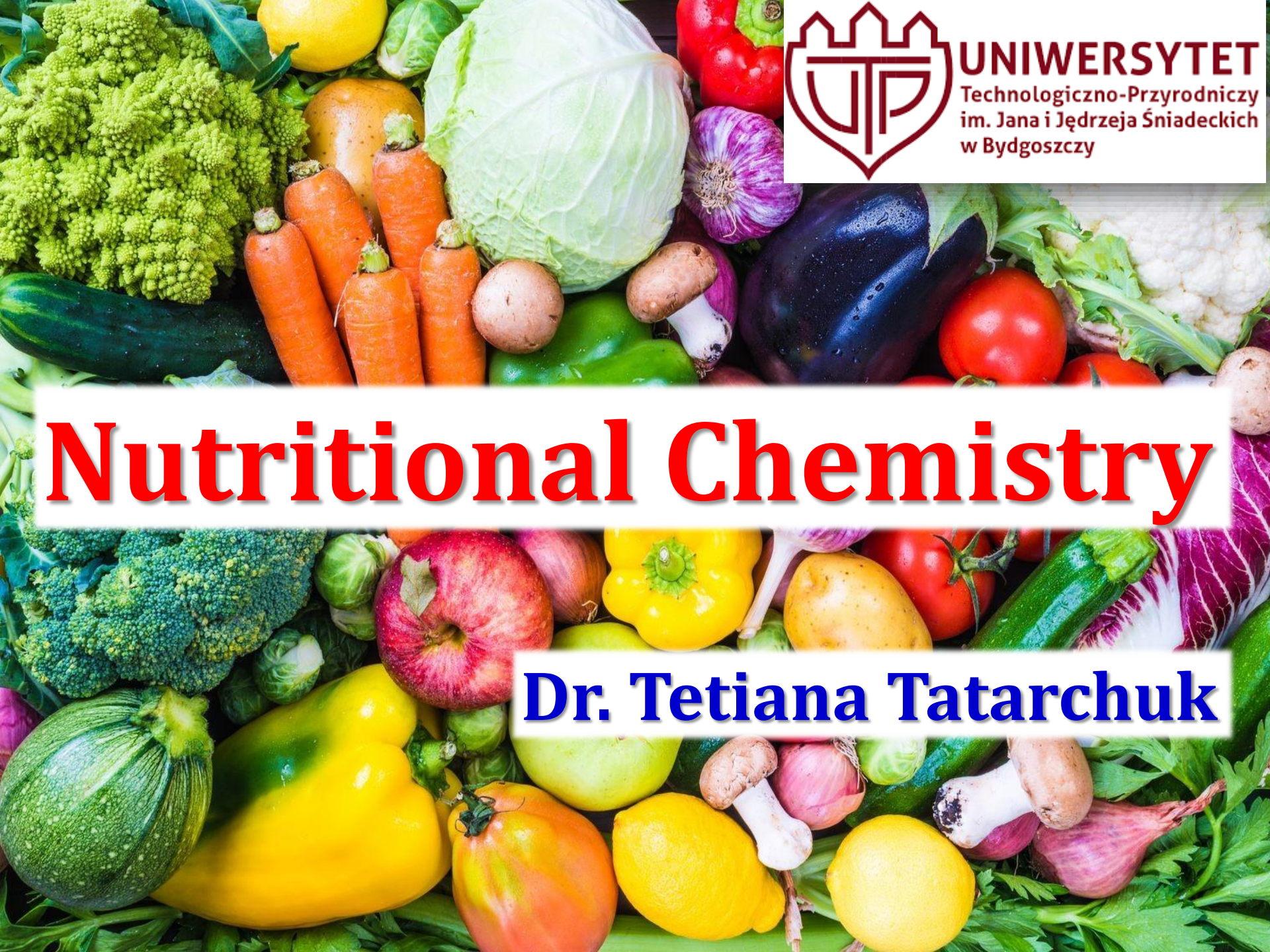


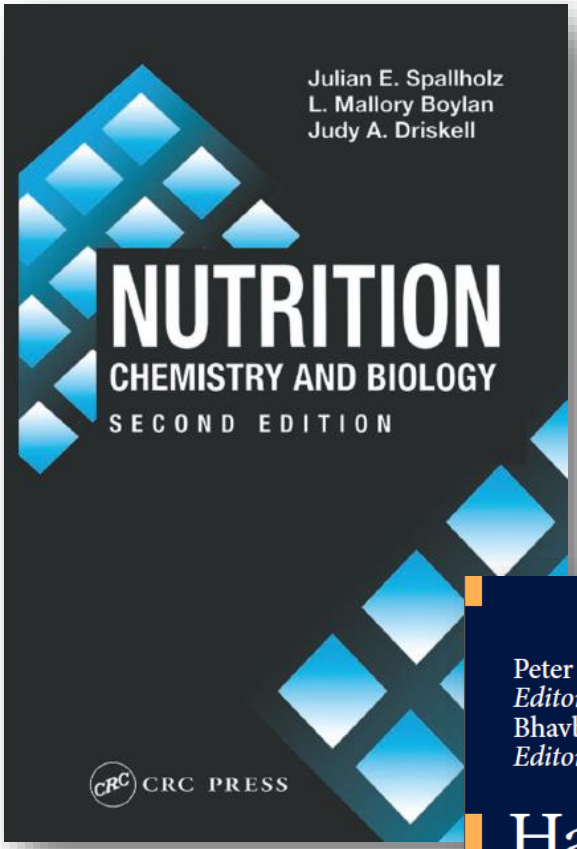
UNIWERSYTET
Technologiczno-Przyrodniczy
im. Jana i Jędrzeja Śniadeckich
w Bydgoszczy

Nutritional Chemistry

Dr. Tetiana Tatarchuk

Schedule of classes

