



FOOD CHEMISTRY

Course ENG-433 2023

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Chimiste cantonal*

1.1 COURSE SYLLABUS

Objectives of the course

After the course, students should be able to :

- ➡ describe the composition and constituents of food ;
- ➡ understand food as chemical systems ;
- ➡ understand the underlying physicochemical mechanisms responsible for food properties ;
- ➡ identify the interactions and identities of biological and non-biological components of food ;
- ➡ understand the properties of food and their changes occurring during processing and storage ;
- ➡ use the concepts of food chemistry and provide real examples as illustrations of them.

1.1 COURSE SYLLABUS

Time and organisation



courses will be given by prerecorded video lectures, powerpoint presentations and online teaching (Monday from 08:15 to 10:00).



Course will be given in french, slides and supplementary material are in english.



On each slide, chapter appears at the bottom right, subchapter and title at the top.

1.1 COURSE SYLLABUS

Copy of slides



Pdf copies of the course slides are available on Moodle



THEY ARE INTENDED FOR PERSONNAL USE ONLY !

1.1 COURSE SYLLABUS

Exams

The examination consists of a set of twenty open questions, available in French and English

Room number and date will be communicated later

After some sessions, example of last year questions will be discussed

1.1 COURSE SYLLABUS

Exams

- On entering the exam room, you will have to identify yourself (student or ID-card).
- Exams will be written and last 3 hours,
- The questions form will be in french and english (at your choice), and you will be allowed to answer in both languages.
- You will be allowed to bring with you your notes and a copy of the slides of the course. No other material will be admitted.
- No personnal computer, notepad and the like will be allowed.
- During the exam, cellular phones will be disconnected.

1.1 COURSE SYLLABUS

Table of contents (I)

1. INTRODUCTION

- 1.1 Course syllabus
- 1.2 Bibliography
- 1.3 Definitions
- 1.4 Food intake
- 1.5 Food functions
- 1.6 Food value
- 1.7 Food chain

2. WATER

- 2.1 Importance of water in food
- 2.2 Molecular structure
- 2.3 Ice and liquid structures
- 2.4 Reactivity
- 2.5 Water-solute interactions
- 2.6 Water adsorption
- 2.7 Water and food degradation
- 2.8 Water analysis
- 2.9 Drinking water

3. LIPIDS

- 3.1 Definitions and classification
- 3.2 Sources
- 3.3 Fatty acids
- 3.4 Acylglycerols
- 3.5 Functionalized lipids
- 3.6 Sterols and tocots
- 3.7 Waxes
- 3.8 Nutritional aspects
- 3.9 Fats and oils production
- 3.10 Degradation

1.1 COURSE SYLLABUS

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4. CARBOHYDRATES

- 4.1 Definitions and classification
- 4.2 Structural representations
- 4.3 Aldoses and ketoses
- 4.4 Pyranoses and furanoses
- 4.5 Disaccharides
- 4.6 Oligo- and polysaccharides
- 4.7 Thermal reactions
- 4.8 Maillard reaction
- 4.9 Nutritional aspects
- 4.10 Saccharose production

5. AMINO ACIDS AND PROTEINS

- 5.1 Structure of amino acids
- 5.2 Physical properties of amino acids
- 5.3 Reactions of amino acids
- 5.4 Peptides

5.5 Structure of proteins

- 5.6 Meat proteins
- 5.7 Milk proteins
- 5.8 Cereals proteins
- 5.9 Soybean proteins
- 5.10 Nutritional aspects
- 5.11 World consumption of proteins

6. ESSENTIAL NUTRIENTS

- 6.1 Essential nutritional requirements
- 6.2 Intake of nutrients
- 6.3 Essential fatty and amino acids
- 6.4 Water-soluble vitamins
- 6.5 Fat-soluble vitamins
- 6.6 Minerals

1.1 COURSE SYLLABUS

Table of contents (III)

7. ADDITIVES

- 7.1 Definitions and classification
- 7.2 Food flavors
- 7.3 Food colors
- 7.4 Food sweeteners
- 7.5 Antioxidants
- 7.6 Preservatives

