibers, made from lupine or wheat (Florigen, NJ)
- Meatless, fermented wheat protein (MGP Ingredients, IL)
- Wheat and lupine (Meat, Foods, USA)
- Soy (Go Forth, Maryland, USA, UK)
- Soy protein isolate / concentrate (Garden of Eatin', CA)
- Peas (The Field Institute, San Francisco, (USA), UK)
- Gene Food (Gene, London, agricultural producer, UK)
- Meat, mushroom, beta glucans (Cabo, CA, Australia)

Highly remarkable vegetarian meat products:

- Woods Field - vegetarian meat
- Faral - remarkable Vito Fish Shrimp ... (French product, German national)
- Thymus, Bismarck, Schottland ... at Pro's Special Vegetarian (South Africa)
- US, meat and dairy, vegetarian, Australia
- Texas - wheat, soybean, wheat-based vegetarian meat
- USA, soy-based soybean, blood, meat replacement (Mati)
- Australian food, veggie-meat, soy-chicken, soy-milk
- Meatless - Innovative Garden (meat, Protein, USA, CA, UK)
- Meat, soy, wheat, soybean, soybean and soybean (UK)
- Meatless - Soybean, soybean, Meat (UK)
- Meatless - soybean, soybean, soybean meat (UK)
- Little Island Foods / (Sofy, UK, Canada, UK)
- Soy (UK, soybean, soybean meat) (UK)
- Meat (UK, soybean, soybean meat) (UK)
- Soybean Soy (soybean meat, soybean) (UK)
- Meat Protein, Meat Alternatives (UK)
- Meat Alternatives - Senter (UK)
- Vegetarian, Protein, Meat, Alternatives (Thailand)

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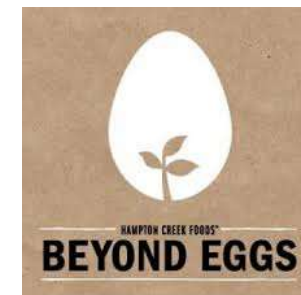
## Plant based alternatives to dairy products

- **Drinks (“milk”), yoghurts, cream, sour cream** made from soy, oat, almond, rice, coco, *quinoa, millet, spelt, barley, kamut*. Often fortified with B2, B12, D2, calcium, A, B6, *folic acid, E*
- **Ice cream** from soy, rice, etc.
- **“Cheese”** from soy protein, pea protein, tofu, potato starch, rice starch, soy oil, other plant based fats and oils, nut butter, thickening agents, yeast, but also: tapioca- u. arrowroot flour, rapeseed oil, safflower oil, coconut oil, etc.
- **Desserts, confectionaries, margarine ...**



## Plant based alternatives to egg products

- **Alternatives to egg products for the industry:** About 10 companies in the US, NL, UK and others. Made of gelling and thickening agents (alginate, carrageen, guar flour, locust bean gum, xanthan gum), soy lecithin, potato protein, potato starch, full soy beans, wheat gluten, corn syrup, sometimes also dairy(!) or egg(!) ingredients  
→ see [http://www.futurefood.org/eggproducts/index\\_en.php](http://www.futurefood.org/eggproducts/index_en.php)
- Interesting startups like “**Beyond Eggs – Hampton Creek**” – supported by Bill Gates, “mayo wars” with Unilever, brought huge popularity





## Plant based alternatives to egg products

- 🌿 **At home:** “Egg replacers” by Ener-G, Orgran or others (potato-, tapioca starch, CMC, citric acid, calcium carbonate)  
Or simply use soy flour, baking powder, mineral water, locust bean gum, agar-agar, soaked linseeds, etc.
- 🌿 **“Vegan fried egg”, “vegan yolk” by “The Vegg”.**  
Or from Tyrol **“MyEy”**: Maltodextrin, pea and potato protein, lupine flour, xanthan, locust bean gum, Kala Namak, curcuma, paprika, white pepper, ...







## Artificial Intelligence as food-designer

- The "Not Company" in Chile
- With "Guiseppe", the *"cleverest food-designer on earth"*
- Guiseppe is an artificial intelligent program that
  - understands molecular connections between food and the human perception of taste and texture
  - uses plant based ingredients
  - can replicate the taste, texture and smell of animal-based products by copying their molecular structure
  - can include side conditions in the creation of recipes like health, eco-balances, price-limits, etc. (fed with data from all ingredients)
  - always learns, never forgets, never retires or dies 😊



## Other options to optimize a possible vegan future nutrition

- Breeding enhancements for crops
- Fertilization of crops
- Well-directed fortification of foods
- Special fermentation processes



## Futuristic approaches

- 🌿 **Biofermenter:** Peter Arras / AKT, Germany, take ruminants as model/guide → food out of straw, harvest waste, etc. (all this would suddenly also be basis for human nutrition).

Companies like AlgaVia/TerraVia:

Experiments to produce algal oils and proteins from lignocellulosic sugars derived from e.g. municipal green waste



**biofermentation.flv**



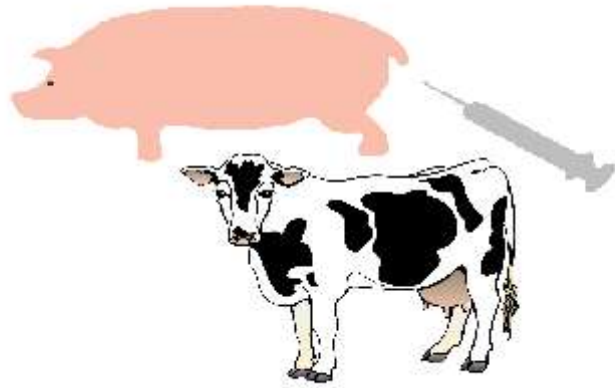
## Futuristic approaches

- 🌱 **Cultured Meat:** “Real” meat without animals made from cells in the lab.

