Molecular Gastronomy

What is molecular gastronomy?

Modernist cooking, science and cooking…
using science and technology to make food…
the more unique versions of foods the more "molecular"

Pisco Marshmallow Cocktail

Liquid Pea Sphere

Oak Moss Vapor

"The scientific study of deliciousness"
- Harold McGee

History… aka who tells the tale!

While chefs/cooks were experimenting with scientific tools to make unique foods, a group of scientists and cooks, bakers created a food and science themed meeting…

Most commonly repeated

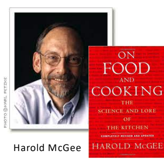
Molecular gastronomy was coined in 1992 by Hungarian physicist Nicolas Kurti and Herve This (who like to be considered the father of Molecular Gastronomy)

But who really said what?

But that name

Elizabeth Cawdry Thomas
- London Cordon Bleu alumna
- Instructor at cooking school in Berkley

Kurti was part of a core of scientists and culinary experts that found funding to bring the mix of science and cooking to Erice Italy.



Harold McGee

Shirley Corriher

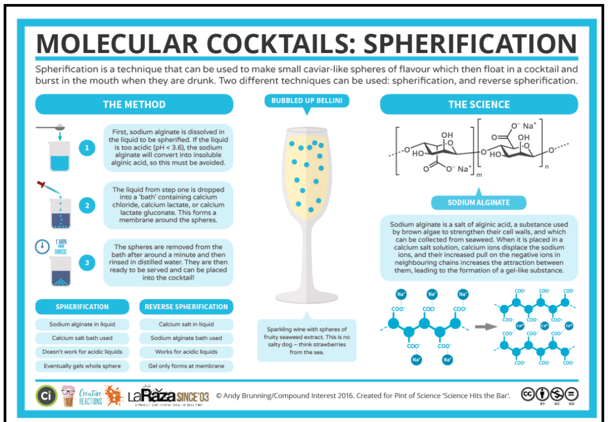
After Thomas attended a scientific conference with her physicist husband in Italy, dinner discussions led to the undervalued idea of science of cooking with other scientists. Encouraged, she organized a workshop which would be directed by Kurti. The initial conference name "science and gastronomy" was thought frivolous and a group of participants voted on the name "Molecular Gastronomy". Corriher tells that it was to get the attention for funding. McGee writes Kurti wasn't part of this first meeting.

Spherification

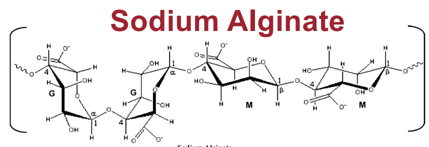
Shaping liquids into spheres using gels for a unique visual and culinary experience

Direct and Reverse Spherification

- Use low pH, calciur and sodium alginat to make thin gel membranes

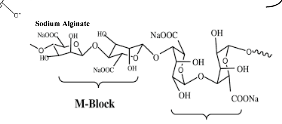


Sodium Alginate



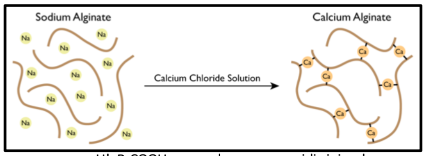
Isolated from kelp and brown seaweed.

- Glucuronate and Mannuronate polymer
- Carboxyl groups of alginate will cross link forming a long polymer gel



Alginate a whole family of linear copolymers containing blocks of (1,4)-linked β-D-mannuronate (M) and α-L-guluronate (G) residues. The blocks are composed of consecutive G residues (GGGGGG), consecutive M residues (MMMMMM), and alternating M and G residues (GMGMGM)

Used as a hydrogel to deliver
Drugs in slow release



pH! R-COOH remember we use acidic juices!

- Calcium ions are added and create links between the individual polymer chains of the alginate.
- These cross-links cause the polymer chains to entangle and are therefore restricted in their motion.
- Restricted motion increases the viscosity of the solution and traps water in its networked structure.

Before alginate can thicken or gel a liquid, it needs to be evenly dispersed into that liquid (with no lumps) and hydrated (so that each molecule is surrounded by water).

This sounds simple, but it sometimes can prove difficult.

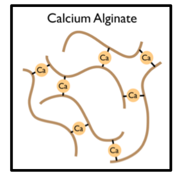
Dispersing alginate into hot liquid tends to cause it to hydrate and gel before the powder has been dispersed. The resulting lumps are unpleasant and cause inconsistent results. For this reason, it's always best to blend alginate into a very cold liquid or to first dry blend it with an ingredient like sugar.

Direct Spherification

Alginate Solution + Flavoring

↓

Calcium Ion Bath



- As alginate drops hit the calcium solution they immediately gel via cross-linking.
- Shell is formed at the interface of the 2 solutions.
- Calcium ions still exist in the network's water.

Problems With Direct Spherification

- Time sensitive
- Liquid interior continues to gel.
- Sensitive to acid.