9. FOOD FRAUDS

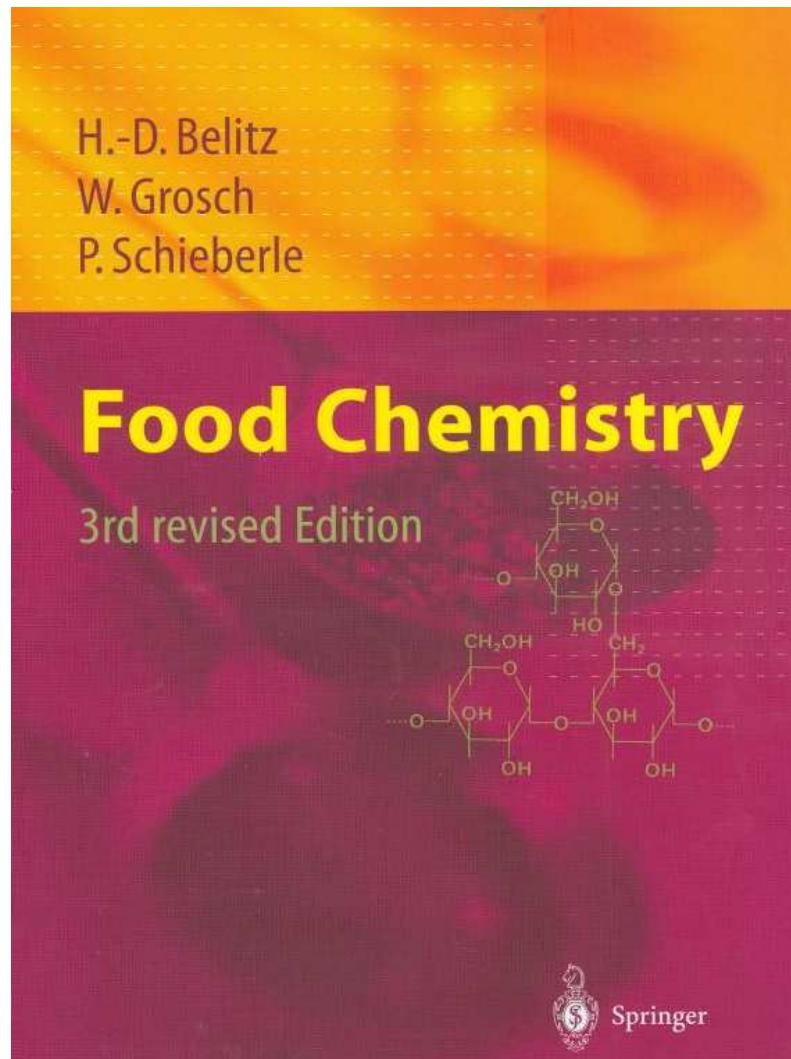
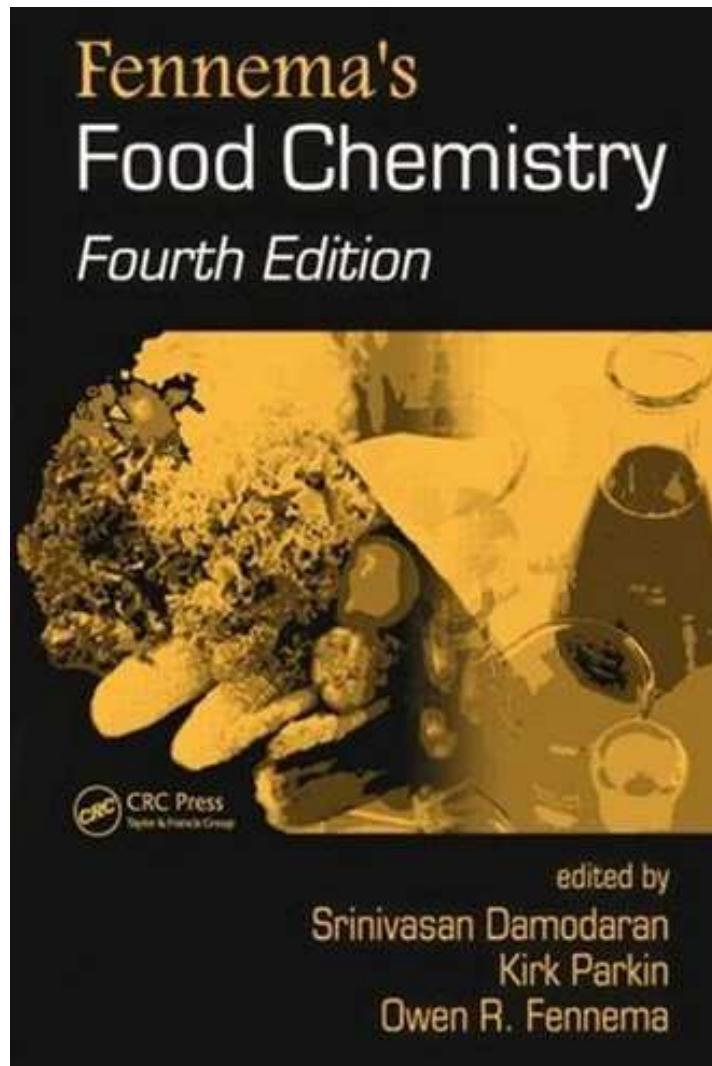
- 9.1 Introduction
- 9.2 Authenticity of foods
- 9.3 Treatment of foods
- 9.4 Degradation of foods

8. TOXIC COMPONENTS

- 8.1 Introduction
- 8.2 Heavy metals
- 8.3 Radioactive elements
- 8.4 Industrial contaminants
- 8.5 Crop control contaminants
- 8.6 Transformation compounds
- 8.7 Natural toxins
- 8.8 Adverse natural compounds
- 8.9 Endocrine disruptors

