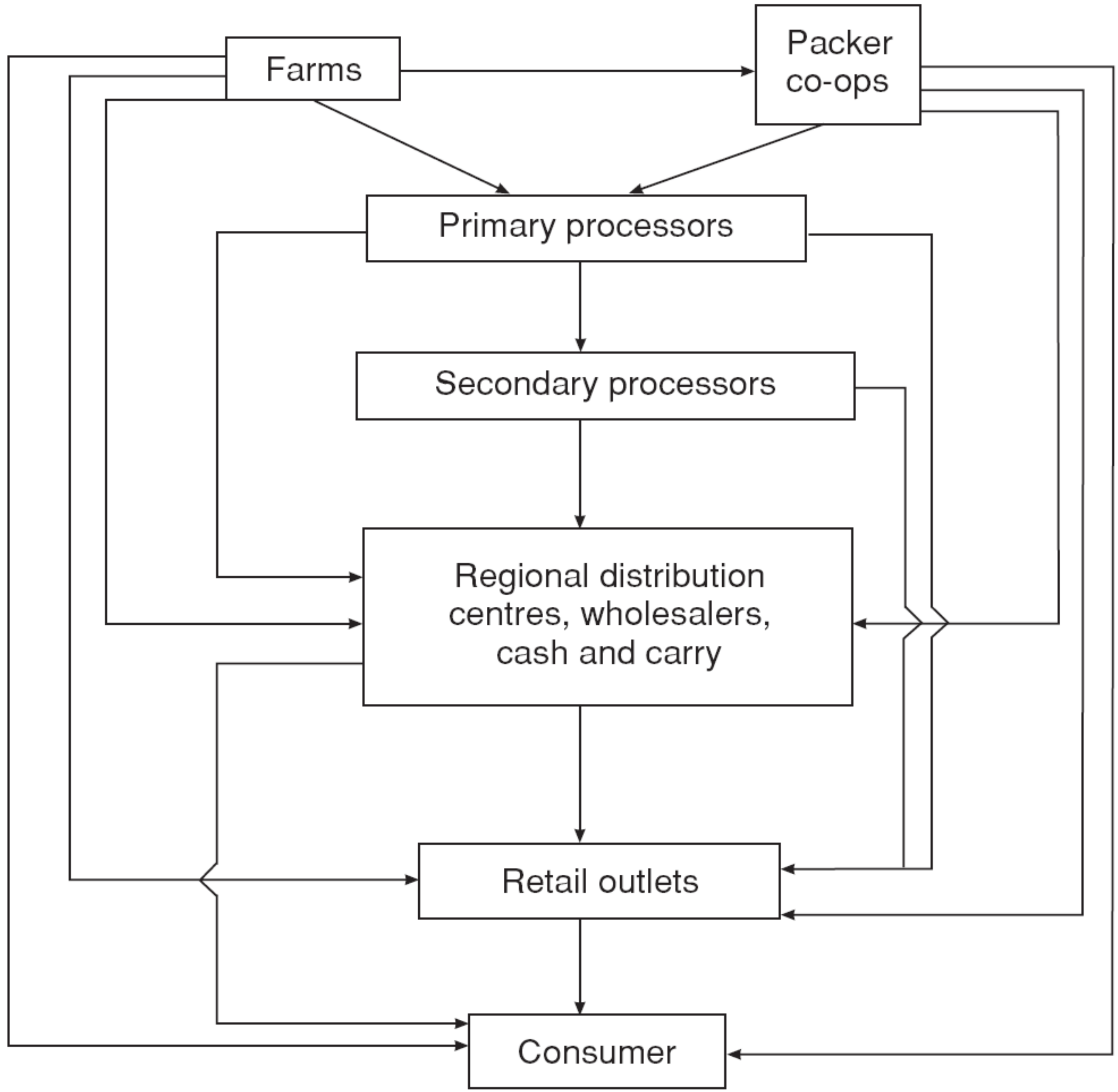
Food Industry and Related Technologies

Daniel Hao Tien Lee



Food distribution systems. (Adapted from Paine & Paine, 1983.)

Food Industry and Technology

- Growing
- Making
- Tracking
- Future Food
- Beverage Industry and Technology
- Gastronomy and Technology

AG (Agriculture) Productivity

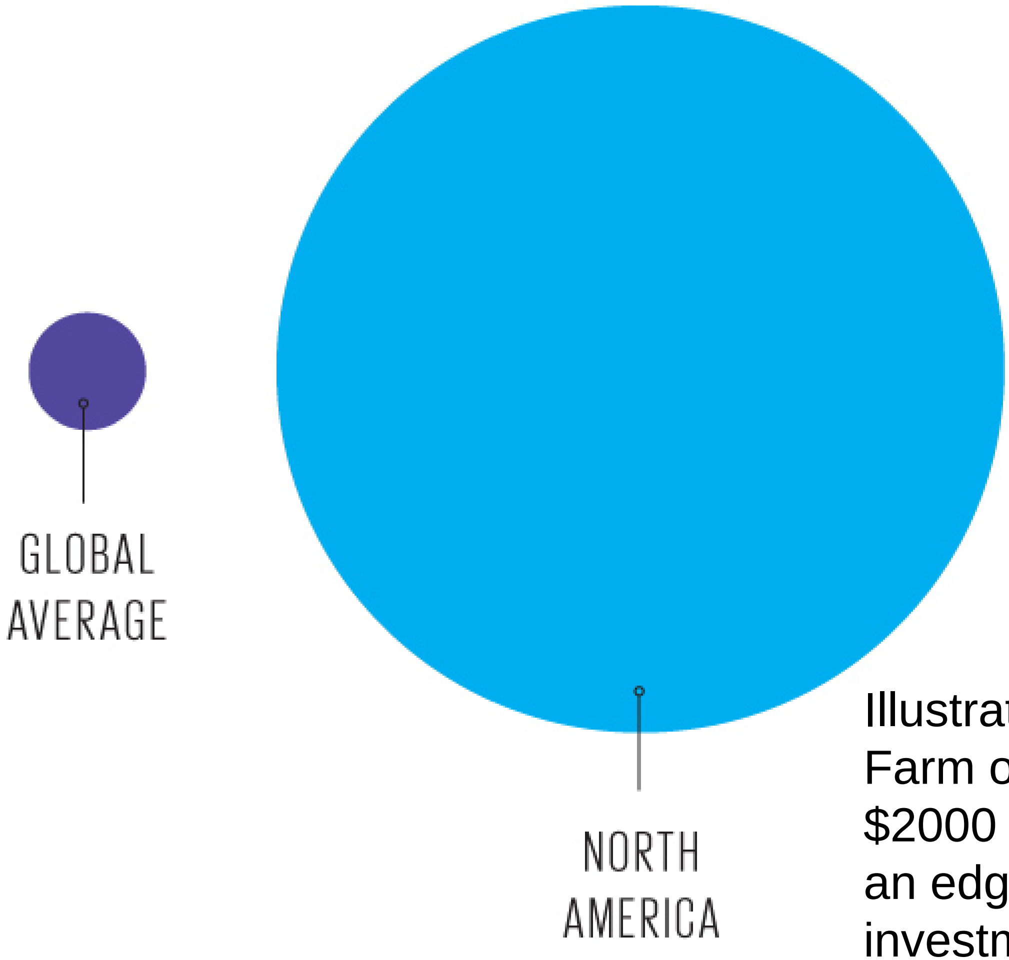


Illustration: Erik Vrielink
Farm output per worker averages US $2000 globally, $90 000 in North America, an edge due in part to higher capital investment, in part to greater efficiency

http://spectrum.ieee.org/static/the-age-of-plenty#food-part-2

Illustration: Erik Vrielink

A cow’s yield has risen fourfold in the United States within living memory, the result of selective breeding and more sophisticated care and feeding.

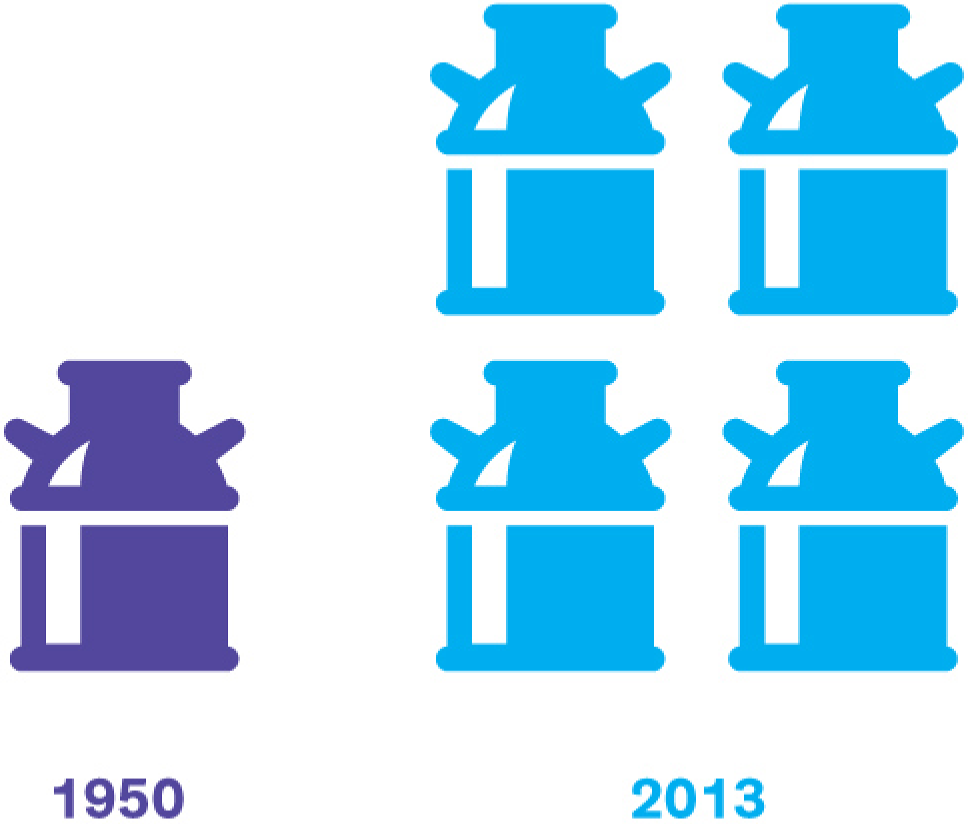


Illustration: Erik Vrielink
Brazil's beef exports rose tenfold in a single decade, one of the many changes that have made it the first tropical country to rank among the advanced agricultural powers.

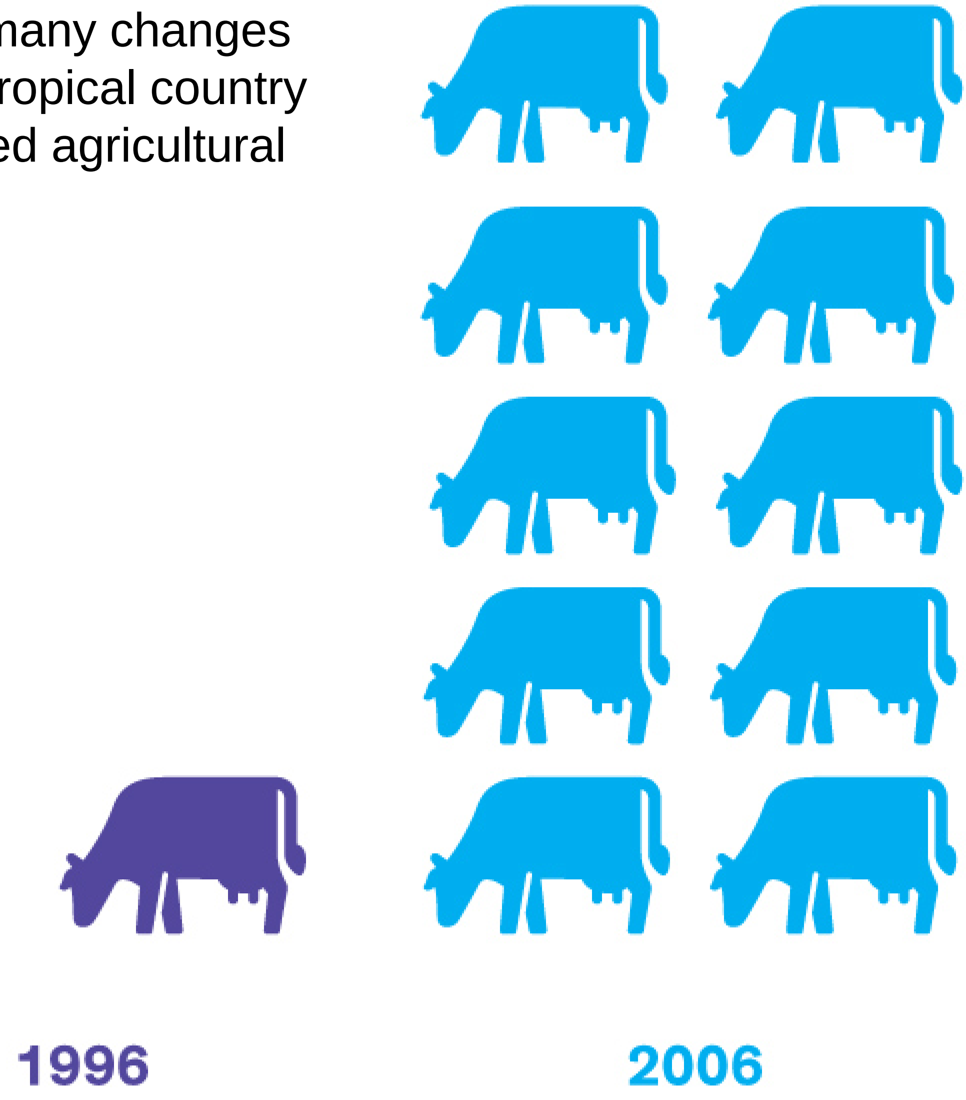
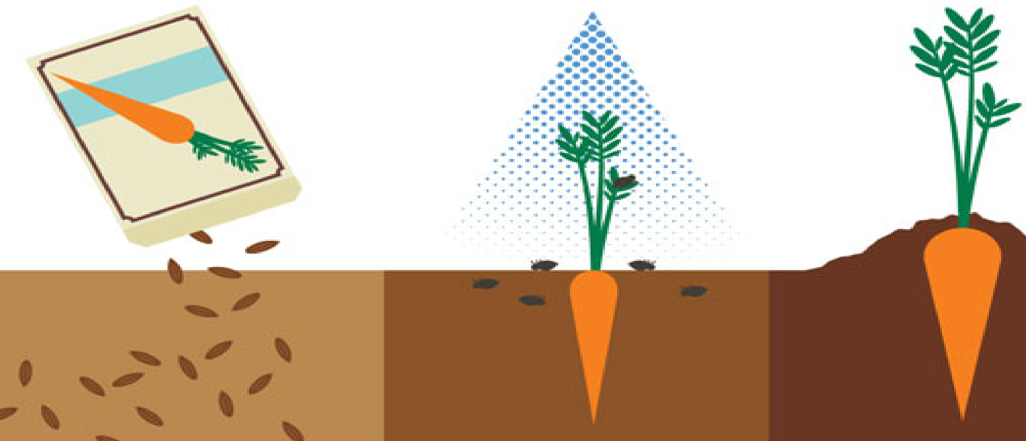
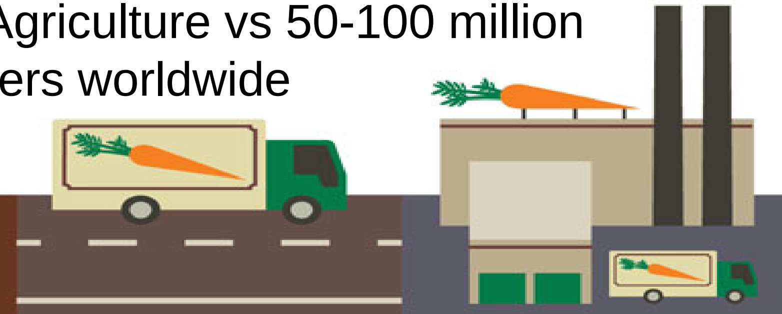


Illustration: Erik Vrielink
World population and food prices have moved in opposite directions, confirming that agricultural productivity can sustain and even improve the standard of living.