Reverse Spherification

Calcium Ions + Liquid Flavorings

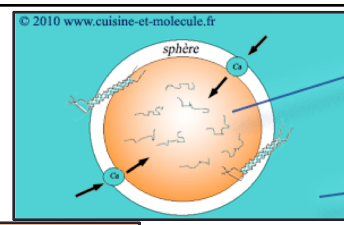
↓

Alginate Bath

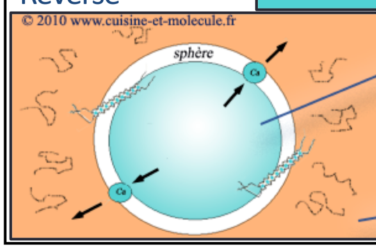
- As drops of liquid hit the alginate, shell is formed.
- Shell is formed on outside at interface.
- Calcium ions diffuse out of liquid and hit the interface.

Advantages of Reverse Spherification

- Spheres can be isolated and interior does not solidify.
- Not sensitive to pH
- Calcium limited!



Reverse



Direct

Foods as Air

Foams – basic emulsification as an "air" that dissolves in your mouth

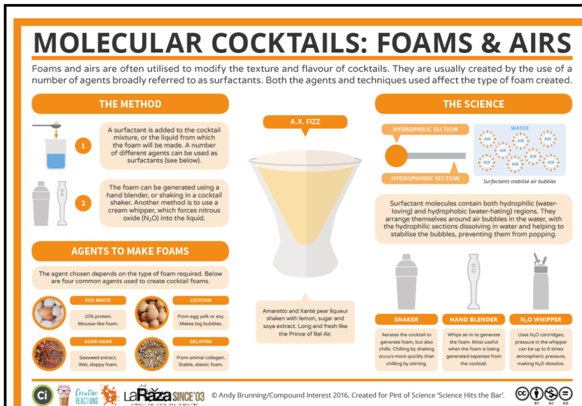
- Colloidal system (dispersion of particles in an aqueous medium) where particles are gas bubbles and the medium is a thin liquid (gas in liquid emulsions)
- These emulsions are stabilized into a cellular spongy or rigid for my emulsification

Culinary foams are often juices or vegetable purees, soups and stock bases

"thicker foams" include whipping creams, meringue, latte, and mousse

Ostwald ripening: smaller bubbles merge as gasses diffuse through liquid. Driven by higher pressure in small bubbles than larger bubbles
Coalescence: limited by strength of liquid

Emulsifiers include lecithin and proteins (gelatin)
- Ampapathic non-polar portion lines up against air with polar end H bonds to water
- Viscosity to slow liquid – air movement stabilizes.
- Solidifying foams with heat (meringue) traps the air
- Gels stabilize to near solid state (marshmallows)



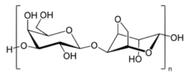
The Science of Cooking

Gelification

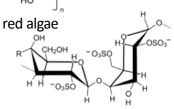
It is the process of turning a liquid into a viscous gel with solid, jelly-like material.

"liquify foods, solidify liquids" for a unique delivery of flavor"

Examples of gelification agents include:
Agar agar, carrageenan, gelatin…

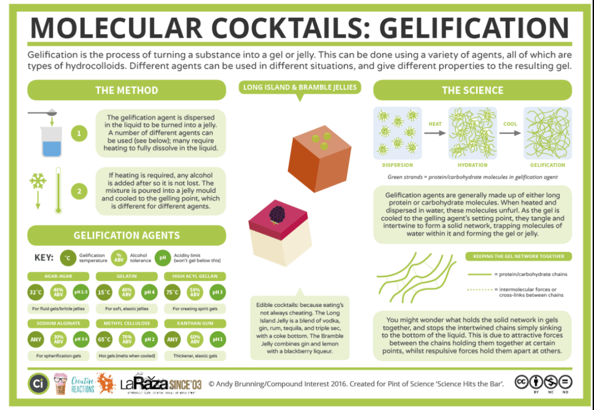


Agar agar – from red algae



λ-carrageenan

One form of carrageenan – from seaweed

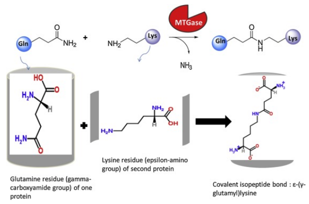


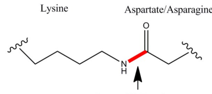
The Science of Cooking

Meat Glue

Transglutaminase – calcium dependent enzyme isolated fro clotting factors from blood, bacteria or plants.

- Generates a stable isopeptide bond of lysine and glutamine between two proteins (crosslinker)

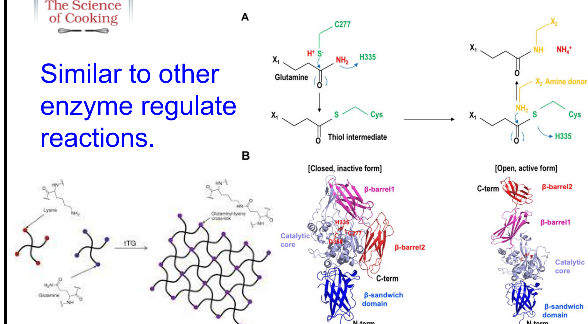




The Science of Cooking

Simple nucleophilic attack!