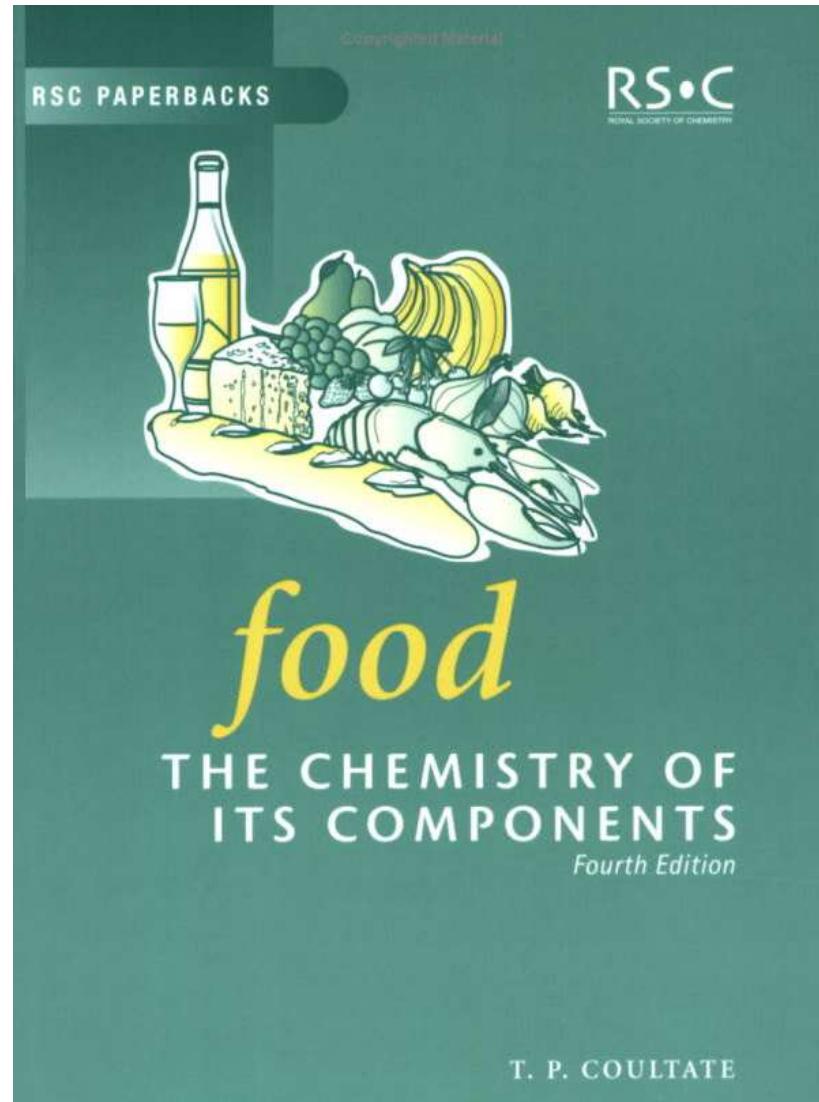
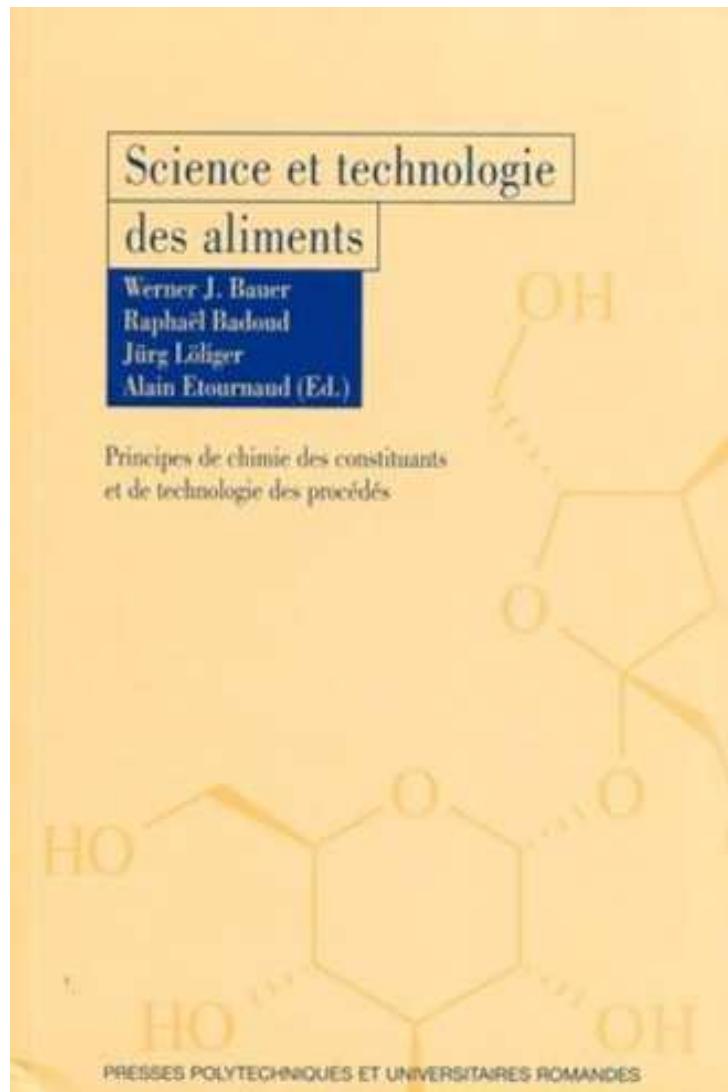
1.2 BIBLIOGRAPHY

General textbooks on Food chemistry (I)



1.2 BIBLIOGRAPHY

General textbooks on Food chemistry (II)



1.2 BIBLIOGRAPHY

Open access journals on food and science (I)



Journal of Food Processing & Technology



<https://www.longdom.org/food-processing-technology.html>



Journal of Nutrition & Food Sciences



<https://www.longdom.org/nutrition-food-sciences.html>



<http://www.mdpi.com/journal/foods>

1.2 BIBLIOGRAPHY

Open access journals on food and science (II)

The Open Food Science Journal



<https://benthamopen.com/TOFSJ/home/>



<http://www.hindawi.com/journals/ijfs/>

1.2 BIBLIOGRAPHY

Open access journals on food and science (III)



Journal of Food Research

<http://www.ccsenet.org/journal/index.php/jfr>



Scientific Research

Food and nutrition science

<http://www.scirp.org/journal/fns/>



Food Science & Nutrition

<http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%292048-7177>

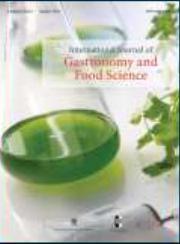
1.2 BIBLIOGRAPHY

Open access journals on food and science (IV)

<http://www.journals.elsevier.com/international-journal-of-gastronomy-and-food-science/>

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 International Journal of Gastronomy and Food Science - an Open Access Journal

1.3 DEFINITIONS

Generalities

Food

Any substance or materials eaten or drunk to provide nutritional support for the body or for pleasure.