Dozen of Oligopolies Control the Big Agriculture vs 50-100 million farmers worldwide





SEED PRODUCERS

65 to 70 percent of the world proprietary-seed market:

MONSANTO CO.
Creve Coeur, Mo.

E. I. DU PONT DE NEMOURS AND CO. (DUPONT)
Wilmington, Del.

SYNGENTA AG
Basel, Switzerland

GROUPE LIMAGRAIN HOLDING SA
Chappes, France

LAND O' LAKES INC.
Arden Hill, Minn.

DOW AGROSCIENCES LLC
Midland, Mich. (Indianapolis)

KWS SAAT AG
Einbeck, Germany

BAYER CROPSCIENCE
Monheim, Germany

PESTICIDE PRODUCERS

75 percent of worldwide market:

MONSANTO

SYNGENTA

DOW AGROSCIENCES

DUPONT

BAYER

BASF SE
Ludwigshafen, Germany

FERTILIZER PRODUCERS

About 65 percent of the 140 million metric tons purchased worldwide:

POTASH CORP. OF SASKATCHEWAN INC. (POTASHCORP)
Saskatoon, Sask., Canada

MOSAIC CO.
Plymouth, Minn.

OJSC URALKALI
Berezniki, Russia

OJSC BELARUSKALI
Soligorsk, Belarus

OFFICE CHÉRIFIEN DES PHOSPHATES (OCP)
Casablanca, Morocco

YARA INTERNATIONAL ASA (FORMERLY NORSK HYDRO)
Oslo, Norway

CF INDUSTRIES HOLDINGS INC.
Deerfield, Ill.

ISRAEL CHEMICALS LTD. (ICL)
Tel Aviv

TRADE & PROCESSING

Dominant companies include:

ARCHER DANIELS MIDLAND CO.
Decatur, Ill.

BUNGE LTD.
White Plains, N.Y.

CARGILL INC.
Minnetonka, Minn.

LOUIS DREYFUS SAS
Rotterdam, Netherlands

FOOD COMPANIES

Among the largest companies are these:

NESTLÉ SA
Vevey, Switzerland

PEPSICO INC.
Purchase, N.Y.

KRAFT FOODS GROUP INC./ MONDELĒZ INTERNATIONAL INC.
Deerfield, Ill.

THE COCA-COLA CO.
Atlanta

ARCHER DANIELS MIDLAND CO.
Decatur, Ill.

ANHEUSER-BUSCH INBEV NV
Leuven, Belgium;
São Paulo

JBS SA
São Paulo

TYSON FOODS INC.
Springdale, Ark.

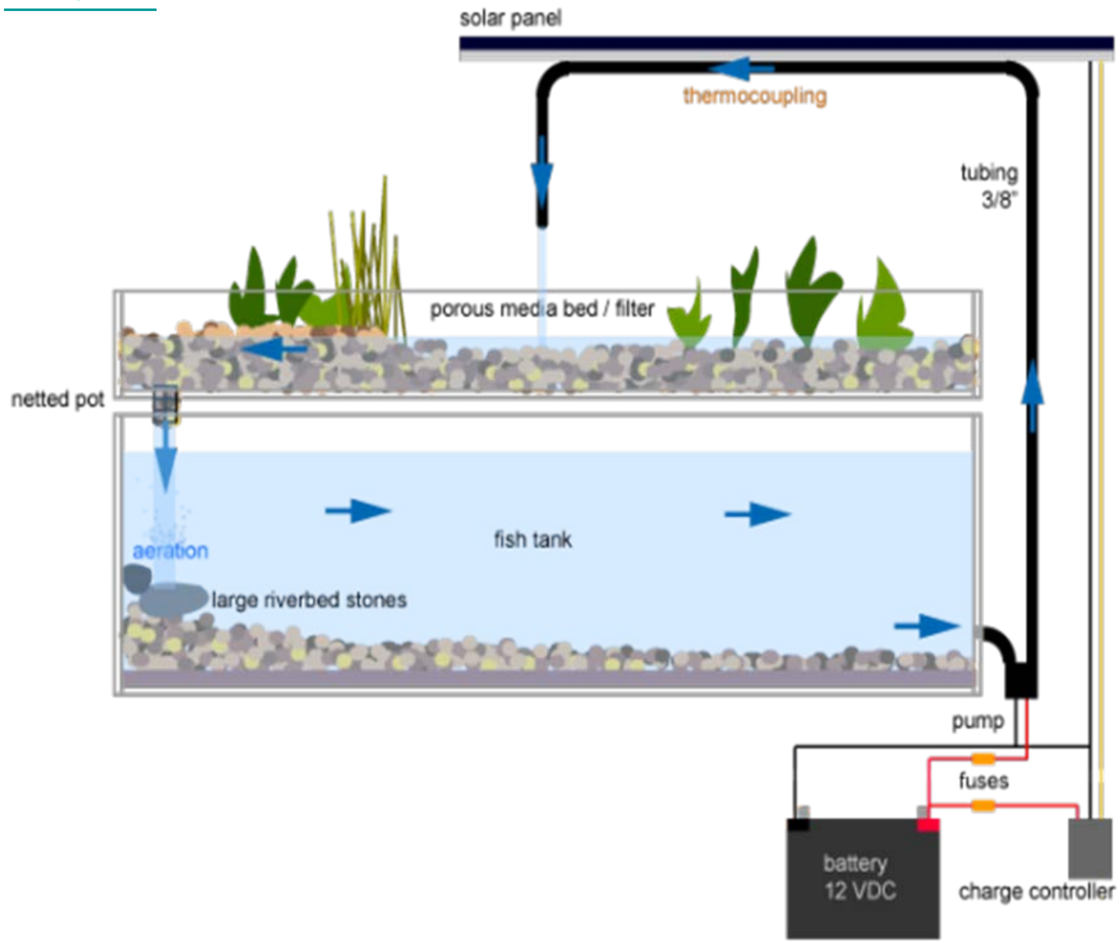
UNILEVER NV
London; Rotterdam, Netherlands

SABMILLER PLC London

Oligopoly in Food Industries: Good or Bad?

The Indoor Aquaponics Farm

http://www.youtube.com/watch?v=TG5HUZN10EY

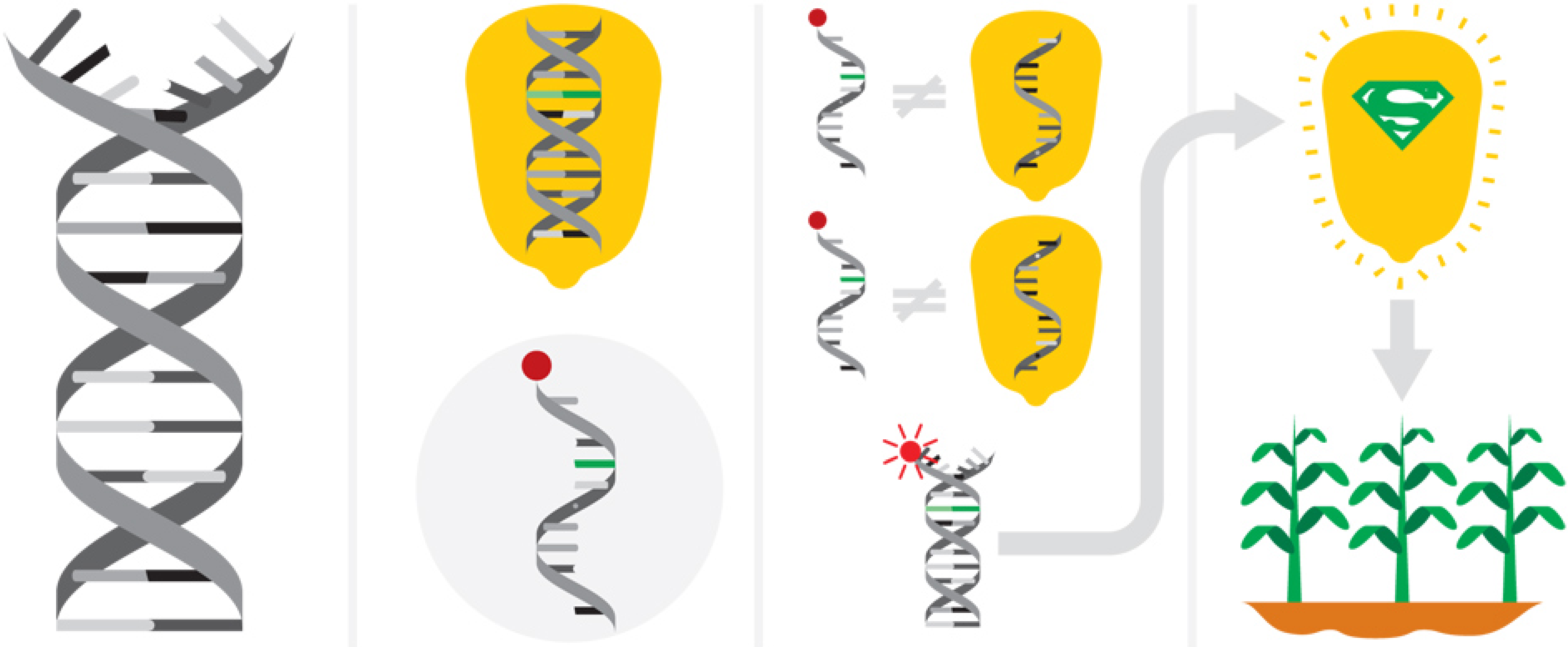


Hydroponics is the art of soiless agriculture. Here the growing medium is a pH adjusted water solution, thus the greek name hydro and ponos, meaning labour. The required minerals are dissolved in the water and absorbed easily. In fact, research has proven that plant roots absorb minerals easier when in water than when in soil. Sometimes inert medium is used to hold the roots e.g. sand, gravel, vermiculite, rockwool, perlite, peatmoss. coir, coconut husks or sawdust.

http://youngagropreneur.wordpress.com/2011/09/29/hydroponics-aquaponics-and-aeroponics/

Illustration by James ProvostRobotic Breeding: Robot-assisted genetic analysis helps plant breeders combine several genetic traits into one plant breed.

http://www.youtube.com/watch?v=XFVU46mJCUE#at=12



DNA is a ladderlike structure with rungs made up of four types of chemicals. Adenine binds only to thymine, and guanine binds only to cytosine.

1 **Scientists discover that** corn with a particular mutation—a change in a single spot—is better able to tolerate drought. They build a genetic probe containing the mutant DNA sequence and a chemical that lights up when the DNA sequence binds to its complement.

2 **Scientists crossbreed the** drought-tolerant plants with a high-yield variety. But which of the thousands of resulting seeds has both genetic traits? To find out, robots extract DNA from the seeds and add the probe. The probe binds only to a complementary DNA sequence.

3 **A breeder can then grow—** and sell—only those seeds that are both high yield and drought tolerant. Or the process can be repeated to add other traits, such as disease resistance.

Hunger Map 2012

Proportion of total population undernourished, 2010-12

- Missing or insufficient comparative data
- <5% — Very low undernourishment
- 5-14% — Moderately low undernourishment
- 15-24% — Moderately high undernourishment
- 25-34% — High undernourishment
- 35% and over — Very high undernourishment
- No data

The map shows the prevalence of undernourishment in the total population as of 2010 – 2012. The indicator is an estimate of the percentage of the population having access to an amount of energy from food insufficient to maintain a healthy life. Further information is available at www.fao.org/publications/sofi/en/

Source: FAO, IFAD and WFP. 2012. *The State of Food Insecurity in the World 2012: Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition.* Rome.

