Gastronomy

• 美食法 (Chinese Translation)
• **Gastronomy** is the study of the relationship between culture and food.
• **University of Gastronomic Sciences** in Italy, offering degree course and post-graduate program.
Molecular Gastronomy

• Not referring to cooking style
• It is a scientific discipline involving the study of Physical and Chemical processes that occur in cooking
• Founders of Molecular Gastronomy
  1. Nicholas Kurt, Professor of physics in Oxford, FRS
  2. Herve. This, Laboratoire de chimie des interactions molyculaires
General Education

• School of Science, HKUST adopted Molecular Gastronomy as one their General Education topics in 2007
• Published in HKUST Newsletter 2009
• Participated in the 334 symposium on general education hosted by CUHK

The Science of Eating & the Art of Teaching Science by May Cheung

Two experimental psychologists, Massimiliano Zampini, from Italy, and Charles Spence of Oxford University, walked away with the Ig Nobel Prize for achievements that "first make people laugh, and then make them think" this year, for showing how a food's taste can be affected by the sound it makes when eaten.

They found that potato chips that sound crunchier taste better.

This astonishing discovery is exactly what HKUST Associate Professor of Biology Dr King Lau Chiew and Adjunct Associate Professor of Chemistry Dr Young Lam Lung are demonstrating at a credit-bearing course "Gastronomy". The course is the School of Science's General Education Program for non-science students.
Molecular Gastronomy, a Scientific Look at Cooking

HERVÉ THIS*

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RECEIVED ON OCTOBER 6, 2008

CONSPECTUS

Food preparation is such a routine activity that we often do not question the process. For example, why do we cook as we do? Why do we eat certain foods and avoid other perfectly edible ingredients? To help answer these questions, it is extremely important to study the chemical changes that food undergoes during preparation; even simply cutting a vegetable can lead to enzymatic reactions.

For many years, these molecular transformations were neglected by the food science field. In 1988, the scientific discipline called "molecular gastronomy" was created, and the field is now developing in many countries. Its many applications fall into two categories. First, there are technology applications for restaurants, for homes, or even for the food industry. In particular, molecular gastronomy has led to "molecular cooking", a way of food preparation that uses " Gulf " tools, ingredients, and methods. According to a British a...
Objectives of Molecular Gastronomy

1. Collect and test “culinary precisions/ proverbs”
2. Understand Culinary Processes and Recipes
3. Invent new dishes by introducing new tools, ingredients and methods into the kitchen
4. Help the general public understand the contribution of science to society/ end the bad public image that sciences have too often, mostly during food crises, e.g. dioxins contaminated food, meamine…
The Kitchen Myths

• Add salt to water when cooking green vegetables
• In preparing steak, hot frying pan is used to seal the juice of the meat
• Meat is tenderized when it is marinated in pineapple juice
How to Cook Vegetables?

• Two major tasks:
  1. To keep the vegetables green
  2. To soften the texture of the vegetables

• Advice from the chefs: add salt (sodium chloride) when cooking vegetables. Reasons:
  1. it keeps the vegetables green
  2. it raises the boiling point of water so the vegetables can cook faster
  3. it improves the flavor
Salt Effect on Vegetable Cooking

Scientists point of view:

1. Salt does not affect the color of vegetables

2. Adding salt does increase the boiling point of water but such a small amount will make no difference to cooking times

3. Salt improves the flavor
What affects the colour of green vegetables during cooking?

- Colour of green vegetables is due to chlorophyll

![Chemical structure of chlorophyll](attachment:image.png)
Acidity on the color change

- Magnesium ion can be replaced by two hydrogen ions to give a compound called phenophytin which is olive green/brown color.
How to keep vegetables green?

• Cook vegetables in high pH
• For example, by using baking soda
Why the texture of vegetables change during cooking?

- Pectins are present in vegetables to form water retaining gels that help to give vegetables their structure.

- During cooking, pectins become soluble and are extracted into the cooking water making the vegetable go mushy.
How to make vegetable to be soggy?

- Calcium ions, $\text{Ca}^{2+}$, found in hard water, can form cross links between pectin molecules making them less soluble and keeping the vegetable tough.
- Cook vegetables in bottled water to reduce this effect and shorten cooking times.
- Since most vegetables require some softening during cooking, cooking in hard water means that longer is needed to achieve the optimum softening.
Meat Cooking

Ways to modify the texture of meat before cooking

Physical method
- Pounding
- Slicing and craving

Chemical method
- Baking soda
- Marinating
- Brining
- Meat tenderizer
Slicing and Craving

- Sliced with the grain (i.e., parallel to these fibres) will result in a long, tough, uninterrupted fibre that may be unchewable.