Nutrient

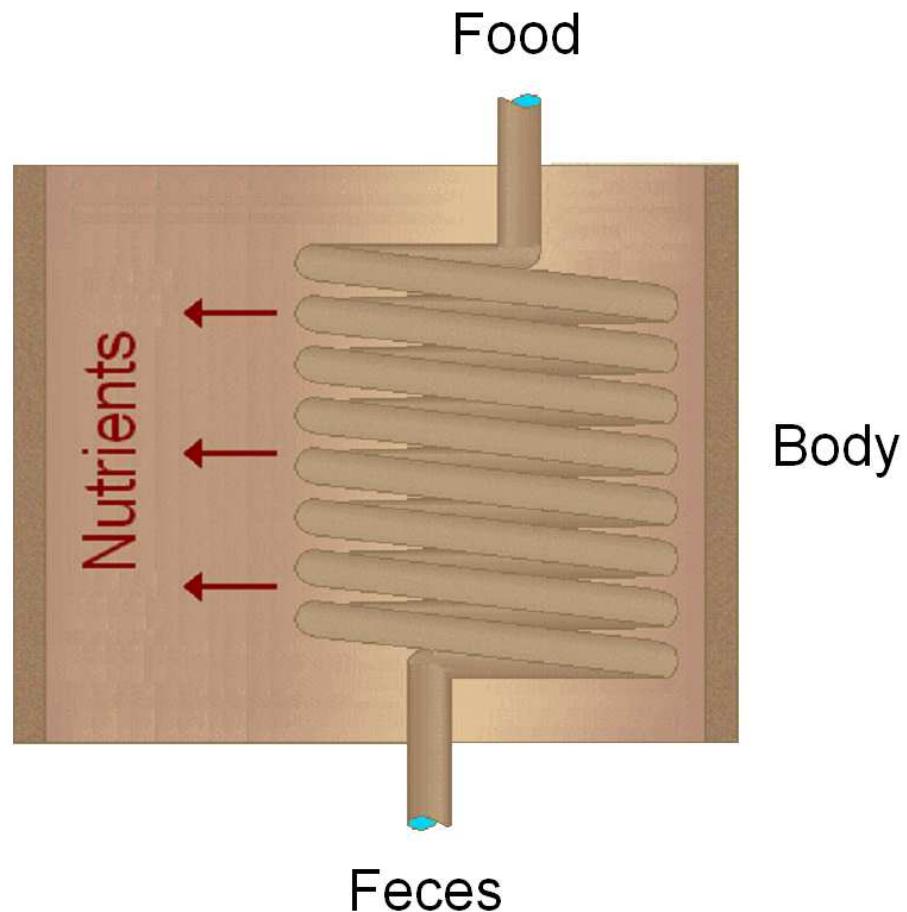
A chemical that the body needs to live and grow. A substance used in the metabolism which must be taken in from the environment.

Food chemistry

Study of chemical and biochemical processes and interactions of components of foods.

1.3 DEFINITIONS

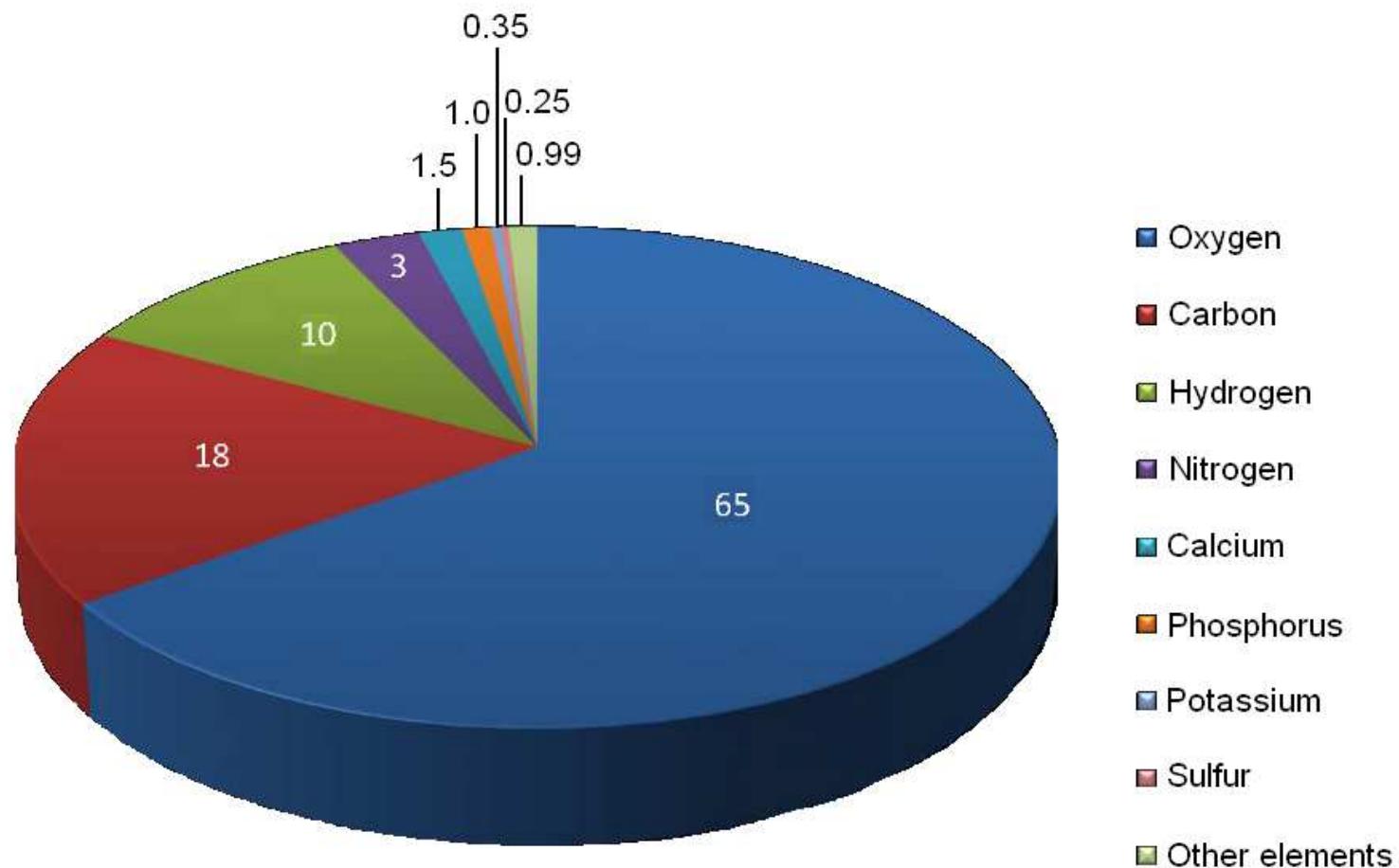
Food consumption and nutrients intake



Topologically speaking,
the body is a toroid !