The designations employed and the presentation of material in the maps do not imply the expression of any opinion whatsoever on the part of WFP concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

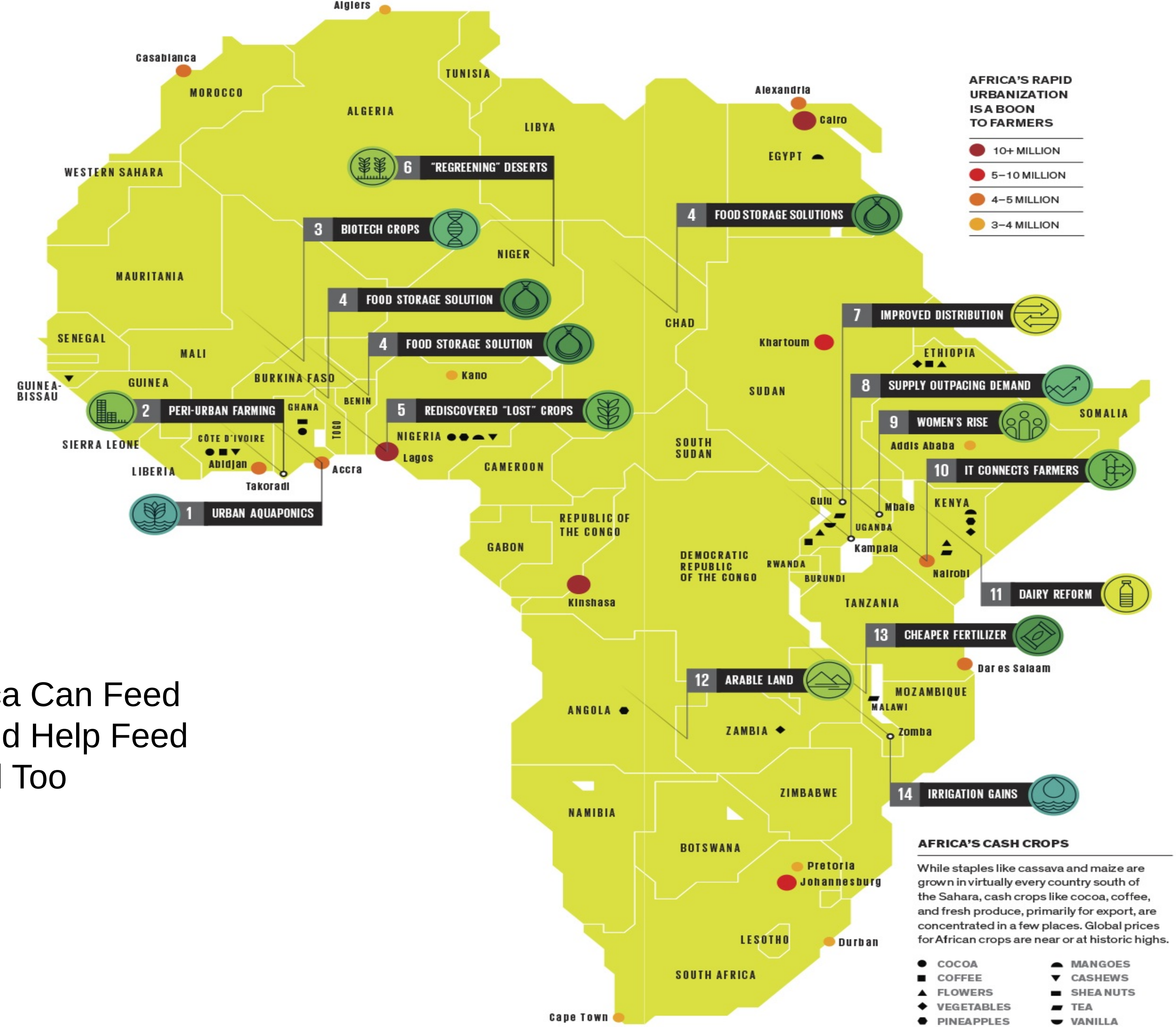
* The Line of Control in Jammu and Kashmir agreed on by India and Pakistan is represented approximately by a dotted line. The final status of Jammu and Kashmir has not yet been agreed on by the parties.

** A dispute exists between the governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

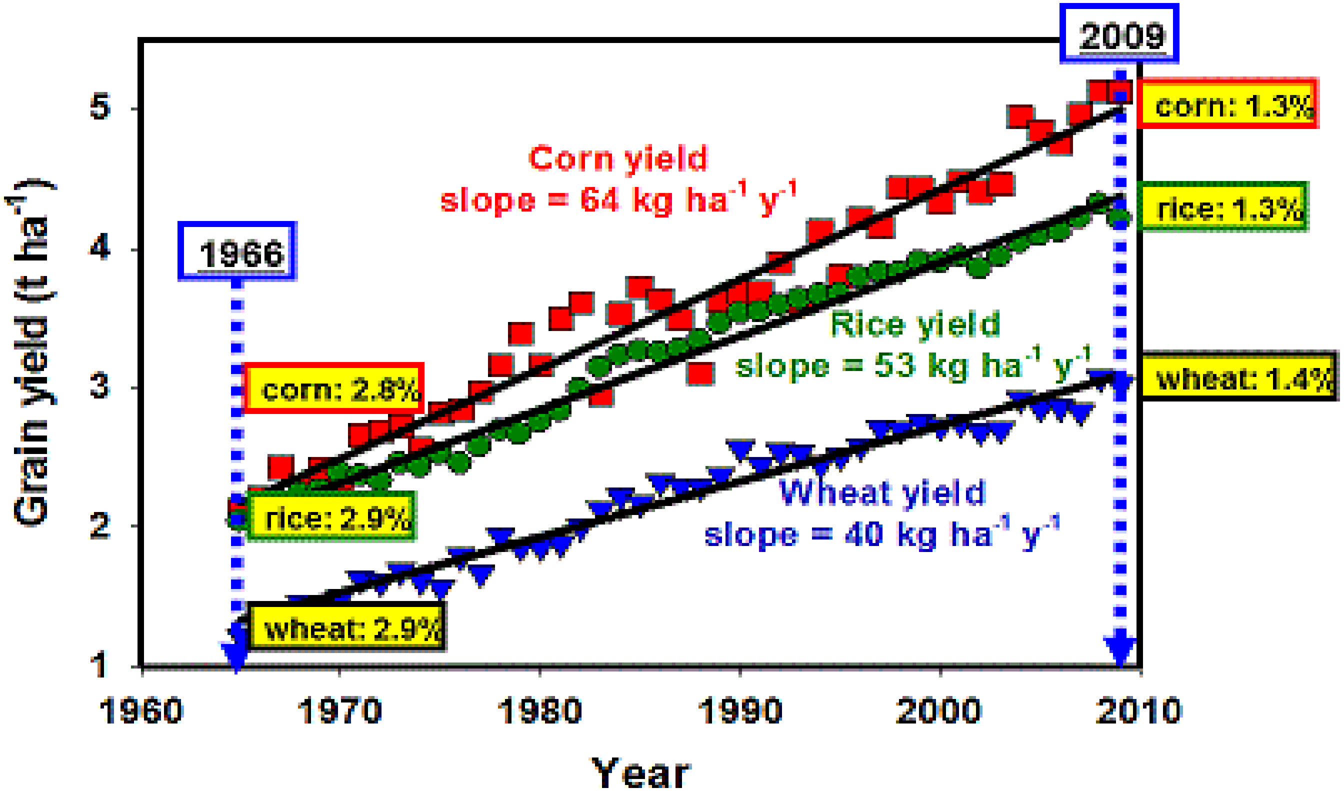
*** Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.

WFP
World Food Programme
wfp.org

Why Africa Can Feed Itself—and Help Feed the World Too



Current rates of yield growth will not meet demand



The relative rate of gain in crop yield has fallen from ~2.9% of average yields in 1966 to ~1.3% today, which is not fast enough to meet expected food demand without a large expansion of crop production area (source: FAOSTAT)

Sustainable Food Production for the Future

https://www.youtube.com/watch?v=NLad4f2Rt9E#t=34

Hacking Tomatoes at the World’s Greenest Greenhouse

http://www.youtube.com/watch?feature=player_embedded&v=X6DmmrglLSs#at=153

The Netherlands has nearly 11 thousand hectares of growing space under glass, or about 40 square miles. That’s almost twice the area of the island of Manhattan. In fact, no country has a greater proportion of its land area under glass.

But these greenhouses boast more than plants. They’re also a breeding ground for high-tech plant experiments and greener energy. Some of the country’s most advanced greenhouses are in Bleiswijk and operated by Wageningen University and Research Center. At the Wageningen greenhouses, researchers can grow as many as 150 pounds of tomatoes in a square yard of space. And by using specially calibrated LED lights, they have managed to produce exotic new tomatoes with a whopping 50 percent more vitamin C than ordinary ones.

Creating Recipes with Artificial Intelligence (AI)

http://www.fastcodesign.com/1672444/try-a-recipe-devised-by-bms-superciomputer-chef

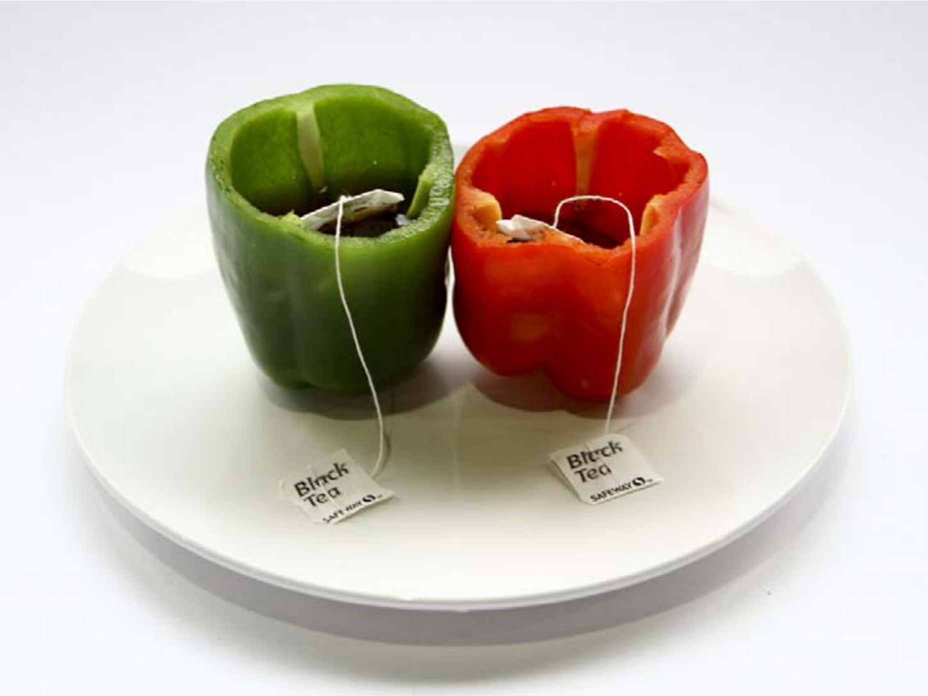
An Ecuadorian strawberry dessert algorithmically maximized for pleasantness, with strawberries, confectioners sugar, salt, black pepper, lemon, lime, heavy cream, whole milk yogurt, dry yeast, flour, canola oil, eggs, peanuts, cocoa powder.

Italian grilled lobster, with a complex set of pairings including salt, pepper, saffron, green olives, tomato, pumpkin, mint, oregano, white wine, water, macaroni, orange juice, orange, bacon, and oil.

Creating Creativity:

[Computers May Someday Beat Chefs At Creating Flavors We Crave]

How about some chocolate drizzled over blue cheese?



Does bell pepper and black tea sound appetizing? A computer may think so.