Technological basics: Starting cells ( $\geq 2$  types), media incl. growth factors, bioreactors, edible “scaffolds” or bioprinters or similar. See e.g.

<http://www.gfi.org/images/uploads/2017/06/Mapping-Emerging-Industries.pdf> or <http://www.futurefood.org/DissertationSchmidinger.pdf>, Chapter 12

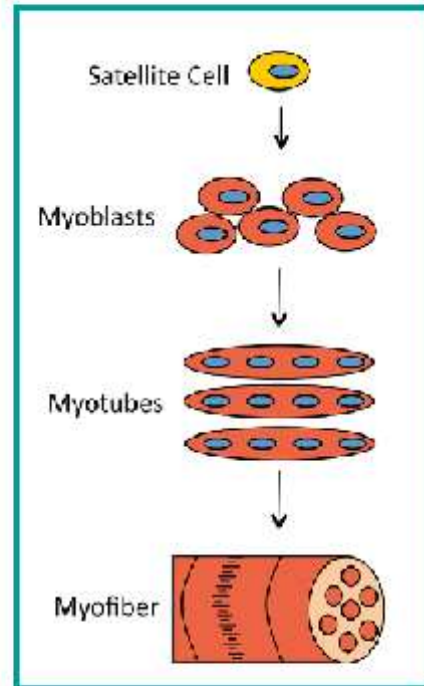
Actual terms: “clean meat” = “cultured meat” = “in vitro meat”



[1] Muscle stem cells are harvested by muscle biopsy.



[2] Cultivation of cells in culture medium. The cells proliferate.



This process is taking place in a bioreactor. In this bioreactor, cells are supplied with culture medium and are kept under ideal conditions.



[4] 20,000 of muscle fibres were combined to create the first in vitro beefburger.



[3] Stem cells pass through myogenesis (muscle development).



## Futuristic approaches – cultured meat

Some protagonists - historical:

- Henk Haagsman and Bernard Roelen (NL): Worked on basic understanding, currently not active
- Julie Gold (Sweden), Jason Matheny (USA, founded new-harvest.org), Stig Omholt (Norway, with 1. in-vitro-meat symposium): Networking
- Vladimir Mironov and Nick Genovese (USA): PeTA, 3-D-printer, networking, mastermind
- Oron Catts & Ionat Zurr (AUS): Artists from Australia
- Willem van Eelen (NL): Pioneer, cultured meat patent
- Winston Churchill 😊



# Futuristic approaches – cultured meat

Some protagonists – actual:

- **MosaMeat / Mark Post (NL):** Sergey Brin (Google) and others as supporters, August 2013 first in-vitro-meat-burger worldwide presented - 250.000 € costs.
- **Modern Meadow,** Gabor and Andras Forgacs (**USA**): 3D-printer, in-vitro-leather, Thiel-Foundation and others as supporters.
- **Memphis Meats (USA):** First in-vitro-meatball 2015, since that time up to now most active group worldwide, received 17US\$ in August 2017 from Bill Gates, Richard Branson and others, but also Cargill. Tyson Foods, the biggest meat company in the US, has joined as an investor in Jan. 2018.
- **Hampton Creek** (“Beyond Eggs”, **USA**): Mainly a producer of egg alternatives (also supported by Bill Gates), but they announced in summer 2017 to produce cultured meat ready for the market by the end of 2018 → ?
- Project **SuperMeat** with Y.Nahmias, I. Savir, K. Barak, S. Friedman in **Israel**, received a 3 million US\$ support at the end of 2017 (among the financiers is PHW – Wiesenhof – poultry giant in Germany)
- **thekitchenhub.com**, also in **Israel**, also work on cultured meat
- Open source "**Shojinmeat Project**" in **Japan**



## Futuristic approaches

### 🌿 **“Real” milk, eggs, fish without animals:**

- 🌿 **“Finless Foods”**: Fish
- 🌿 **“Clara Foods”**: Eggs
- 🌿 **“Perfect Day” (former “Muufri”)**
  - 🌿 Mission: “Real” milk (proteins, fatty acids), but without lactose and cholesterol, so a “more healthy milk”
  - 🌿 received a \$25 million funding Feb 2018 from several investment firms
  - 🌿 Cows genome analysed, more precise, the genetic sequences for milk proteins analysed, and these genes synthesized
  - 🌿 These copied (never been in an animal) genes put into yeast
  - 🌿 This yeast is grown in large quantities and it produces milk proteins out of a solution composed of amino acids. (*price?, where to get it from?*), final product is seperated from the host (yeast) (*how long can the yeast be used?*) => final product GMO-free (?)

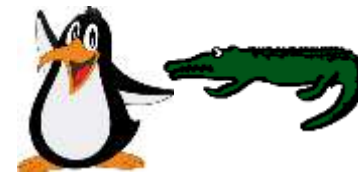




## Futuristic approaches – a scenario for the market entry of clean meat

- Initially expensive
- + Produce „healthy meat“, less saturated fatty acids, cholesterol, arachidonic acid, purines, ... , but more omega-3s, etc.
- + Smaller eco-footprints, less waste of resources, animal friendly
- + Make fancy, brand new mixtures like crocodile-kangaroo-penguin-burgers (later also filets), all without harming these animals

=> Celebrities as first consumers and multipliers?





## Futuristic approaches

Video from IndieBio-lab in San Francisco, where many mentioned startups work, or have started:

<https://www.cnbc.com/2017/09/04/tour-the-lab-that-spawned-the-lab-grown-meat-start-up-funded-by-bill-gates-and-richard-branson.html>

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