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

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Innovations to replace meat, eggs and dairy. Global overview of leading technologies and researchers
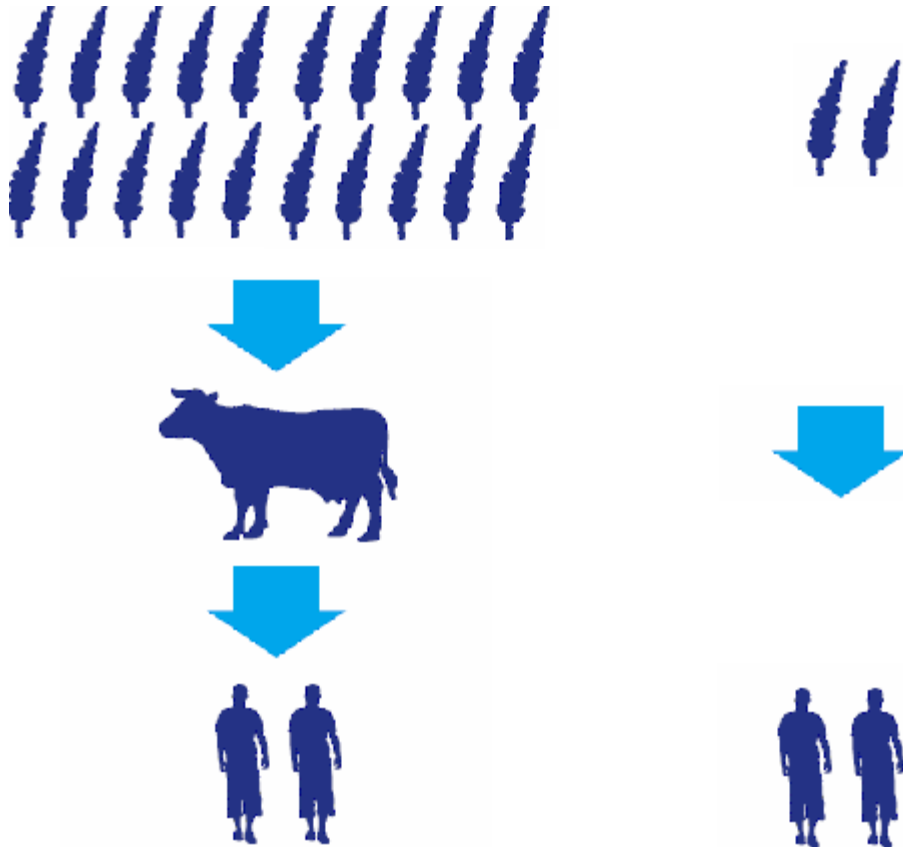
Kurt Schmidinger – www.futurefood.org

Geophysicist & Food Scientist

www.futurefood.org - alternatives to animals products

- **The reasons**
  - **Environment (climate)**
  - **Health**
  - **Animal welfare**
  - **World nutrition / hunger**
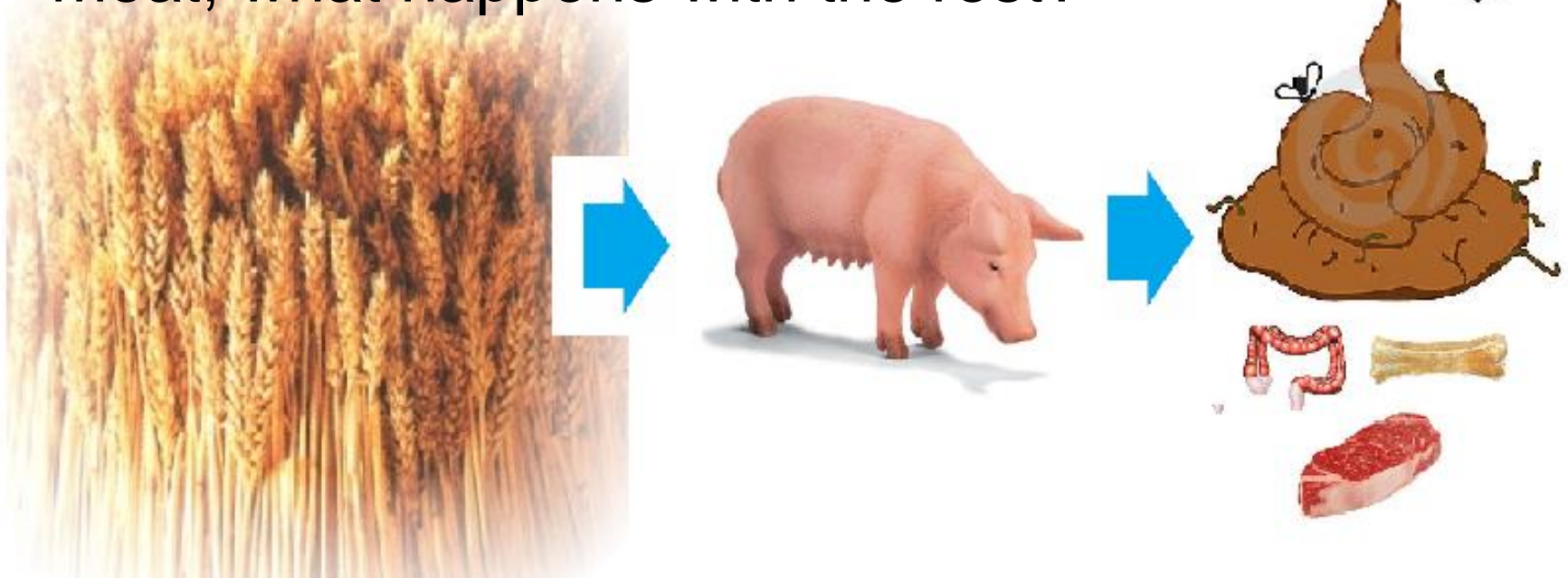
World hunger / environment