Indian Turmeric Paella

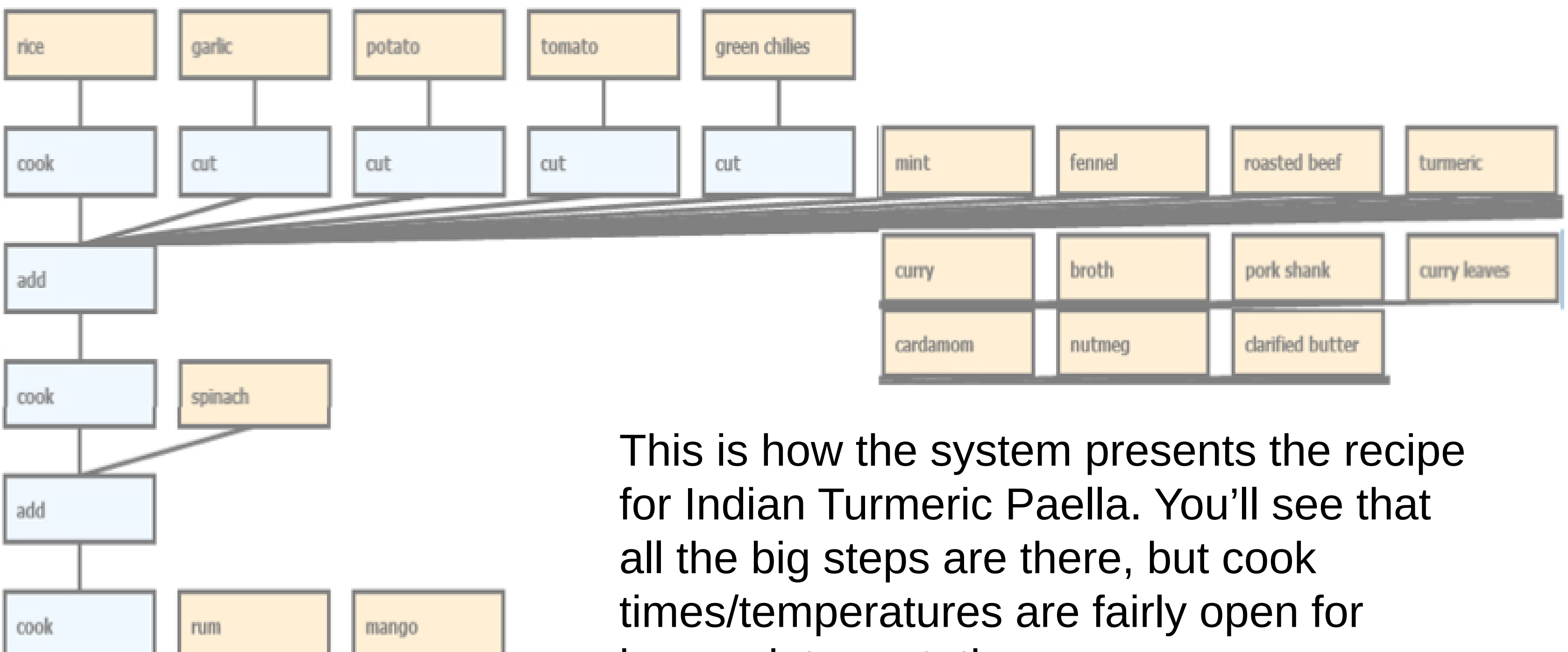
Indian Turmeric Paella

garlic
tomato
potato
green
chilies
spinach

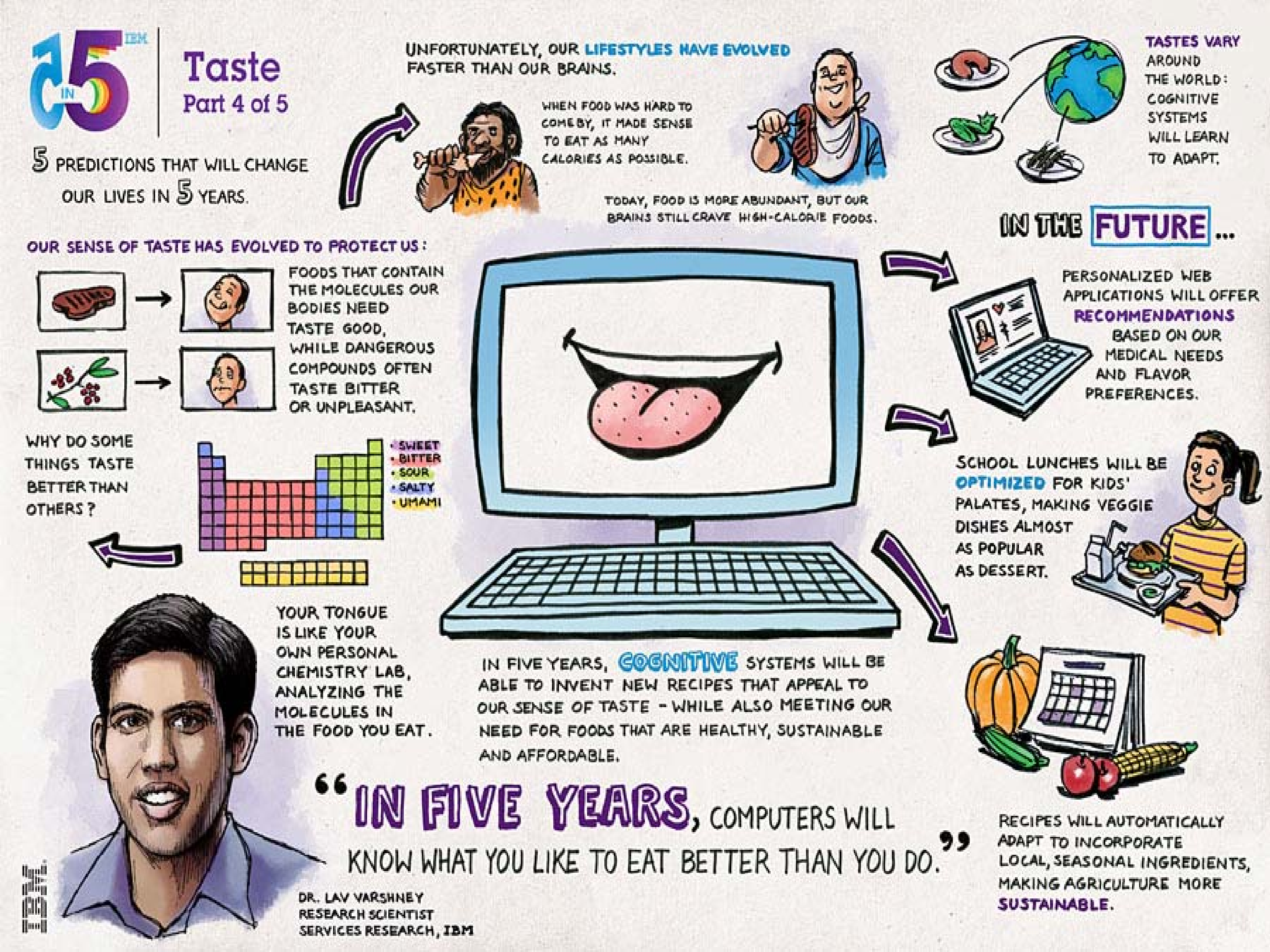
turmeric
curry
nutmeg
cardamom
mint

fennel
curry leaves
broth
roasted beef
pork shank

rice
clarified butter
rum
mango



This is how the system presents the recipe for Indian Turmeric Paella. You'll see that all the big steps are there, but cook times/temperatures are fairly open for human interpretation.



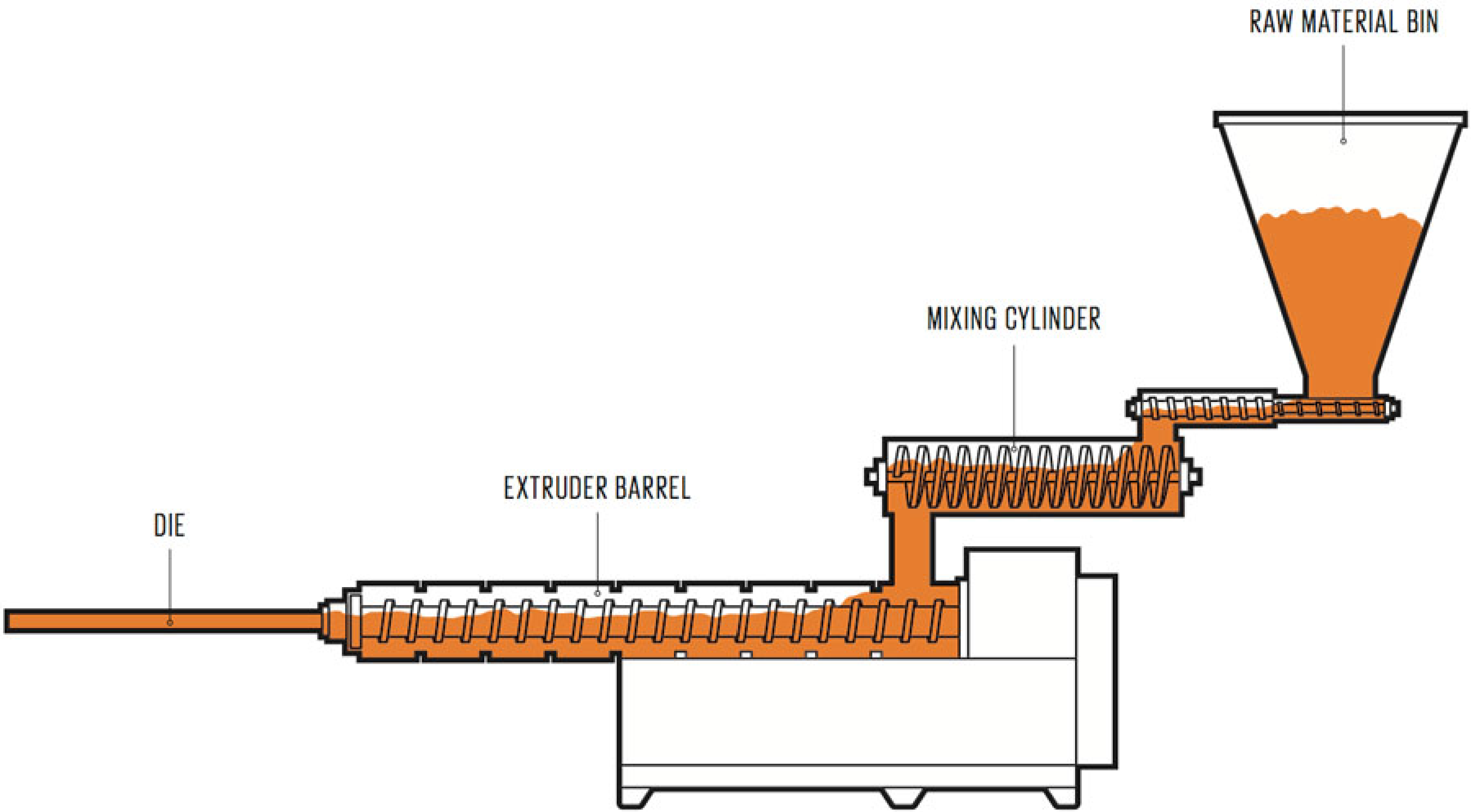
5 in 5 IBM
Taste
Part 4 of 5
5 PREDICTIONS THAT WILL CHANGE OUR LIVES IN 5 YEARS.
UNFORTUNATELY, OUR LIFESTYLES HAVE EVOLVED FASTER THAN OUR BRAINS.
WHEN FOOD WAS HARD TO COME BY, IT MADE SENSE TO EAT AS MANY CALORIES AS POSSIBLE.
TODAY, FOOD IS MORE ABUNDANT, BUT OUR BRAINS STILL CRAVE HIGH-CALORIE FOODS.
TASTES VARY AROUND THE WORLD: COGNITIVE SYSTEMS WILL LEARN TO ADAPT.
OUR SENSE OF TASTE HAS EVOLVED TO PROTECT US:
FOODS THAT CONTAIN THE MOLECULES OUR BODIES NEED TASTE GOOD, WHILE DANGEROUS COMPOUNDS OFTEN TASTE BITTER OR UNPLEASANT.
WHY DO SOME THINGS TASTE BETTER THAN OTHERS?
• SWEET
• BITTER
• SOUR
• SALTY
• UMAMI
IN THE FUTURE...
PERSONALIZED WEB APPLICATIONS WILL OFFER RECOMMENDATIONS BASED ON OUR MEDICAL NEEDS AND FLAVOR PREFERENCES.
SCHOOL LUNCHES WILL BE OPTIMIZED FOR KIDS' PALATES, MAKING VEGGIE DISHES ALMOST AS POPULAR AS DESSERT.
YOUR TONGUE IS LIKE YOUR OWN PERSONAL CHEMISTRY LAB, ANALYZING THE MOLECULES IN THE FOOD YOU EAT.
IN FIVE YEARS, COGNITIVE SYSTEMS WILL BE ABLE TO INVENT NEW RECIPES THAT APPEAL TO OUR SENSE OF TASTE - WHILE ALSO MEETING OUR NEED FOR FOODS THAT ARE HEALTHY, SUSTAINABLE AND AFFORDABLE.
RECIPES WILL AUTOMATICALLY ADAPT TO INCORPORATE LOCAL, SEASONAL INGREDIENTS, MAKING AGRICULTURE MORE SUSTAINABLE.
"IN FIVE YEARS, COMPUTERS WILL KNOW WHAT YOU LIKE TO EAT BETTER THAN YOU DO."
DR. LAV VARSHNEY
RESEARCH SCIENTIST
SERVICES RESEARCH, IBM
IBM


IBM
5 in 5
Smell
Part 5 of 5
5 PREDICTIONS THAT WILL CHANGE OUR LIVES IN 5 YEARS.
CONTEXT IS EVERYTHING:
OUR BRAINS COMBINE SENSE DATA FROM OUR NOSE WITH INPUT FROM OUR MEMORIES AND OUR OTHER FOUR SENSES TO HELP US MAKE DECISIONS.
HOW DO WE KNOW WHEN SOMETHING DOESN'T SMELL RIGHT?
THE HUMAN NOSE CAN DETECT UP TO A THOUSAND DIFFERENT CHEMICALS.
IN FIVE YEARS, COGNITIVE COMPUTING SYSTEMS WILL BE ABLE TO NOT ONLY RECOGNIZE ODORS, BUT PLACE THEM IN CONTEXT TO DRAW CONCLUSIONS AND TAKE ACTION.
FARMERS WILL PLANT SENSORS IN THEIR FIELDS TO SMELL WHEN THE CROPS ARE READY TO BE PICKED.
"IN FIVE YEARS, COMPUTERS WILL HAVE A SENSE OF SMELL."
DR. HENDRIK HAMANN
RESEARCH MANAGER
PHYSICAL ANALYTICS, IBM
TINY SMELL SENSORS CAN BE PLACED IN PHONES, BUILDINGS, CARS - ALMOST ANYWHERE.
IN THE FUTURE...
YOUR PHONE WILL BE ABLE TO SMELL WHEN YOU'RE GETTING SICK.
SENSORS WILL SNIFF OUT BACTERIA IN THE FOOD SUPPLY, PREVENTING OUTBREAKS.
HEALTHCARE FACILITIES WILL BE INSTRUMENTED WITH SENSORS TO DETECT INFECTIONS.
IBM

AI Taste+Smell to Create the next Star Chef!

The Better Meat Substitute

All-Plant Kebab: State-of-the-art extrusion technology gives Beyond Meat the look and feel of chicken.



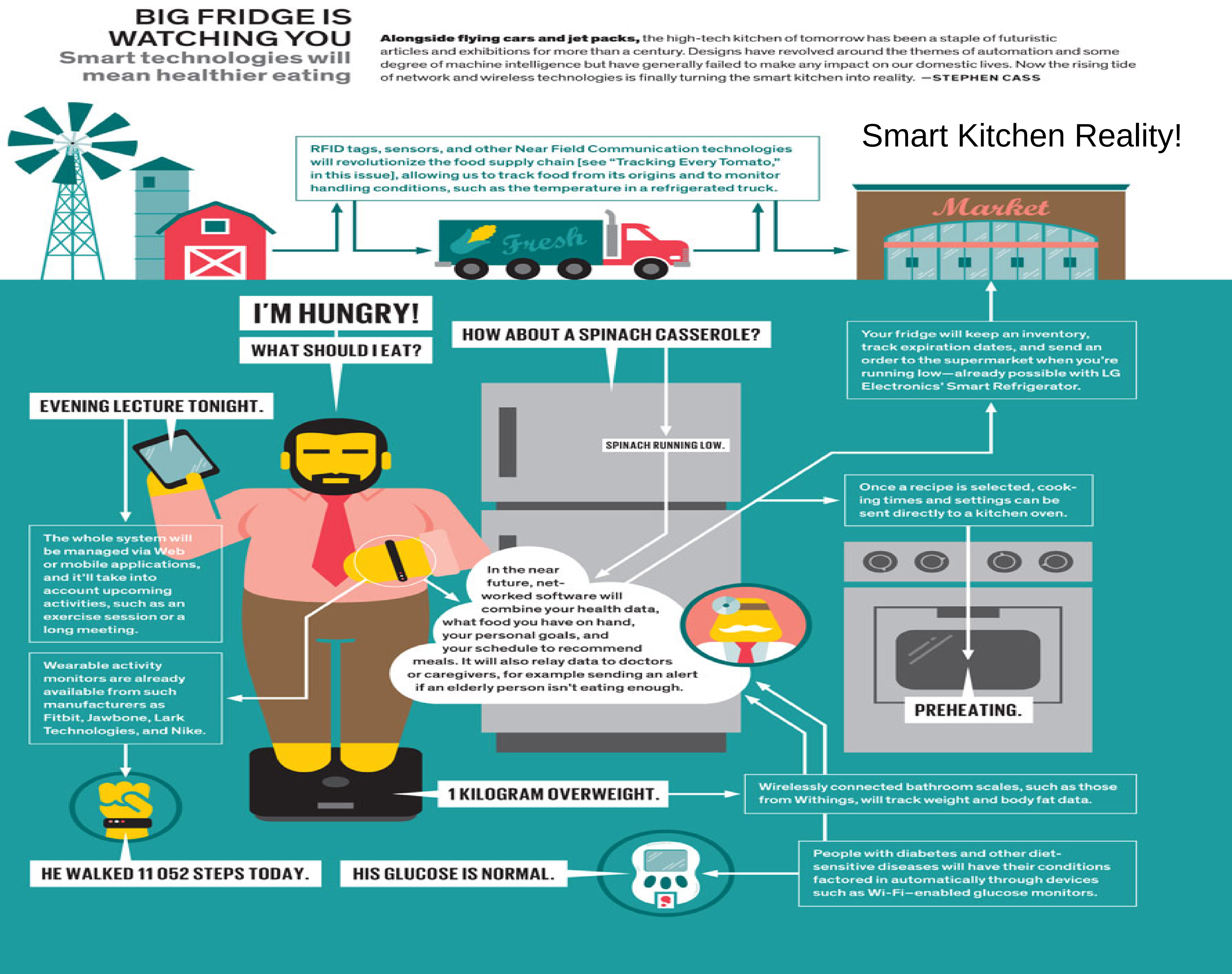
“Chicken” From an Extruder To make a high-moisture meat analogue, start by mixing plant protein powders with water and oil. Then knead the mix in an extruder barrel, and finally shear and cut in a die.

