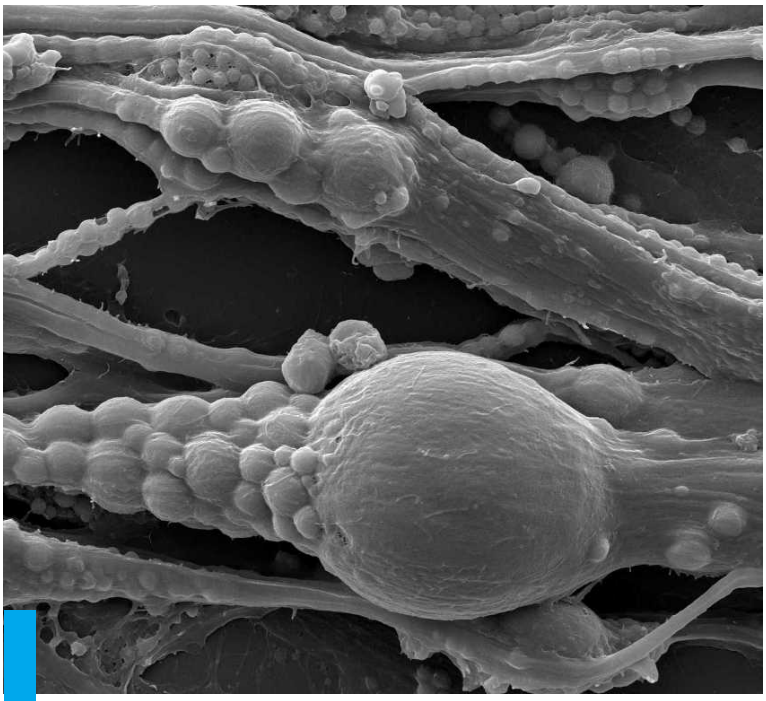
Nestlé Research Center's

science **in action**

Nestlé
Good Food, Good Life



During the last 25 years, obesity rates have risen 3-fold or more in some countries. Today, more than 1.1 billion adults are overweight, of which, about 320 million are obese; and by the year 2015, worldwide obesity prevalence is estimated to reach 700 million people.

Weight Management

Focus On: Weight Control

In response to today's obesity crisis, the Nestlé Research Center (NRC) has adopted a multidisciplinary research approach, integrating the expertise of nutritionists, food scientists, human physiologists, cellular and molecular biologists. Six primary research axes compose NRC's weight management research strategy:

- **Food technology & sensory perception** - lowering energy density while maintaining pleasurable taste
- **Food preference** - promoting healthy food acceptance
- **Food intake control** - increasing satiating properties of food
- **Energy metabolism** - identifying ingredients that promote diet-induced thermogenesis and fat oxidation
- **Nutritional & metabolic programming** - ensuring optimal maternal and infant nutrition
- **Diet-gene interactions –** understanding the interface of genetics and diet

NRC Research Initiatives

Food technology & sensory perception
Lowering the fat content, added sugars and most importantly, energy density of food products is a key part of Nestlé's strategy to provide practical solutions for weight management. This approach requires the development of innovative food processes to maintain pleasurable taste.

Low temperature extrusion
A specific proprietary technology, Low Temperature Freezing (LTF), was invented by NRC scientists, allowing the production of reduced-fat ice cream that has the same taste and texture of full-fat ice cream. The LTF process creates ice cream with a finer microstructure - smaller air bubbles, smaller ice crystals and smaller and better distributed fat globules. This finer microstructure provides a rich and creamy texture with half the fat and a third less calories than regular ice cream.

Figure 1: Standard Freezing, -5°C

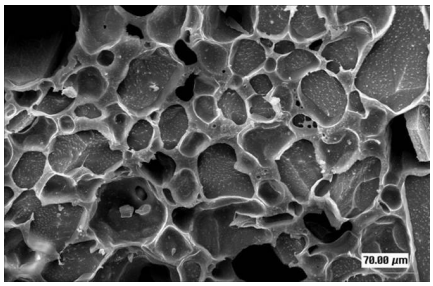
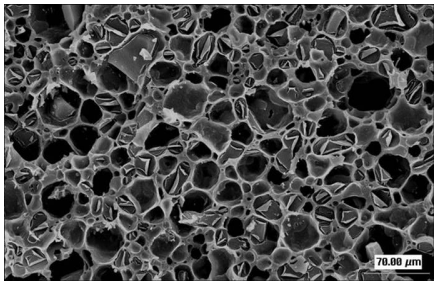


Figure 2: Low Temperature Freezing, -13°C; Finer microstructure



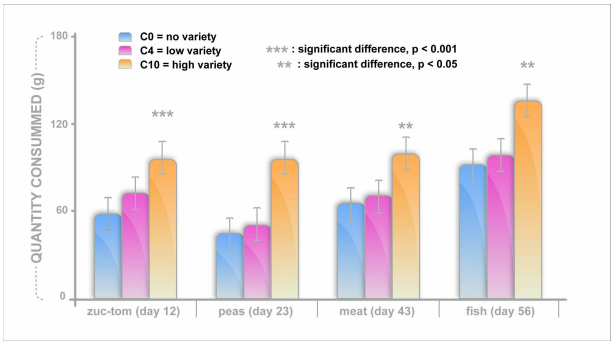
Multimodal perception of fat
Consumer demand for low-fat and low-calorie foods has presented the challenge for food companies to provide low-fat products that taste and feel like their full-fat counterparts.