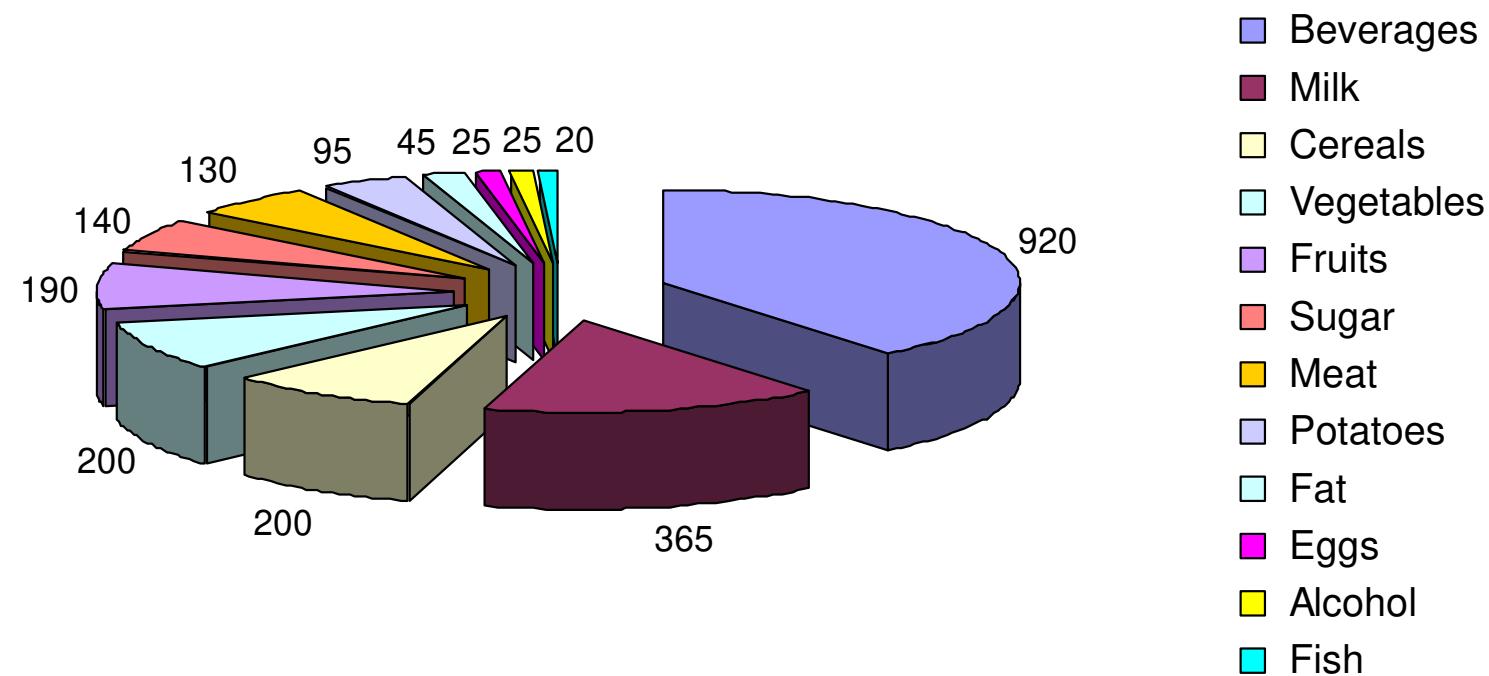
1.4 FOOD INTAKE

Elements in the body (in mass percent)



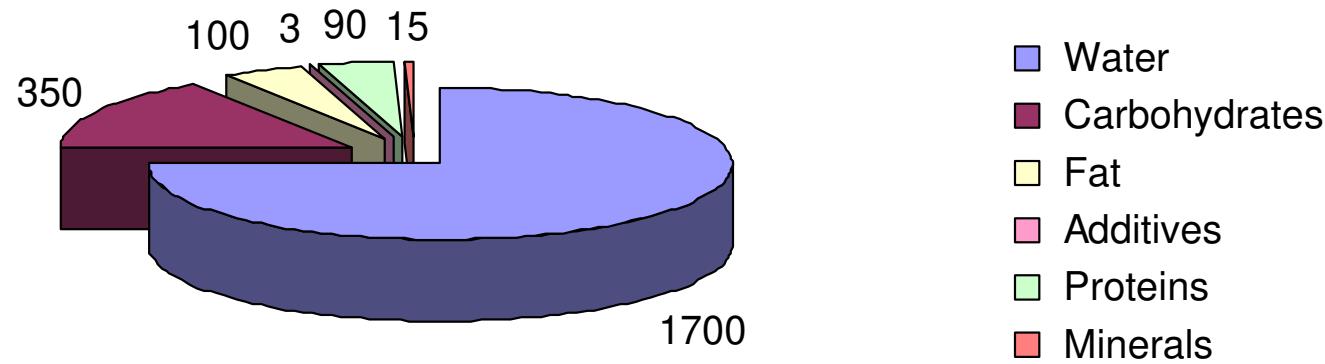
1.4 FOOD INTAKE

Daily food intake in Switzerland (in grams)



1.4 FOOD INTAKE

Daily nutrients intake in Switzerland (in grams)



Recommended daily allowances :

	% of energy intake	Approximate mass for 10 MJ/d
Carbohydrates	40 – 55	300 g
Fat	< 30	< 80 g
Proteins	10 - 20	90 g

1.5 FOOD FUNCTIONS

Energy supply

Food has to cover energy needs

Mean requirements :

Women 2100 – 2400 kcal/d (8.8 – 10.0 MJ/d)

Men 2700 – 2900 kcal/d (11.3 – 12.1 MJ/d)

Energy sources :