About a third of the food produced for human consumption never gets eaten. That's a lot wasted—some 1.3 billion metric tons worldwide each year

It seems like a no-brainer. This is a problem that needs to be fixed. But where to start? In developing countries, inefficient harvesting, unrefrigerated storage, and frequent holdups in transportation and distribution leave food rotting in fields and warehouses and on the backs of trucks. In developed countries, efficient harvesting, processing, and distribution systems that include refrigerated warehouses and trucks mean that most food waste can't be blamed on spoilage, although some farmers choose to leave crops in the field when they think market prices are too low. It's when food gets into the store, restaurant, or kitchen that the real problems happen—leading to some 222 million metric tons' worth of food being thrown out each year.

Solutions ? http://www.leanpath.com/

Smart Kitchen Reality!



Future Food: The Perfect Fake

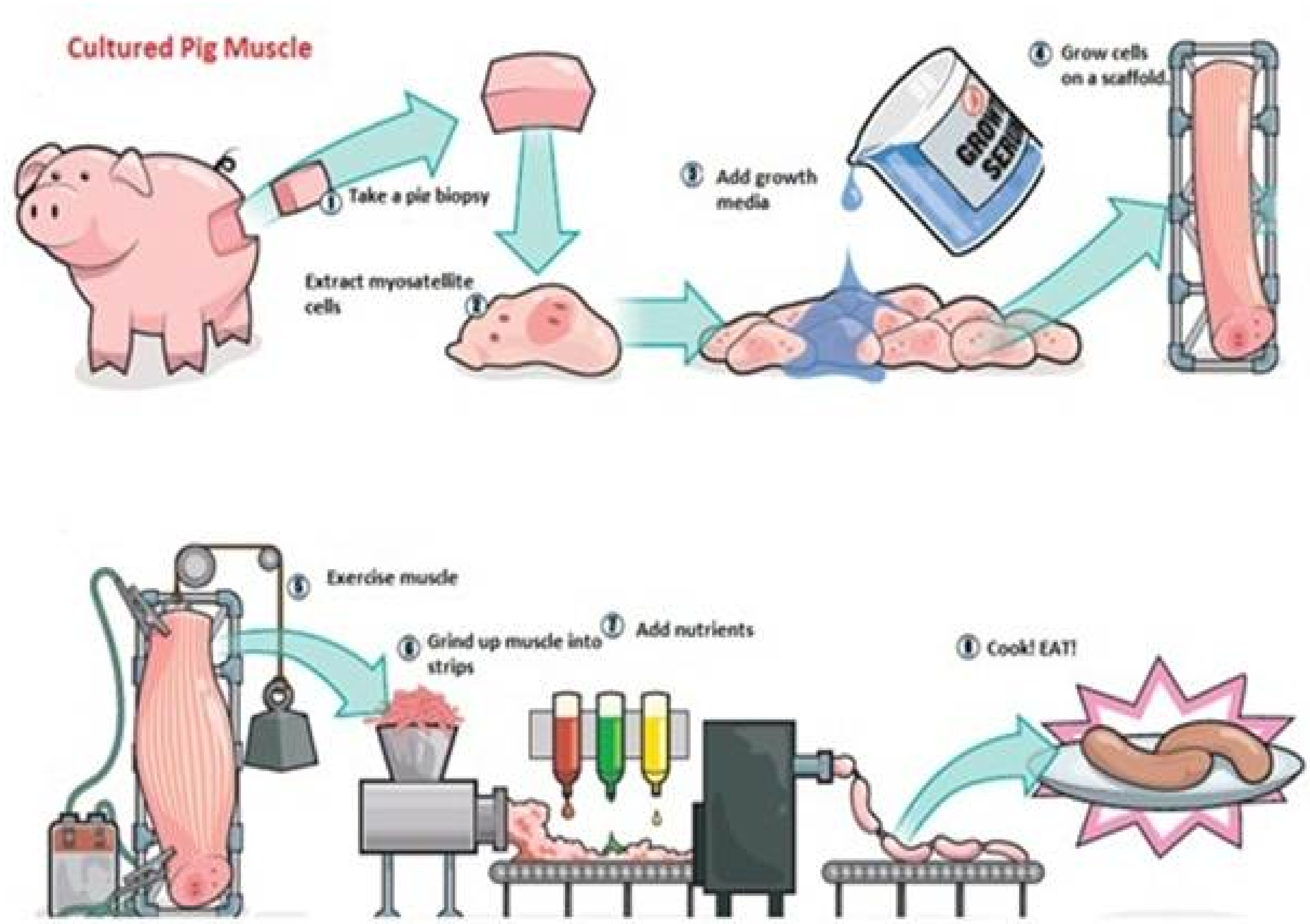
http://www.thegatesnotes.com/features/future-of-food

Future Food: In-Vitro Meat (Cultured Meat, Guilt-Free Meat)

First lab-grown burger

http://aht.seriouseats.com/archives/2013/08/worlds-first-lab-grown-burger-is-short-on-flavor-but-has-good-texture.html

In Vitro Meat

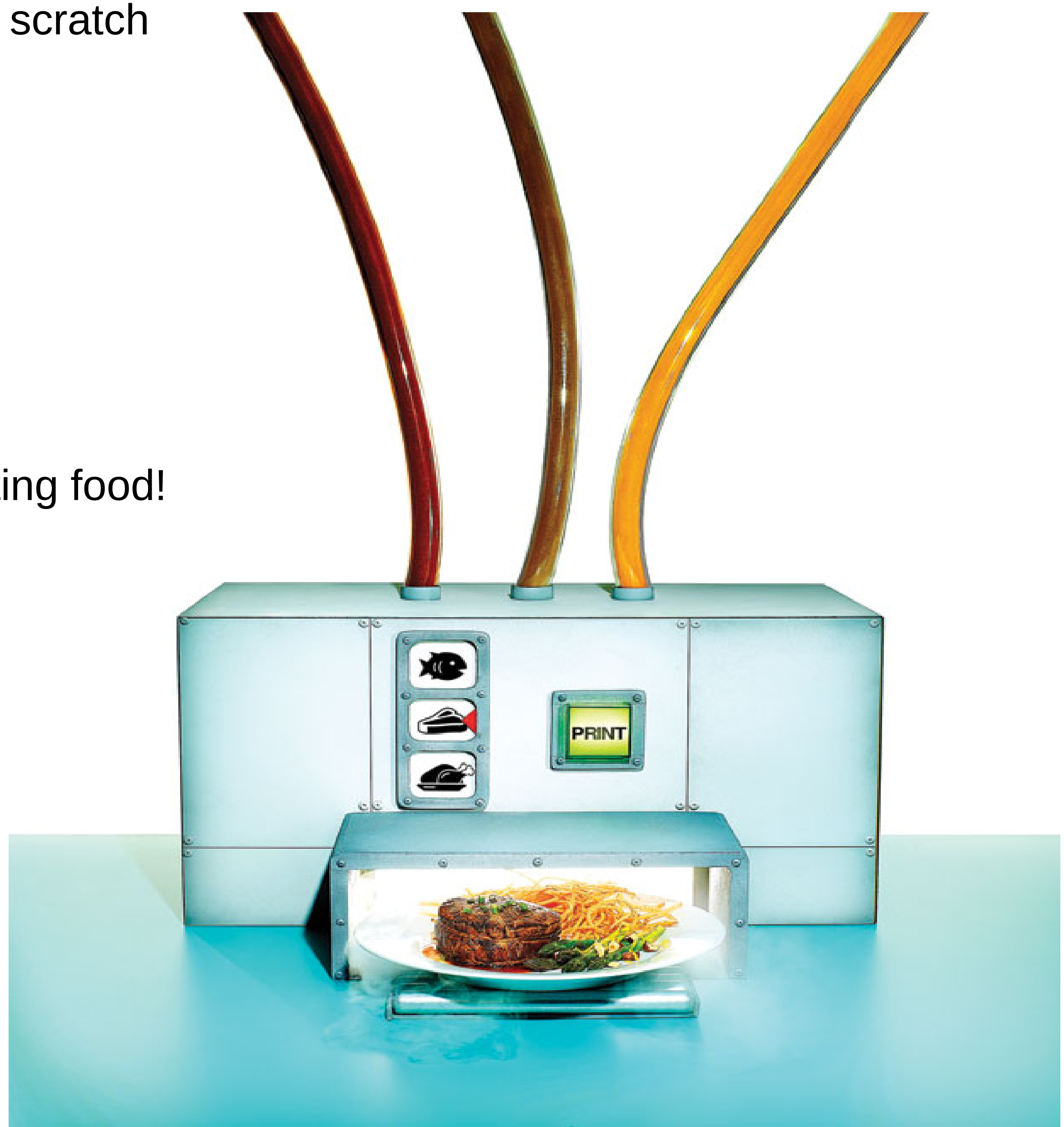


http://www.experimentation-online.co.uk/article.php?id=1170

Chef in a Box Chef in a Box:

In the kitchen of the future, a food compositor could fabricate haute cuisine from scratch

How about 3D printing food!



FOOD TECH & MEDIA INDUSTRY 2013

http://www.foodtechconnect.com/2013/07/17/food-tech-media-startup-funding-ma-and-partnerships-june-2013/

Smart Food Ecosystem

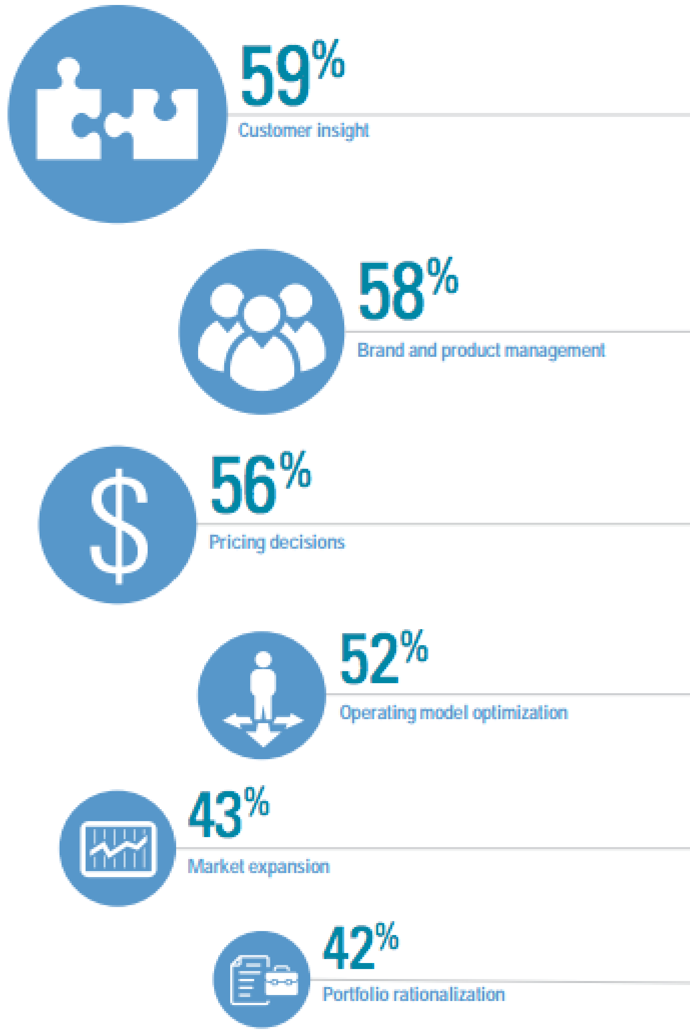
http://www.ibm.com/smarterplanet/us/en/food_technology/ideas/

KPMG 2013 Food and Beverage Outlook Survey: Big Data Analytics

Actionable insights

In the current customer-driven environment, data and analytics are proving to be increasingly valuable in getting to know customers better. In addition to obtaining customer insight, food and beverage companies are leveraging data and analytics to support brand and product management decisions, pricing decisions, and when looking to optimize operations. In fact, each of the responses to this question was selected with relatively high frequency, demonstrating the broad applicability of data and analytics.

Q: In what areas does your organization use data and analytics to help support strategic decision making?