Although the presence of fat in a product can be detected by the five senses (vision, hearing, smell, taste and touch), the prevailing belief holds that fat is mostly perceived by its textural cue. Research at NRC showed that the textural properties of products could be readily modified by the type of emulsifier used, therefore lowering the fat content while providing the in-mouth sensation of a full-fat product.

Food preference: Early sensory experience
There is considerable evidence that sensory experiences early in life can influence flavour preferences and food acceptance later in life. In collaboration with external partners, NRC scientists conducted a study examining the effects of different levels of vegetable variety early in weaning (no, low or high) on acceptance (intake and liking) of new foods.

The study showed that exposure to greater food variety at weaning facilitated greater acceptance of new foods. The effect of exposure to food variety depended more on the number of daily changes offered than the number of foods. The effects of repeated exposure appear to be long lasting because nine months post-study, 63% of the infants were still eating and liking the initially-disliked vegetables. This study shows that persistent, repeated exposures to new foods are essential elements in facilitating acceptance.

Figure 3: Vegetable exposure and acceptance



Food intake control
Eating behaviour (food intake) is a reflection of biological, environmental and psychological factors. NRC research works toward gaining a holistic understanding of eating behaviour.

At the cell level, scientists are investigating how different nutrients, or nutrient combinations, impact the expression of genes and the regulation of signaling pathways involved in appetite and satiety control.

At the systems level, researchers conduct clinical trials to better understand how nutrients and diet influence the physiological control of appetite, satiety, and food intake. Biological studies measure the circulating hormones and peptides implicated in the control of food intake. Conversely, psychological studies aim to understand the effect of learning and expectations on appetite, satiety and food intake.

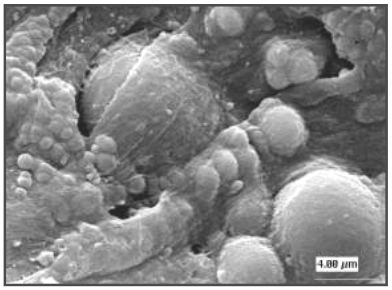
Energy metabolism
In the area of energy metabolism, Nestlé Research studies how nutrition can promote energy expenditure and fat oxidation and also limit energy storage and fat mass development.

Diet-induced thermogenesis (DIT)
Daily energy expenditure consists of three components: basal metabolic rate, the energy cost of physical activity and the thermogenesis induced by diet. Thermogenesis is the energy expenditure of the body in the metabolic processing (digestion, absorption and disposal) of food. Although this is the smallest component of daily energy expenditure, it may play an important role in adjusting energy balance and controlling body weight.

NRC scientists actively study the stimulatory effects of caffeine on thermogenesis and fat oxidation in humans. In collaboration with external partners, Nestlé has recently provided evidence that consumption of a beverage containing green tea catechins and caffeine increases energy expenditure by 106 +/- 31 kcal/24 hours.

Fat mass development
The dysregulation of the distribution of ingested nutrients towards storage in adipocytes rather than oxidation by the muscles may contribute to excess fat mass development.

Figure 4: Differentiated human preadipocytes



Currently, NRC scientists are investigating the role of gut microbiota on energy metabolism and identifying potentially beneficial probiotics for body weight management.

Nutritional & metabolic programming
Environmental factors, including nutrition during early life, may affect a person's susceptibility to chronic diseases during adulthood. This is known as metabolic programming.

The late stage of fetal life and the first year of postnatal life are the most active periods for human fat mass development, which could be critical windows for increased susceptibility to obesity later in life. NRC research works to better understand the impact of various macronutrients on early adipose tissue development and the effects of early nutrition on the propensity to develop obesity later in life.

Additionally, NRC is an active member of the Metabolic Imprinting Task Force at the International Life Science Institute (ILSI Europe), which aims to provide insight into the effects of diet on the different phases of metabolic imprinting/programming, with respect to metabolic and immunological disorders.

Diet-gene interactions

Diet interacts with genes and genes predispose us to certain diets. *Nutrigenomics* is the study of how dietary components influence gene expression, and *Nutrigenetics* is the study of how an individual's genetics influence their response to dietary intervention.

The Nestlé Research Center investigates these diet-gene interactions, particularly within the frame of a large European project called "DiOGenes – Diet, Obesity and Genes". This 5-year study involves 34 partners from industry and academia. At the center of the investigation is a dietary intervention for weight loss and maintenance. The project involves nutrigenetics and nutrigenomics, population-based studies, food technology aspects and consumer behaviour research.

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In bold, NRC scientists