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!

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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

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„*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

FUTURE food ?

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 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, joghurt 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: Lab grown 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™

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".

Beyond Meat

California, USA.

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

and many other companies

VEGETARIAN MEAT

HOME – OVERVIEW
FOR THE WORLD
SUCCESS CRITERIA
VEGETARIAN MEAT
CULTURED MEAT
NON-DAIRY MILK DRINKS
REPLACE EGG PRODUCTS
> FOOD INDUSTRY
> SCIENTISTS
> NON-PROFIT ORGANIZATIONS
> EVERYONE
CONTACT – ABOUT US

Dissertation Futurefood

VEGETARIAN MEAT
Remarkable intermediate products for the production of vegetarian meats:
Meatless, vegetable fibres, made from lupine or wheat (Meatless, NL)
Wheatex, textured wheat protein (MGP Ingredients, US)
Ultra-Soy and Imagic (Legacy Foods, US)
Soy Iso Fibers (Nutriant, Kerry US)
Soy protein isolates / concentrates (Solae)
Nexsoy Low-Fat textured Soy Proteins (Nexcel, US)
Sonic Biochem - Indian soyameat-producer (IN)
Mase, innovative tofu machines (also on youtube)

Highly remarkable vegetarian meat products:
Valsoia Italy - vegetarian meat
Pural - remarkable Veg. Fish Sticks, ... (French product, German website)
Burgers, Nuggets, Schnitzels, .. at Fry's Special Vegetarian (South Africa)
US meat and dairy substitutes overview
Topas - Wheaty Germany, wheat based vegetarian meat
Yaso, sprouted soybean based meat replacement (Hun)
Australian tofu, veggie-meat, soy-cheese, soy-milk
iGardein - Innovative Garden grown Protein (USA, Can, UK)
Linda McCartneyFoods, sausages and burgers (UK)
Sojaprodukt - Slovak Vegetarian Meat (SK)
healthy-eating.com, various brands vegetarian meat (US)
Turtle Island Foods / Tofurky (US, Canada, UK)
Beyond Meat, vegetarian "chicken meat" (US)
Field Roast Grain Meat (US)
Bahama Rice based meat alternatives (US)
Match Premium Meat Alternatives (US)
Witmit Argentina - Seitan (AR)
VegieVegie Premium Meat Alternative (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**, m**argarine** ...

Some top brands for dairy alternatives

🌿 Alpro / Provamel

Belgium, but also Germany, UK

European market leader, huge variety, mostly based on soy, to a lesser extent on rice, almond or oat,

Provamel is the brand for the organic product range

🌿 Turtle Mountain

Oregon, USA

„So Delicious" and "Purely Decadent", ice cream, frozen desserts, based on soy

Some top brands for dairy alternatives

Valsoia

Italiy

Drinks, Desserts, ice cream, confectionary based on soy, partly
also rice, also vegetarian meat products (burgers, sausages cutlets, …)
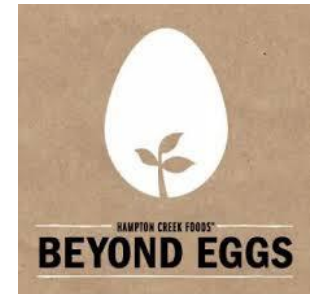

Daiya

Canada

Cheese alternatives, also cooperation with other veggie-food-
producers (e.g. as pizza cheese), unique composition: tapioca-
and arrowroot flour, rapeseed oil, safflower oil, coconut oil, pea protein

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
- 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, …