Multiple responses allowed

Beverage Industry and Technology

- Coco-Cola Freestyle Fountain
- Packaging
- Marketing

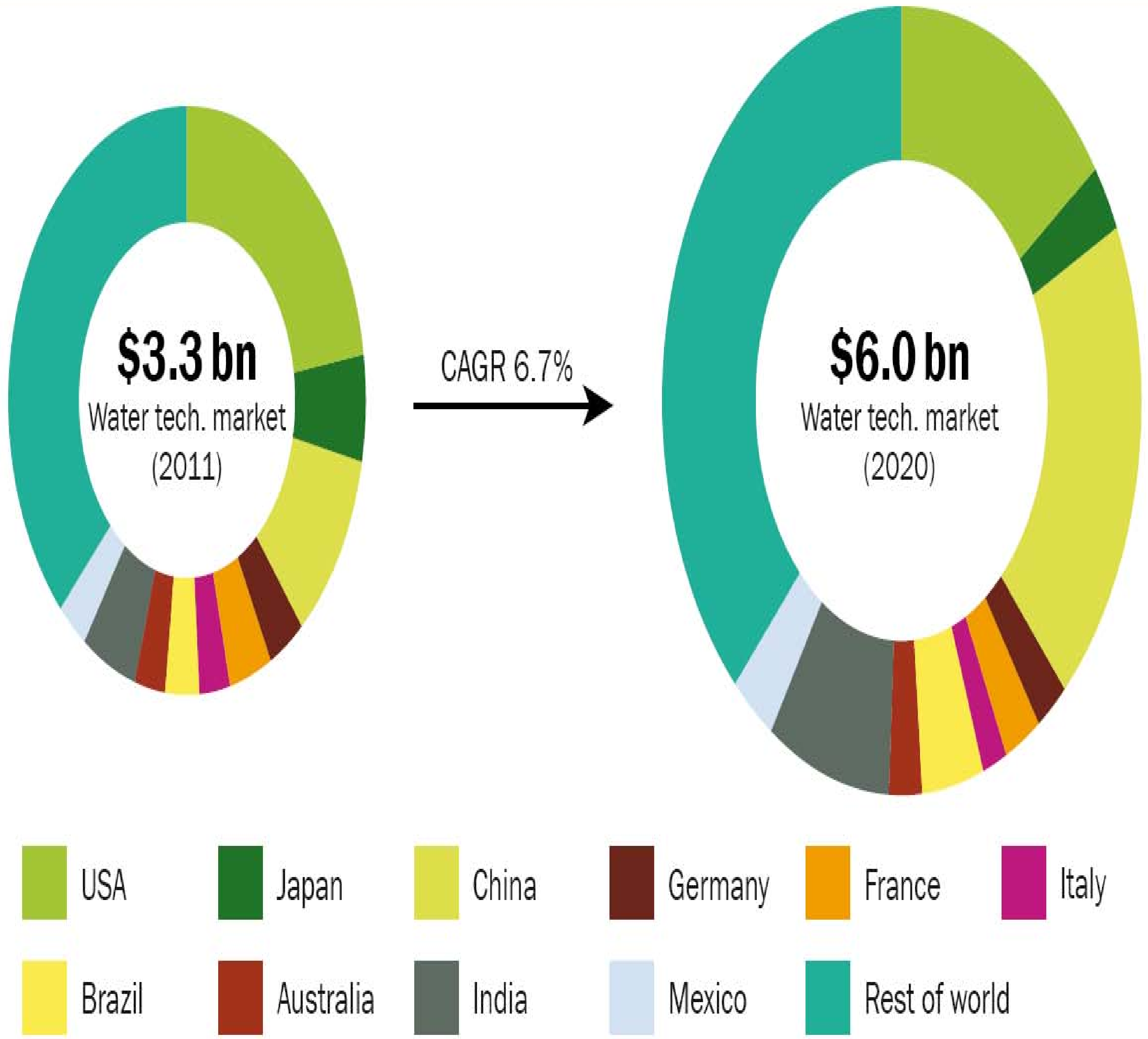
Coca-Cola Freestyle is a touch screen soda fountain introduced by The Coca-Cola Company in 2009. The machine features over 125 different Coca-Cola drink products, and custom flavors.The machine allows users to select from mixtures of flavors of Coca-Cola branded products which are then individually dispensed. The machines are currently located in major Coca-Cola partners and retail locations as a part of a gradual and ongoing deployment.

http://www.pininfarina.it/en/coca_cola_freestyle/

Coco-Cola Freestyle Fountain Machine

- Designed by the Italian automotive design firm Pininfarina
- Technologies involved include microdispensing technology and proprietary PurePour technology. Both technologies were originally developed to deliver precise doses of drugs.
- One Freestyle unit with a similar footprint to a current vending machine can dispense 126 kinds of carbonated and non-carbonated beverages from one freestanding unit. Microdosing blends one or more concentrated ingredients in 46 US fl oz (1.36 L) packets with water and sweetener at the point where the beverage is dispensed,thus avoiding the use of traditional 5 US gal (18.9 L) boxes of syrup (also known as a bag-in-a-box).
- Cartridges store concentrated ingredients in the dispenser cabinet and are RFID enabled. The machine uses RFID chips to detect its supplies and to radio resupplying needs to other units. The machines transmit supply and demand data to both Coca-Cola and the owner including brands sold, times of the day of sales, troubleshooting information, and service data.
- The traditional ice cube dispenser remains. The maximum rate of output is 95 drinks per hour

Global water technology market for food and beverage, 2011 and 2020



Gastronomy and Modernist Cuisine

Background introduction:

Harvard's Food and Science Lectures

http://www.youtube.com/watch?v=_Ft0cwxjBKE&feature=youtu.be

http://modernistcuisine.com/

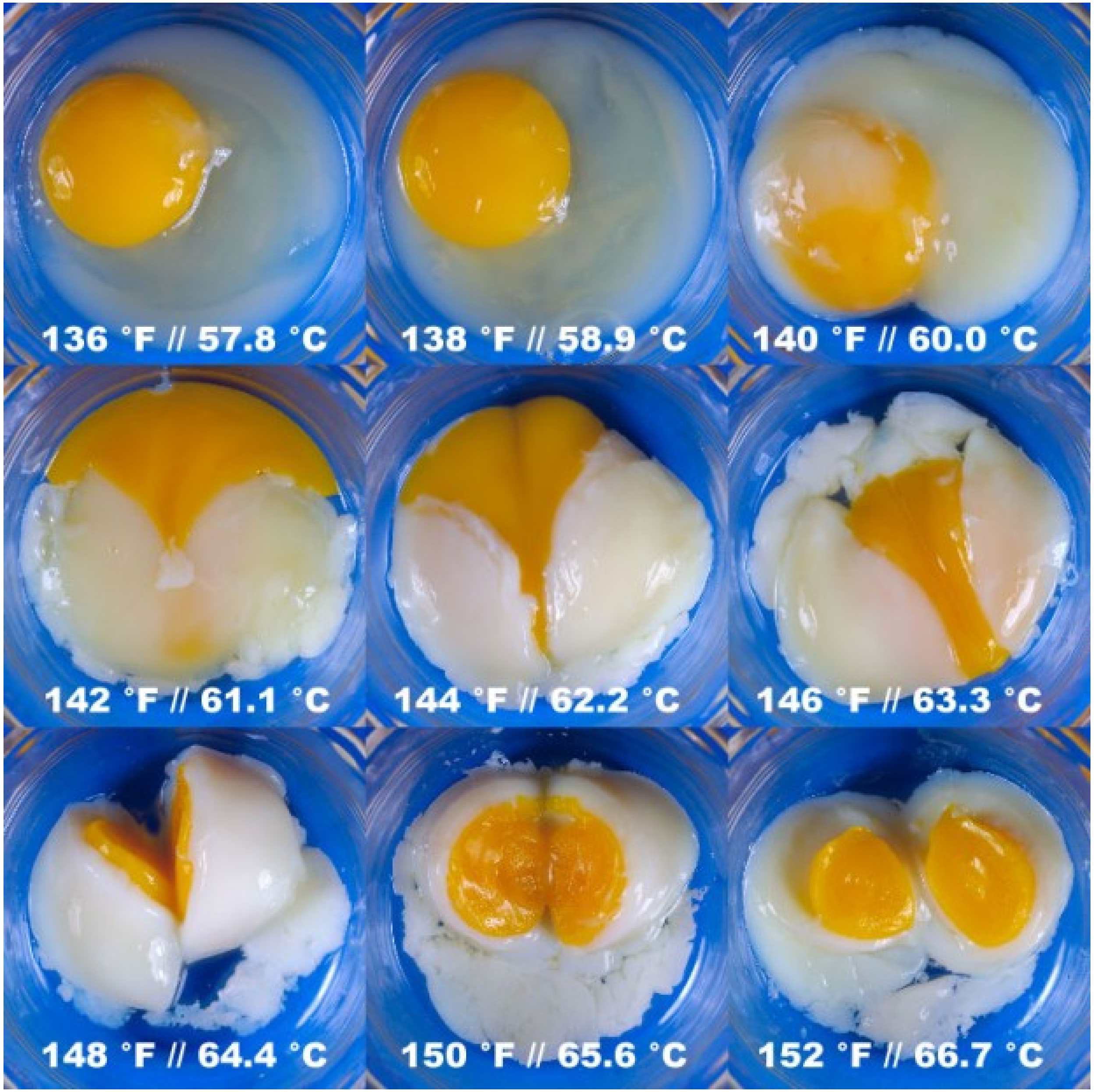
Egg-Drop Soup vs Poached Egg

Drop an egg into a pot of hot, still water, and you 're likely to end up with something closer to egg-drop soup than a poached egg

Stir the pot vigorously before the egg goes in , however, and a phenomenon known as Ekman pumping will gather the egg for you into a nice , compact mass at the center.

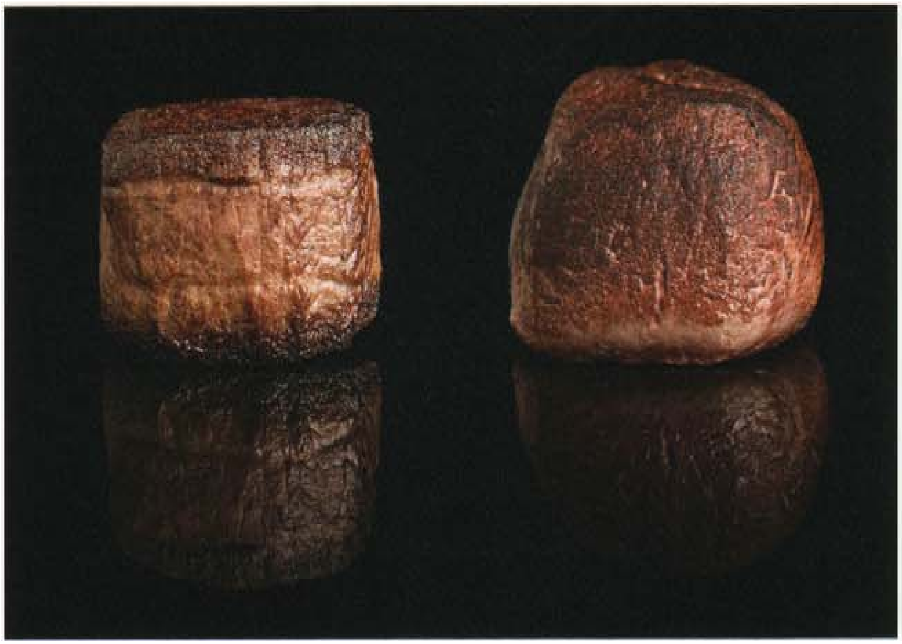
Courtesy of Modernist Cuisine by Nathan Myhrvold

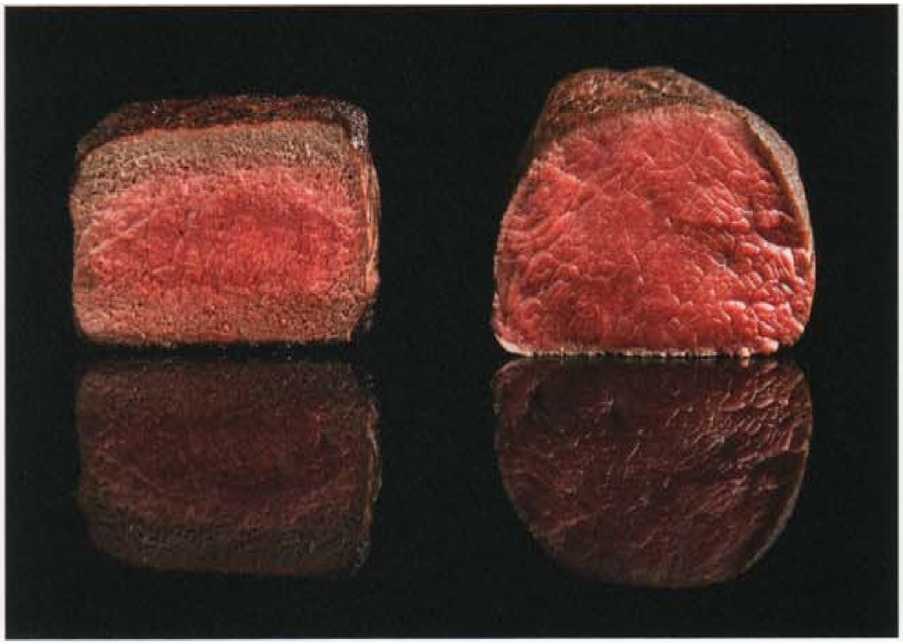
Which one you like!



http://4.bp.blogspot.com/-qqqG8kCeOgc/TqjgkgYJK3I/AAAAAAAAC18/rfooAGsZJpk/s1600/eggchartfull.jpg

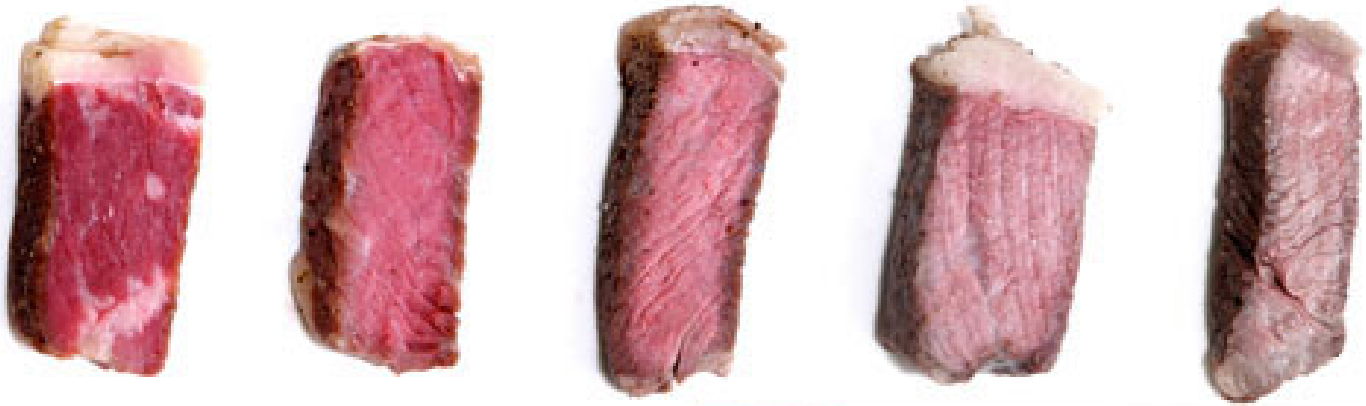
Which one is more likeable!