Carbohydrates 4.1 kcal/g 17.1 kJ/g

Lipids 9.3 kcal/g 38.9 kJ/g

Proteins 4.1 kcal/g 17.1 kJ/g

Dietary recommendations :

Ethanol 7.0 kcal/g 29.3 kJ/g

Lipids < 30% energy

Organic acids 3.0 kcal/g 12.5 kJ/g

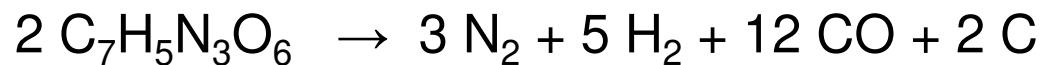
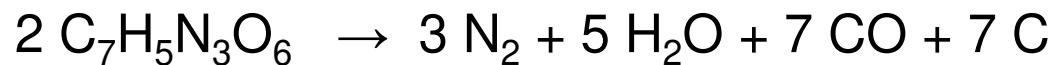
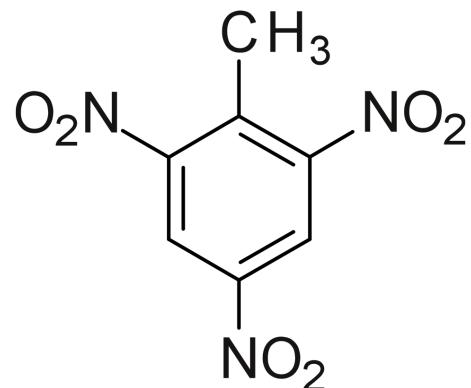
Carbohydrates < 55% energy

Polyols 2.4 kcal/g 10.0 kJ/g

Fibers 2.0 kcal/g 8.4 kJ/g

1.5 FOOD FUNCTIONS

Comparison of energy supplies



Decomposition of TNT : 4.6 MJ / kg

Oxydation of lipids : 39 MJ / kg

Oxydation of carbohydrates : 17 MJ / kg

1.5 FOOD FUNCTIONS

The basal metabolic rate (BMR)

BMR is the amount of daily energy expended while at rest in a neutrally temperate environment, in the post- absorptive state.

Mifflin and St Jeor equation (*M.D. Mifflin & al., Am. J. Clin. Nutr. 51,241-247, 1990*)

$$E = \left(\frac{10 \text{ m}}{1 \text{ kg}} + \frac{6.25 \text{ h}}{1 \text{ cm}} - \frac{5 \text{ a}}{1 \text{ year}} + s \right) \text{ kcal/day}$$

S = + 5 for men
S = -161 for women

Multiplication factor to get total daily energy expenditure :

Sedentary = BMR * 1.2

Lightly active = BMR * 1.375

Moderately active = BMR * 1.55

Very active = BMR * 1.725

Extremely active = BMR * 1.9

1.5 FOOD FUNCTIONS

Energy expenditure

Contributions to the basal metabolic rate

Organ	Energy consumption (%)	Energy consumption (% per 100g of organ)
Liver	25	1.6
Brain	20	1.5
Heart	10	2.4
Kidneys	10	3.4
Muscles	20	< 0.1
Adipose tissues	5	< 0.1
Other organs	10	

Total energy expenditure (for moderate activity)

Basal metabolic rate	~ 60 %
Physical activity	15 – 30 %
Post-prandial thermogenesis	10 – 20 %

For the BMR, most of the energy is consumed in maintaining fluid levels in tissues through osmosis, and about one-tenth is consumed for mechanical work, such as digestion, heartbeat, and breathing.

1.5 FOOD FUNCTIONS

Nutrient source

Food has to cover body needs

Tissue growth :

Proteins
Lipids
Calcium
Potassium

Metabolic regulation :

Vitamins
Essentials amino acids
Essentials fatty acids
Essentials elements

Mechanical function (peristaltism) :

Dietary fibers

Attractiveness :