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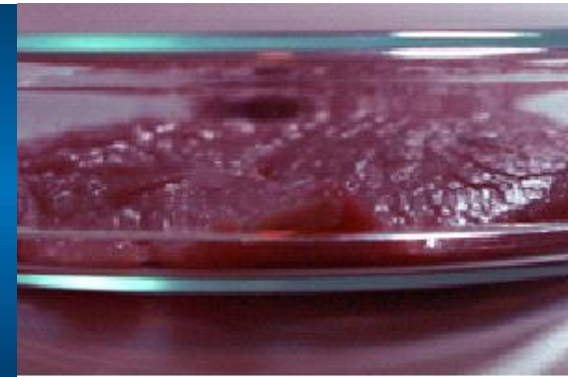**Kurt Schmidinger** – www.futurefood.org

Geophysicist & Food Scientist

Artificial Intelligence as food-designer

- The **"Not Company"** in Chile
- With "Guiseppe", the *"cleverest food-designer on earth"*
- Guispeppe 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
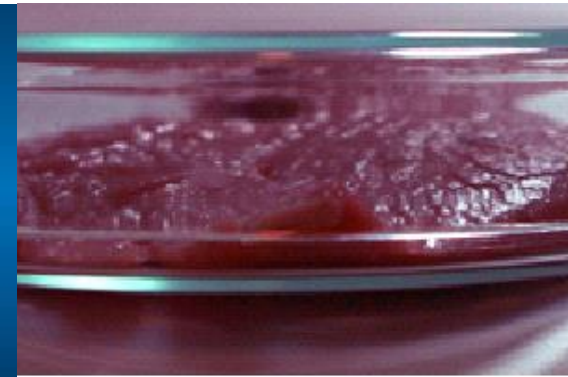- Special fermentation processes

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 (or meat-brewery).
Technological basics: Starting cells (>= 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
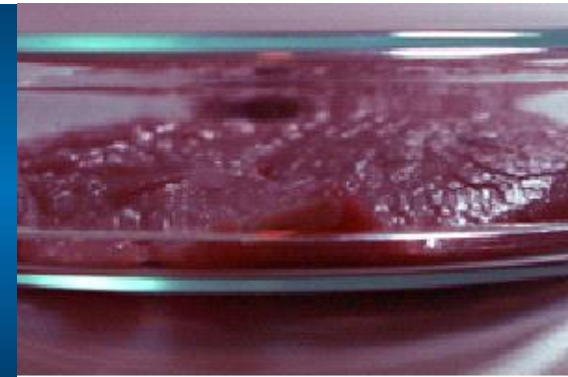Actual terms: "clean meat" = "cultured meat" = "in vitro meat"

Futuristic approaches – cultured meat
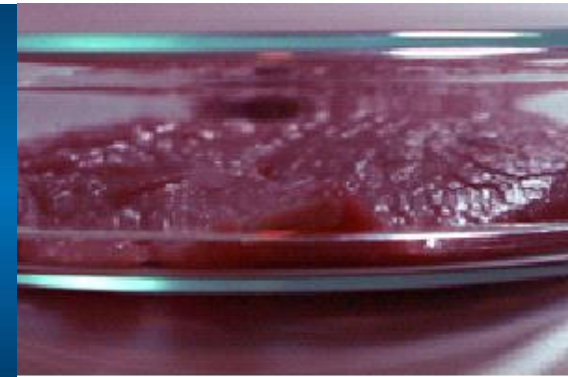
Some protagonists - historical:

- 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
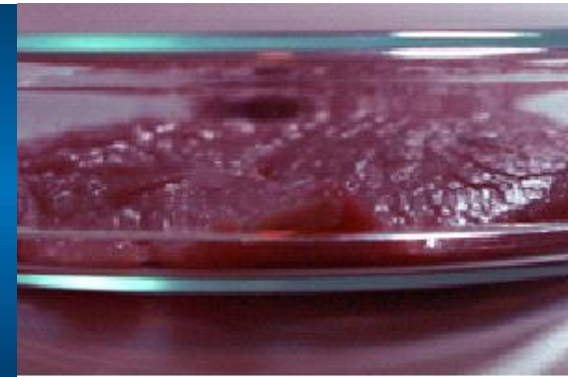
Some protagonists – more actual:

- **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.

- **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 Yaakov Nahmias in **Israel**

- **thekitchenhub.com**, also in **Israel**, reportedly also work on cultured meat → ?

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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"

🍃 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

🍃 These genes in the yeast produce milk proteins out of a solution composed of amino acids. *(price?, where to get it from?)*, final product free of these genes/yeast *(how long can the yeast be used? How to separate milk proteins from yeast?)* => final product GMO-free (?)

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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