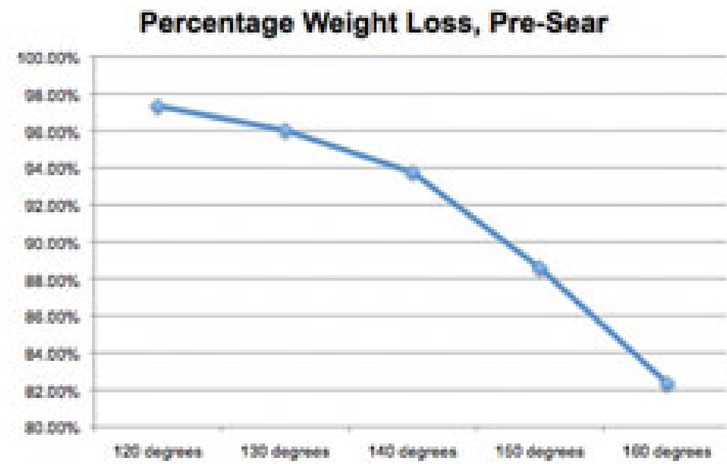


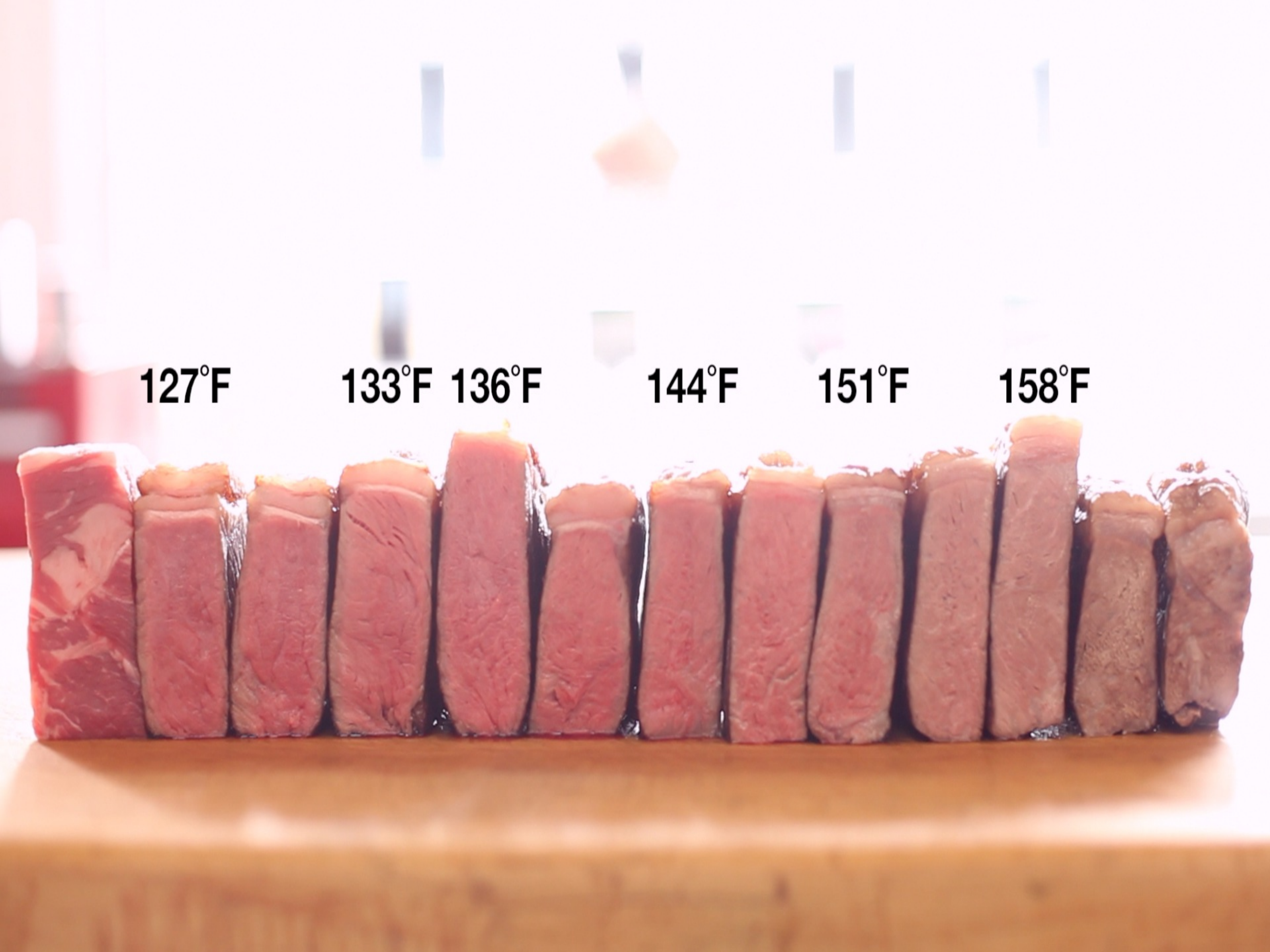


Courtesy of Modernist Cuisine by Nathan Myhrvold

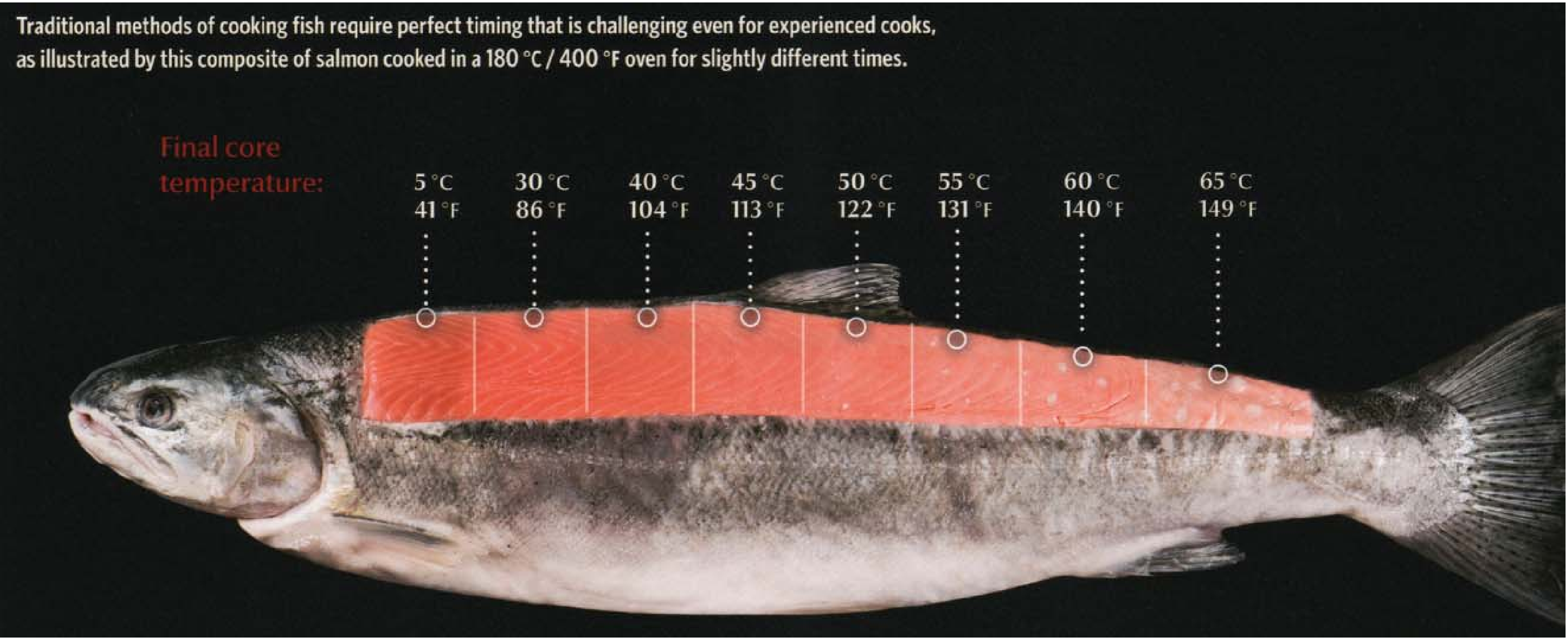
Courtesy of Modernist Cuisine by Nathan Myhrvold




Percentage Weight Loss, Pre-Sear
100.00%
98.00%
96.00%
94.00%
92.00%
90.00%
88.00%
86.00%
84.00%
82.00%
80.00%
120 degrees
130 degrees
140 degrees
150 degrees
160 degrees


127°F
133°F
136°F
144°F
151°F
158°F

How to cook this fish!



The table at right incorporates FDA-recommended cooking times (bounded in red) for meat roasts for temperatures from 54.4–68.9 °C / 130–156 °F, and it extends the times to both higher and lower temperatures by using the 6.5D thermal death curve for Salmonella. Times are given in hours (h), minutes (m), and seconds (s).

°C	°F	Time
52.0	125.6	5h 14m
52.2	126.0	4h 46m
52.8	127.0	3h 48m
53.0	127.4	3h 28m
53.3	128.0	3h 1m
53.9	129.0	2h 24m
54.0	129.2	2h 17m
54.4	130.0	1h 54m
55.0	131.0	1h 31m
55.6	132.0	1h 12m
56.0	132.8	1h
56.1	133.0	57m 31s
56.7	134.0	45m 44s
57.0	134.6	39m 51s
57.2	135.0	36m 22s
57.8	136.0	28m 55s
58.0	136.4	26m 23s
58.3	137.0	23m
58.9	138.0	18m 17s
59.0	138.2	17m 28s
59.4	139.0	14m 32s
60.0	140.0	11m 34s
60.6	141.0	9m 12s
61.0	141.8	7m 39s
61.1	142.0	7m 19s
61.7	143.0	5m 49s
62.0	143.6	5m 4s
62.2	144.0	4m 37s
62.8	145.0	3m 41s
63.0	145.4	3m 21s
63.3	146.0	2m 55s
63.9	147.0	2m 19s
64.0	147.2	2m 13s
64.4	148.0	1m 51s
65.0	149.0	1m 28s
65.6	150.0	1m 10s
66.0	150.8	58s
66.7	152.0	44s
67.0	152.6	39s
67.8	154.0	28s
68.0	154.4	26s
68.9	156.0	18s
70.0	158.0	11s
71.1	160.0	7.1s
72.2	162.0	4.5s
75.0	167.0	1.4s
76.7	170.0	0.7s
77.0	170.6	0.6s
79.4	175.0	0.23s
80.0	176.0	0.18s
82.2	180.0	0.07s
85.0	185.0	0.02s

Sous Vide Table

°C	°F	Time
55	131	7h
56	133	4h 37m
57	135	3h
58	136	2h
59	138	1h 20m
60	140	50m
61	142	33m
62	144	21m
63	145	15m
64	147	11m
65	149	10m

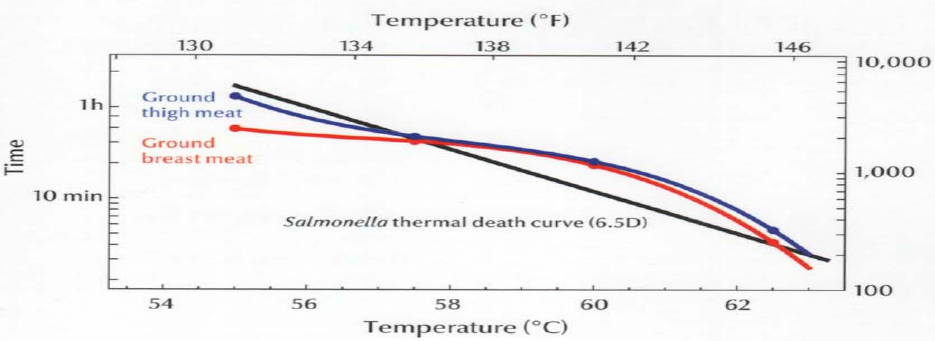
When using low cooking temperatures, remember that an accurate thermometer is critical because even small temperature changes can require sizeable differences in the corresponding cooking times.

When cooking sous vide at equilibrium, pasteurization will occur if the food takes at least as much time as shown in the table at left to reach the core temperature given. No additional holding time is required to achieve a 6.5D reduction.

If cooking for shorter than the time listed at left, or if using a hotter-than-core approach, hold the food at the target temperature for the time shown in the table at above right.

Poultry Breast and Thigh Curves

The most recently published time-and-temperature recommendations by Juneja for cooking ground chicken breasts and thighs are presented in the table at right and in the graph below. The red curve plots time-temperature combinations for breasts, the blue curve for thighs; both curves roughly follow the FDA's standard curve for a 6.5D reduction in *Salmonella* for whole-meat roasts (black line). At temperatures below 57.5 °C / 135.5 °F, however, the recommendations by Juneja are less conservative, particularly for chicken breast meat. His recommendations between 57.5 °C and 62.5 °C / 135.5 °F and 144.5 °F, on the other hand, are more conservative than the FDA's general standard and require significantly longer cooking times. Although the original Juneja paper includes only four data points, we compiled this graph and the Simplified Poultry table at left by using a mathematical algorithm known as a smooth spline interpolation of those points.