- Sliced thinly across the grain will result in tiny length of fibre and is easy to chew.

Meat Tenderizer

- protein-digesting enzymes (*proteases*) extracted from a number of plant, such as pineapple, kiwi and ginger.
Changes during meat cooking

1. Browning of the outside
2. Denaturing of meat protein, causing meat to harden (about 40°C)
3. Softening of the connective tissue, converting collagen to gelatine (about 60°C)
4. Releasing meat odour
The Maillard Reaction

- A complex series of reactions between proteins and carbohydrates.
- Over 1,200 compounds identified as reaction products
- Occurs most readily at temperature over 140°C and release meat flavour
Maillard Reaction

reducing sugar + amino compound → rearrangement

FLAVOUR COMPOUNDS
MELANOIDIN PIGMENTS

amino compounds → H$_2$S aldehydes

CH$_2$=CH−CONH$_2$ → ASPARAGINE

carbonyl compounds
How to cook a perfect steak?

1. Put the meat (used a rib eye steak for this experiment) in a thick plastic bag. Add any spices you like (salt and pepper always works well).

2. Heat a pot of water to 60 °C and place the plastic bag with meat in the water. Regarding the temperature, start with and leave the meat in the water for at least 30 minutes - more for a thicker cut. You can leave it for much longer (several hours) provided the temperature does not come above 60 °C.
How to cook a perfect steak?

3. Heat a frying pan, add a fat of you choice, remove meat from plastic bag and brown both sides of the meat. Since you take the meat directly from the water bath it’s already at about 60 °C. Therefore the browning is very fast.

4. A temperature of 60 °C (140 F) gives the meat a pink interior. It’s succulent and juicy. The short frying gives it a nice browned crust and the chewing resistance is perfect. All in all a wonderful combination of taste, aroma, texture and mouth feel!
Invention of New Dishes

• Red bean soup (紅豆沙)
Spherification

- Make a membrane that hold liquid inside
- Reaction between algin and calcium ions
- Becomes alginate (membrane)
How to Make Spherification?

Two types of Spherification:

1. Basic Spherification
   • submerged the liquid with Algin in the Calcic bath
   • for the watery density liquid and thick liquid

2. Reverse Spherification
   • submerged the liquid with Gluco* in the bath of Algin
   • for the liquid that have a high content of calcium or alcohol

*Gluco is the mixture of calcium gluconate and calcium lactate
Chemical Theory of Spherification -

- Algin
  - a high-molecular-weight polymer
- Two types of Algin
  - M-Blocks
  - G-blocks
Chemical Structures of G- and M-Block Algin

Block types in algae: GBlock (Top), MBlock (middle), MGBlock
Membrane Formation

• Sodium alginate is water soluble and can be mixed with many different fruit/vegetable juices and purés.
• When dripped into a solution containing calcium ions, each calcium ion (which holds a charge of +2) knocks away two sodium ions (each holding a charge of +1). The alginate molecule contains loads of hydroxyl groups (OH’s) that can be coordinated to
Membrane Formation

- Each calcium ion (black dots in the image below) coordinates to two alginate chains, linking them together.

- The flexible chains become less flexible and form a huge network - a gel
Video Demonstration of Spherification
Recipe of Spherification

• Fruit/vegetable juice/red bean soup with 1-2% sodium alginate

• 2% calcium chloride solution (approx. 10g in 1/2 L of water) - because calcium chloride has a slightly bitter taste, it is a good idea to rinse these pearls with water before consumption. This is also the reason why calcium lactate is often used instead.
Science of Ice Cream Making

Ice cream consists mainly of:

• Ice
• Fat (can use either milk or cream)
• Sugar
• Air
• Flavour (can be egg yolk or other ingredients)
Texture of Ice Cream

• Smooth, no lumps of ice

How to achieve?

• Milk contains lactose
• Mix egg yolks and milk and stir in sugar along with flavouring such as vanilla. This can help to prevent lactose molecules forming crystals
• Heat the mixture with stirring but no more than 65°C. This can prevent the egg protein from denaturing and coagulating into lumps
• Cool the mixture
Ice Cream Making Demonstration

Kitchen Chemistry with Heston Blumenthal
The ice cream world record

Royal Society of Chemistry