Similar to other enzyme regulate reactions.



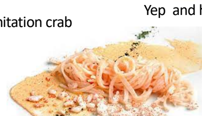
The Science of Cooking

Meat Glue Examples

Transglutaminase, also called **meat glue**, is an enzyme that can be used to bind proteins to make uniform portions of fish filet, tenderloins, etc. that cook evenly

Imitation crab

Yep and hot dogs



Shrimp noodles!

Mock filet mignon

The Science of Cooking

Deconstruction

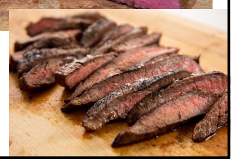
This technique involves breaking down the elements of a dish and rebuilding the presentation. Usually, a deconstructed dish consists of multiple components of a dish that are presented together.

For example, you can serve a small cake next to the frosting or topping with bits of dehydrated marshmallow on the side.

This technique provides a basis for developing a ***unique presentation and plating method*** *for a molecular gastronomy creation.*

Sous Vide

French for "*under vacuum*". But not really - Circulating water bath with precision control. Food is NOT immersed in the water (that is par boiling) but is in a bag with air removed.



It is a way to heat the entire food at the "core" temp to denature protein without losing the water holding capacity. Also pasteurizes food.

Not "new" nor "boiling"

Used in restaurants to prepare food with higher shelf life and fast production '90s

- Used in top restaurants since the 70's

Efficient heat transfer (water vs air as a medium) and increases shelf-life with elimination of contamination during storage

Prevents oxidation and evaporative losses and volatile flavorants lost during traditional cooking

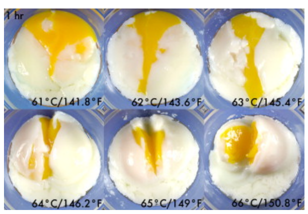
Pasteurization at lower temps for repeatability

Makes tough cuts traditionally braised or boiled tender with medium-rare doneness.

Temp and Time

Denaturing "melting" proteins is one of the three reasons food is cooked.

- Softens the meat to the tooth.
- Connective tissues and collagen as well as myosin are all denatured but partially in a med-rare steak



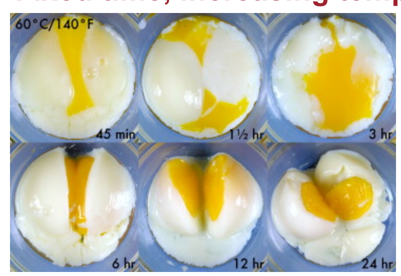
61.5 °C/143 °F: conalbumin denatures and causes the egg white to form a loose gel;

64.5 °C/148 °F: livetin denatures and causes the egg yolk to form a tender gel;

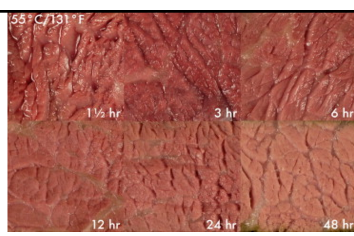
70 °C/158 °F: ovomucoid denatures and causes the egg white to form a firm gel (the egg yolk also coagulates around this temperature);

84.5 °C/184 °F: Ovalbumin denatures and causes the egg white to become rubbery

Fixed time, increasing temp



Egg cooked at 60 °C/140 °F for 45 min, 90 min, 3 h, 6 h, 12 h, and 24 h. The texture of the 3-h-egg's yolk was noticeably thicker than the 90-min-egg's yolk, which was thicker than the 45-min-egg's yolk.



Muscle (beef, pork, chicken) is ~75% water, 20% protein & 5% fat (varies on cut…)

Connective fiber tissues denature at different rates.

Collagen content and primary sequence of fish vs beef provides a different melting point

Results in less connective tissues and tender meat

- At lower temps, proteases also are active!

During heating, the muscle fibers shrink transversely and longitudinally, the sarcoplasmic proteins aggregate and gel, and connective tissues shrink and solubilize.

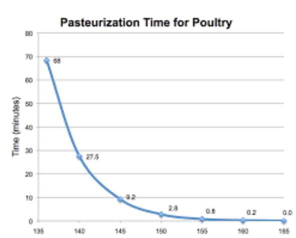
- muscle fibers begin to shrink at 35–40 °C/95–105 °F up to 80 °C/175 °F.
- The aggregation and gelation of sarcoplasmic proteins begins around 40 °C/105 °F ton 60 °C/140 °F.
- Connective tissues start shrinking around 60 °C/140 °F but contract more intensely over 65 °C/150 °F.
- The slow changes mainly increase tenderness by dissolving collagen into gelatin and reducing inter-fiber adhesion.

But is it safe?

Time and temp

- kind of

  CV =CV



Each dot is how long it takes at a given time and temp to reduce pathogen with aa 7-$\log_{10}$ lethality. Reduction that ensures 1 of 10 million bacteria will survive…

Sooo what else?

LN2 hamburgers?

Finish it!

Maillard and caramelization