Simplified Poultry Breast and Thigh Table

Breast

°C	°F	Time
55.0	131.0	39m 31s
55.6	132.0	36m 35s
56.0	132.8	34m 55s
56.1	133.0	34m 35s
56.7	134.0	33m 4s
57.0	134.6	32m 16s
57.2	135.0	31m 43s
57.8	136.0	30m 14s
58.0	136.4	29m 32s
58.3	137.0	28m 22s
58.9	138.0	25m 58s
59.0	138.2	25m 25s
59.4	139.0	22m 59s
60.0	140.0	19m 30s
60.6	141.0	15m 42s
61.0	141.8	12m 39s
61.1	142.0	11m 54s
61.7	143.0	8m 24s
62.0	143.6	6m 34s
62.2	144.0	5m 29s
62.8	145.0	3m 17s
63.0	145.4	2m 36s

Thigh

°C	°F	Time
55.0	131.0	1h 15m
55.6	132.0	57m 39s
56.0	132.8	48m 57s
56.1	133.0	47m 14s
56.7	134.0	40m 30s
57.0	134.6	37m 34s
57.2	135.0	35m 56s
57.8	136.0	32m 32s
58.0	136.4	31m 22s
58.3	137.0	29m 42s
58.9	138.0	27m
59.0	138.2	26m 27s
59.4	139.0	24m 8s
60.0	140.0	20m 56s
60.6	141.0	17m 24s
61.0	141.8	14m 27s
61.1	142.0	13m 42s
61.7C	143.0	10m 5s
62.0	143.6	8m 5s
62.2	144.0	6m 51s
62.8	145.0	4m 15s
63.0	145.4	3m 24s

How to grind herbs into powder without mashing them into a paste!

Courtesy of Modernist Cuisine by Nathan Myhrvold

Molecular Gastronomy

The application of scientific methods and tools to cooking
Subdiscipline of food science that seeks to investigate, explain, and make practical use of the physical and chemical transformations of ingredients that occur while cooking

http://www.youtube.com/watch?v=OCBxGwzNhmg

Classical Molecular Gastronomy: Examples

- Sous-Vide Cooking
  - (vacuum sealed, low-controlled temperature in an immersion circulator)
    http://www.youtube.com/watch?v=WQD3os7OVIs
- Chemical/Enzymatic Cooking
  - Example: Ceviche
    http://www.youtube.com/watch?v=VJdYIVx_91s

Modern Molecular Gastronomy: Examples

- Gelification
- Spherification
- Emulsification
- Transformation

http://www.moleculargastronomynetwork.com/additives.html

Gelification

http://www.youtube.com/watch?v=Kpezxm-nlsE

- Gelatins: substances that when heated become a viscous liquid that recovers its original texture on cooling
- They are used to give texture to liquids by making it into a gel
- Traditionally: gelatin in the form of sheets from fish
- Animal-based gelatins do not make stable gelatins when heated
- Late 1990’s: Ferran Adrià made a hot cod and black truffle gelatin using Agar-Agar - a natural thickening agent obtained from seaweed and used in Japan since the 18th century

Spherification

http://www.youtube.com/watch?v=xBoII-HXHrk

- Process of shaping a liquid into spheres which visually and texturally resemble caviar
- Developed at elBuille under the direction of Ferran Adrià
- Two main methods:
  - For substances containing no calcium, the liquid is mixed with **sodium alginate, and dripped into a cold solution of calcium chloride**
  - 'Reverse' spherification, for use with substances which contain calcium, requires dripping the substance into an alginate bath (more versatile).
- Can be used to develop caviar equivalents of just about anything

Emulsification

- Emulsion: mixture of two or more liquids that are normally immiscible (un-blendable)
- In an emulsion, one liquid (the dispersed phase) is dispersed in the other (the continuous phase)
- Emulsifiers are a must for maintaining a uniform dispersion of one liquid in another, such as oil in water
- Popular emulsifiers: soy lecithin and xanthan gum
- Examples: vinaigrettes

http://www.youtube.com/watch?v=Bd-6SgNnqww&feature=c4-overview-vl&list=PL9Vifd4YLOLJoTTOkyyeGdg6xNNsff0Oh

http://www.youtube.com/watch?v=pdv6gPYOM8g

Transformation

- Technique of converting a high-fat liquid into a powder using Tapioca Maltodextrin
- The powder melts in your mouth as soon as it gets in contact with your tongue.
- Examples:
  - Milk Wonder
  - Olive Oil Powder
  - Nutella Powder

http://www.youtube.com/watch?v=l7fBp9DqqfA

Molecular Recipes

- Sous Vide Egg Yolk Croquette with Gruyere Foam http://www.molecularrecipes.com/eggs/sous-vide-egg-yolk-croquette-gruyere-foam/
- http://www.molecularrecipes.com/molecular-gastronomy-restaurants-molecular-mixology-bars/

-- More

- Sous Vide http://www.youtube.com/watch?v=HokQ26SCZ5U
- Combi Steamer/Oven → automatic food preparation http://www.youtube.com/watch?v=dHQ_OwfZJH0
- Foams http://www.youtube.com/watch?v=-nTMHsZhMLY&list=PL9Vifd4YLOLJNXUSn6EWMMCSHeYv8v5Il
- Liquid Nitrogen http://www.youtube.com/watch?v=yktlibR7ywE&list=PL9Vifd4YLOLJNXUSn6EWMMCSHeYv8v5Il
- 3D Printed Food http://www.youtube.com/watch?v=x6WzyUgbT5A

Combi Steamer/Oven

- Cooking appliance that combines the functionality of a convection oven and a steam cooker. That is, it can produce dry heat, moist heat or a combination of the two at various temperatures. The appliance is therefore fit for many culinary applications, including baking, roasting, grilling, steaming, braising, blanching and poaching. The advantages of this technology are short cooking times and a gentle preparation method, both of which lead to enhanced vitamin and nutritional preservation when compared to traditional cooking methods.
- The advantages of a combi steamer over other thermal equipment include:
  - prepared at the same time, each preserves its flavour, vitamins and nutritional value
  - simultaneous processing of different products (up to 10-12 dishes) without smell mixture
  - food preparation without oil, grease crust and carcinogen formation
  - space saving due to fcontrol of both temperature and humidity in the chamber, which reduces cooking time
  - uniform preparation
  - no need to reverse products
  - if different dishes are ewer kitchen appliances
  - reduction of final product shrinkage losses
  - electricity savings
  - reduction of labour costs
  - self-cleaning

COMBI OVEN RIB EYE

Yields 900 g

INGREDIENT	QUANTITY	SCALING	PROCEDURE
Beef rib eye, bone in	900 g	100%	① Brush rib eye with butter.
Unsalted butter, melted	as needed		② Place meat on perforated rack, and begin program.
Salt	to taste		③ After stage 5, brush with more butter.

(2010)

PROGRAM

STAGE	TEMP	HUMIDITY	COMMAND
1	**55** °C / **131** °F	100%	④ Preheat the oven to **54** °C / **131** °F in steam mode
2	**55** °C / **131** °F	100%	⑤ Steam until core temperature reaches **54** °C / **129** °F, about 1 h.
3	**55** °C / **131** °F	0%	⑥ Dry for 5 min.
4	**58** °C / **136** °F	0%	⑦ Dry for 5 min.
5	**61** °C / **142** °F	0%	⑧ Dry for 15 min.
6			⑨ Remove steak from oven.
7	**300** °C / **575** °F	0%	⑩ Preheat oven until it reaches temperature, about 10 min.
8	**300** °C / **575** °F	0%	⑪ Sear for 2 min. ⑫ Turn and sear another 2 min.

This cooking program uses 25 min of drying to prepare the surface for searing. During the drying steps, the temperature is increased, but the humidity is decreased so that the wet-bulb temperature does not exceed the cooking temperature. The temperature is increased in stages to give the oven time to get rid of the extra humidity. The temperatures at left are for what we judge to be a medium-rare steak. The temperatures can be adjusted for other levels of doneness by using the table below.

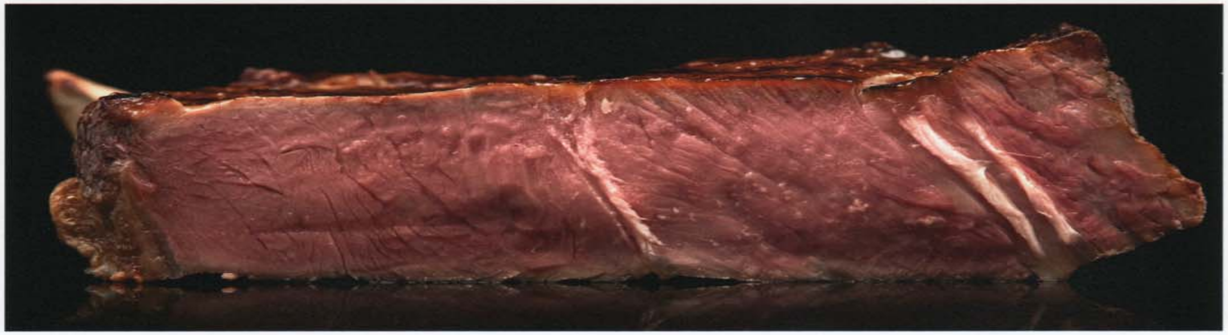
Courtesy of Modernist Cuisine by Nathan Myhrvold

STAGE	RARE	MEDIUM RARE	MEDIUM
1	**51** °C / **124** °F with 100% humidity to core of **50** °C / **122** °F	**55** °C / **131** °F with 100% humidity to core of **54** °C / **129** °F	**60** °C / **140** °F with 100% humidity to core of **58** °C / **136** °F
2	**51** °C / **124** °F with 0% humidity for 5 min	**55** °C / **131** °F with 0% humidity for 5 min	**60** °C / **140** °F with 0% humidity for 5 min
3	**53** °C / **127** °F with 0% humidity for 5 min	**58** °C / **136** °F with 0% humidity for 5 min	**63** °C / **145** °F with 0% humidity for 5 min
4	**56** °C / **133** °F with 0% humidity for 15 min	**61** °C / **142** °F with 0% humidity for 15 min	**66** °C / **151** °F with 0% humidity for 15 min

2

7

12



A CVap oven will not get hot enough for the browning stage, but you can do stage 1 in CVap with Doneness at the same temperature as the combi oven examples and with Browning at zero. Sear with a torch, *plancha* or other means (see page 267). The drying stage can be done by then increasing the Texture setting to 4.

COMBI OVEN–STEAMED BROCCOLI

Yields 1.5 kg

INGREDIENT	QUANTITY	SCALING	PROCEDURE
Rice vinegar	100 g	10%	① Whisk together to make pickling brine.
Sherry vinegar	100 g	10%	② Bring to simmer.
Water	64 g	6.4%	③ Reserve.
Sugar	28 g	2.8%	
Salt	3 g	0.3%	
Broccoli stems, peeled and thinly sliced	40 g	4%	④ Combine. ⑤ Pour warm brine over broccoli-stem mixture to pickle.
Shallots, thinly sliced	28 g	2.8%	⑥ Cool completely.
Currants	18 g	1.8%	⑦ Reserve.
Broccoli florets	1 kg	100%	⑧ Arrange florets in one layer in combi oven steam basket. ⑨ Steam at 90 °C / 195 °F and 100% humidity for 8 min, or until desired texture is achieved.
Broccoli, small florets	200 g	20%	⑩ Toss small florets in oil, and place on baking sheet.
Frying oil	50 g	5%	⑪ Oven fry in combi oven at 270 °C / 520 °F and 0% humidity for 4 min. ⑫ Drain.
Salt	to taste		⑬ Season steamed and fried broccoli.
Pickling brine, from above	to taste		⑭ Strain reserved pickled mixture, reserving brine. ⑮ Toss steamed and fried broccoli with pickles, brine, pumpkin seeds, and chili oil.
Toasted pumpkin seeds	50 g	5%	
Chili oil see page 330	30 g	3%	
Salted lardo, frozen and very thinly sliced	100 g	10%	⑯ Drape over warm broccoli mix, and serve.

(2010)

Courtesy of Modernist Cuisine by Nathan Myhrvold

CANTONESE FRIED RICE

Yields 1.2 kg

INGREDIENT	QUANTITY	SCALING	PROCEDURE
Chicken fat, rendered, see page 3·116	56 g	7%	① Preheat oven to **245** °C / **475** °F. ② Add fat to nonstick roasting pan, and let heat.
Shiitake mushroom, thinly sliced	80 g	10%	③ Add mushrooms, followed by sausage, and oven-fry until mushrooms soften and sausages blister, about 5 min.
Chinese sausage, thinly sliced	80 g	10%	
Jasmine rice, cooked and cooled	800 g	100%	④ Add, stir to evenly distribute other ingredients into rice. ⑤ Oven-fry for 3 min.
Garlic chives, cut into 5 cm / 2 in lengths	80 g	10%	⑥ Add, stir to distribute evenly, and oven-fry for about 30 s.
Scallions, white only, fine julienne	40 g	5%	
Red Thai chili, seeded and cut in fine julienne	2 g	0.25%	
English peas, shucked and blanched (frozen peas work)	80 g	10%	⑦ Fold into rice and oven-fry for about 2 min. ⑧ Remove rice mixture from oven, leaving heat on.
Duck egg, beaten	160 g (four eggs)	20%	⑨ Make a well in the middle of the fried rice. ⑩ Return rice mixture to **245** °C / **475** °F oven to heat. ⑪ Add egg, and allow to cook until just coagulated, about 1½ min. ⑫ Remove fried rice from oven.
White soy sauce	32 g	4%	⑬ Combine liquids and stir into fried rice evenly to season. ⑭ Check seasoning and serve.
Dark soy sauce	24 g	3%	
Mushroom soy sauce	12 g	1.5%	
Toasted sesame oil	1.5 g	0.4%	

(2008)

2

3a

3b

4

6a

6b

11a

11b

This recipe uses a combi oven as a substitute for a wok to fry the ingredients. A combi oven has a big advantage over a wok if you want to cook in quantity. In the example photos, we made one half-sheet pan of rice, but we could have made five pans' worth simultaneously.

13

A variety of vegetables will work, such as mushrooms or scallions (photo below). It's entirely up to the cook what to include.

Your favorite Dishes and Recipes: Make a video uploaded into Youtube would be even better!

How about to perform a cooking exercise with your favorite recipe as part of this course exercise!