Aroma
Flavor
Colour
Consistency

1.6 FOOD VALUE

Nutrient profiling of food

SNA : score of nutrients adequacy

SLIM : score of nutrients to be limited

nutrient_{ip/l} : quantity of nutrient *p/l* in food *i*

RV_{*p*} : daily recommended value for nutrient *p*

E_{*i*} : energy contents of food *i*

MRV_{*l*} : daily maximal recommended value for nutrient *l*

Positive nutrients ; proteins, fibers, vitamin C, calcium, iron

Limited nutrients : saturated fatty acids, added sugar, salt

$$\text{SNA}_i = \frac{\sum_{p=1}^5 \text{ratio}_{ip}}{5}$$

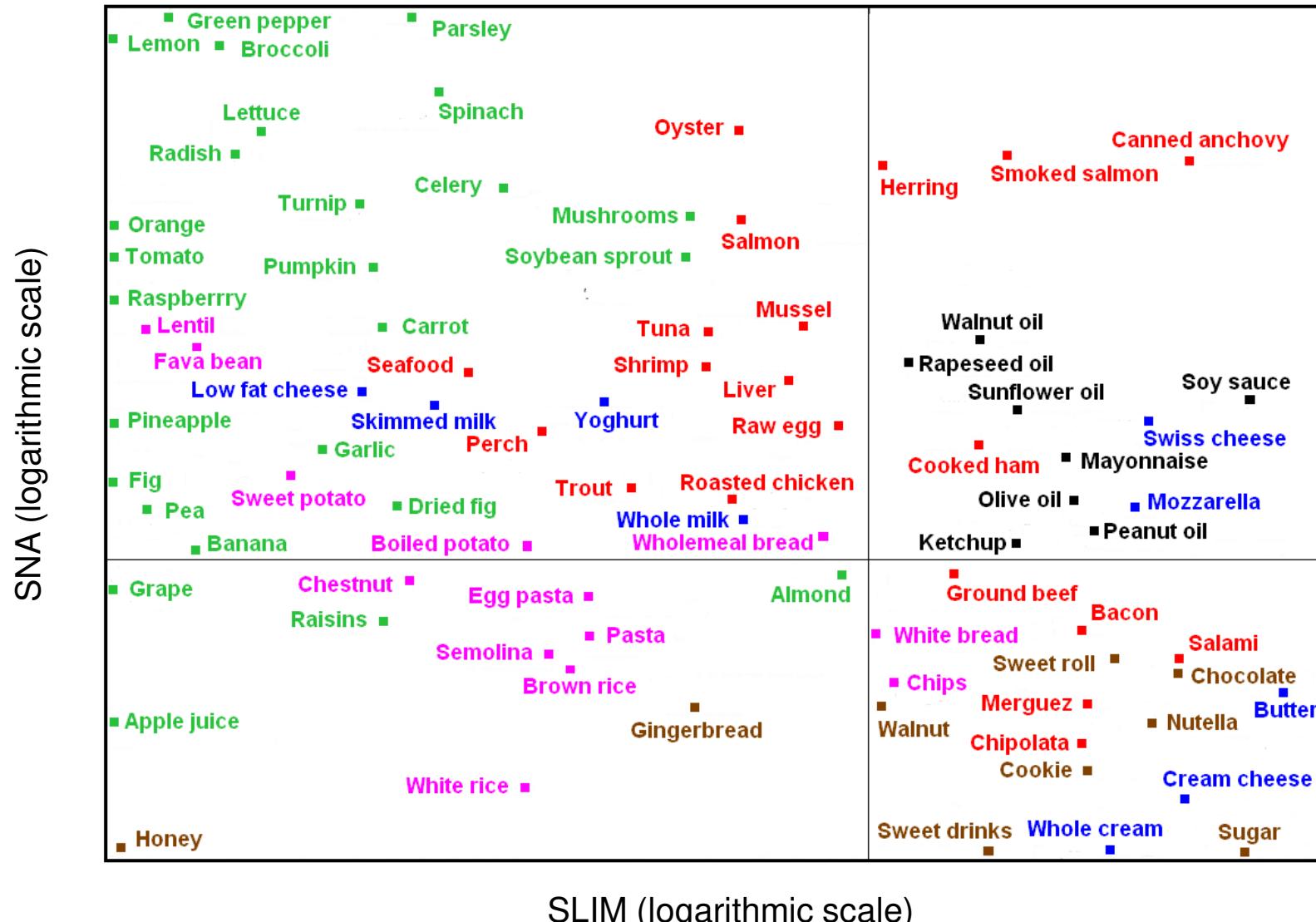
$$\text{ratio}_{ip} = \left[\frac{\text{nutrient}_{ip}}{\text{RV}_p} \right] \times \frac{100}{E_i}$$

$$\text{SLIM}_i = \frac{\sum_{l=1}^3 \text{ratio}_{il}}{3}$$

$$\text{ratio}_{il} = \left[\frac{\text{nutrient}_{il}}{\text{MRV}_l} \right] \times 100$$

1.6 FOOD VALUE

Classification of selected foods according to SNA/SLIM



1.6 FOOD VALUE

The swiss nutrition pyramid

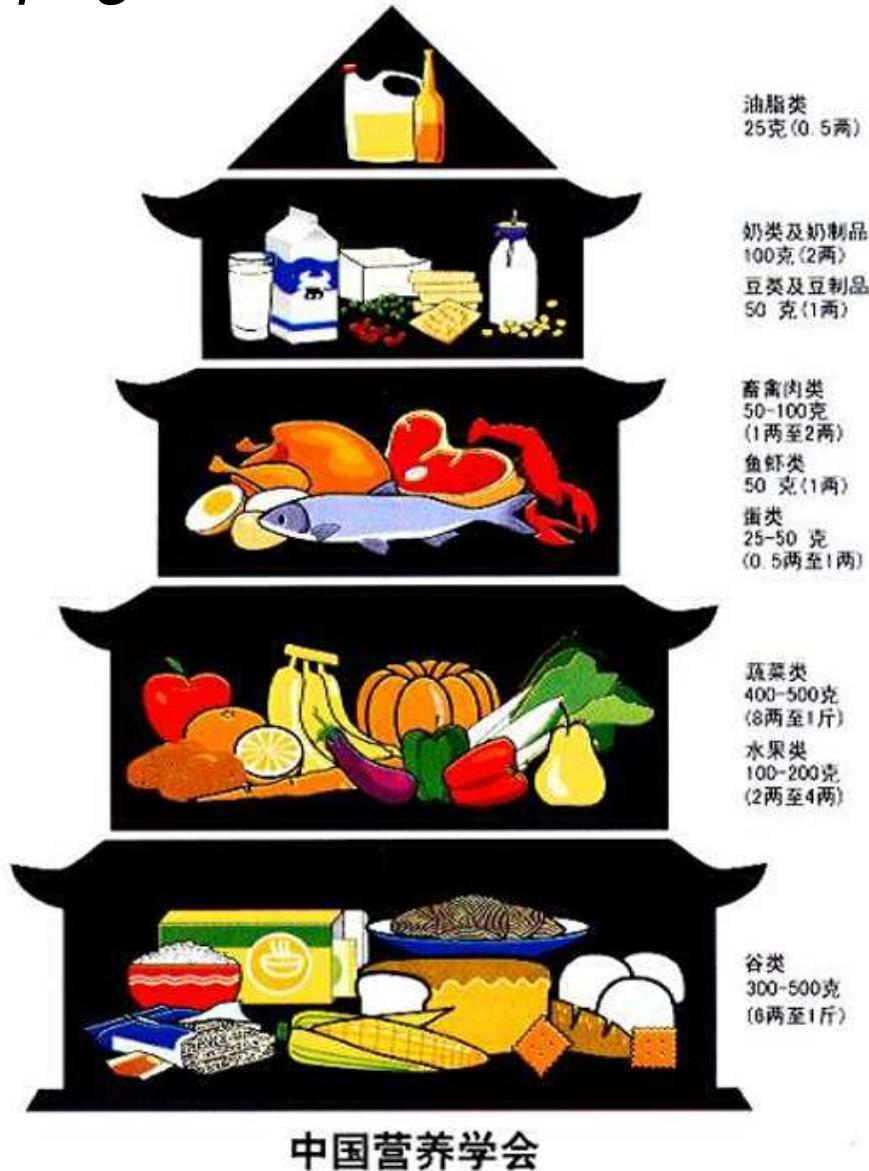


Federal office of public health

Swiss nutrition society

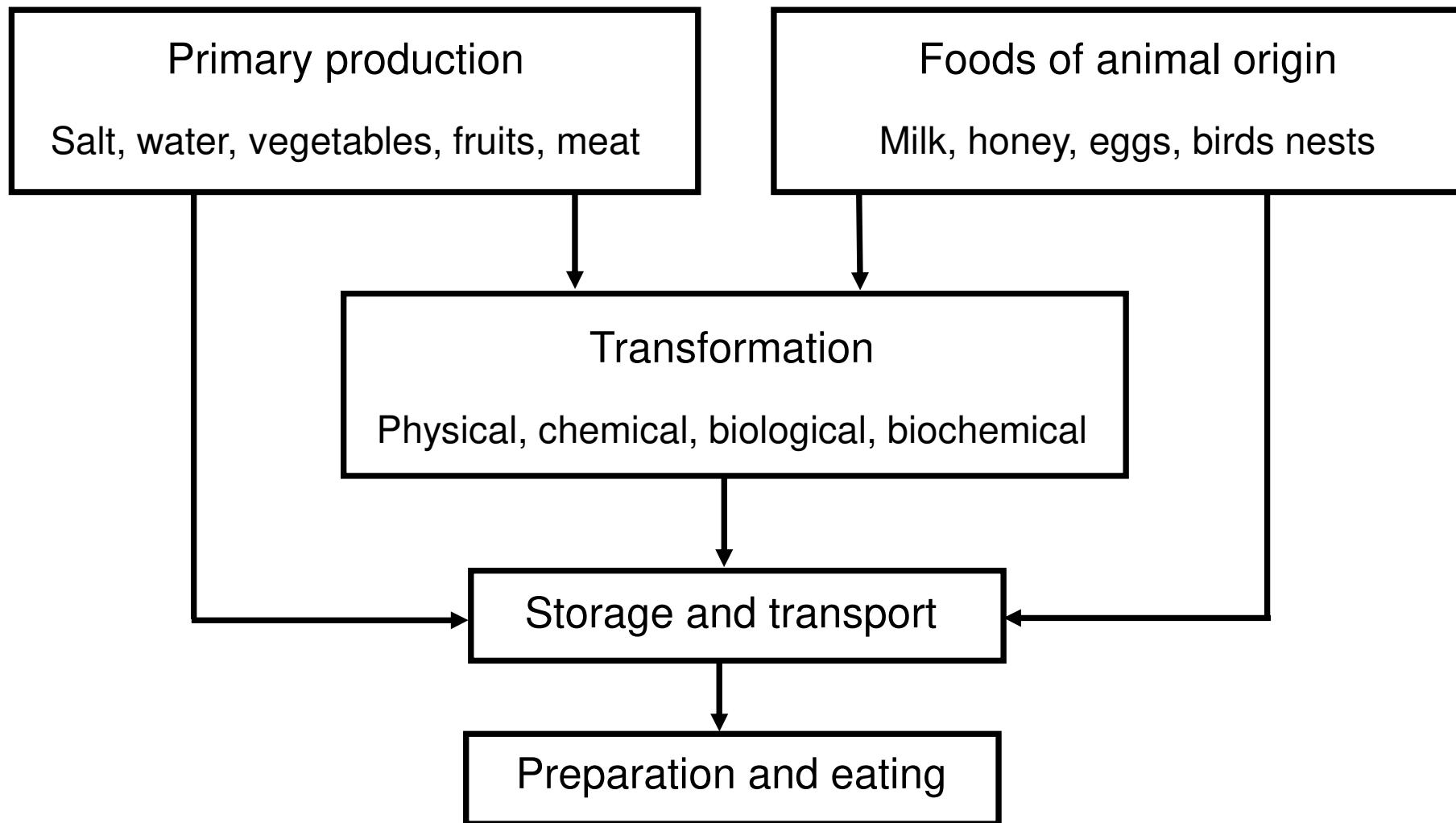
1.6 FOOD VALUE

The China food pagoda



1.7 FOOD CHAIN

Elementary steps



1.8 LABELLING

Informations nutritives	par 100ml	AJR *
valeur énergétique	170 kJ 41 kcal	
protéines	4g	
glucides	5g	
dont sucres	4,5g	
lipides	0,2g	
dont acides gras saturés	0,1g	
fibres alimentaires	< 0,5g	
sodium	0,04g	
calcium	160mg	20%

AJR * = Apport Journalier Recommandé

Ingrediénts: yogourt (au lait écrémé et pasteurisé) 85%, 7% de purée de fraises provenant de concentré, eau, fructose, épaississant: pectine, concentré de jus de citron, colorant: concentré de jus de betterave rouge, clorure de calcium, édulcorant: Acésulfame K, arômes, Contient des cultures de Lactobacillus acidophilus et de bifidobactéries

Conserver à 5°C au maximum

i | Allergie
Contient du lait

Drink-Leicht Yogourt
Fraise

Yogourt maigre avec concentré de fraise, valeur énergétique réduite, avec 0.05% de graisse du lait, avec sucre et édulcorant



CH
9999

500ml



7

Rosa's Feinkost
Milchverarbeitung
CH-3000 Bern

Élaboré en Suisse

Enrichi avec du calcium

Valeur énergétique réduite

Bien agiter avant de servir

A vendre jusqu'au
A consommer jusqu'au

09.03.12
15.03.12