- **Lectures – 30 hours**
- **Classes – 15 hours**
- **Exam**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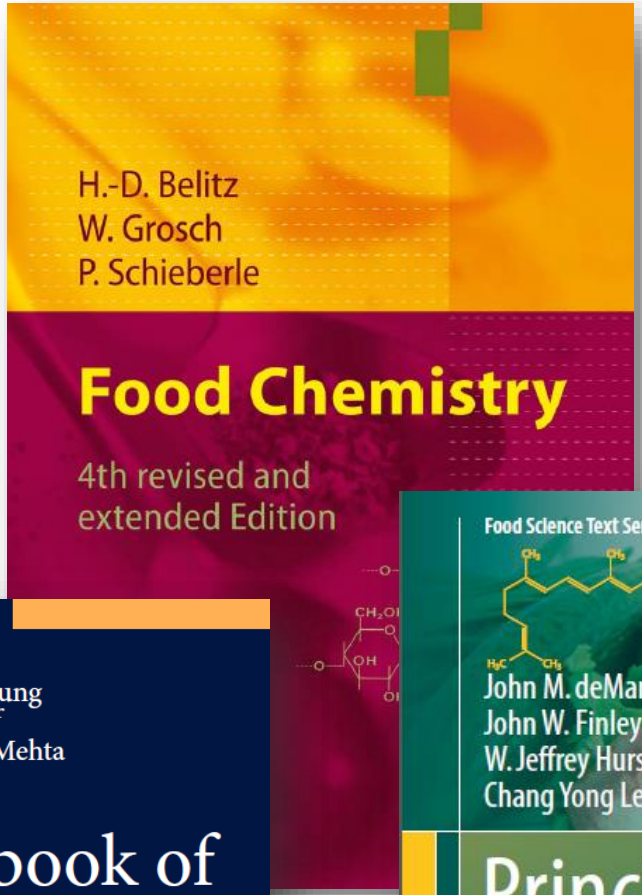
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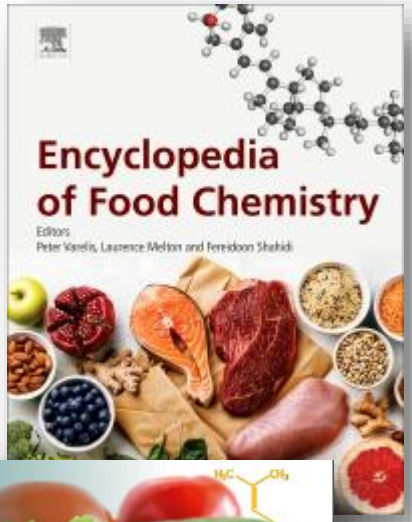
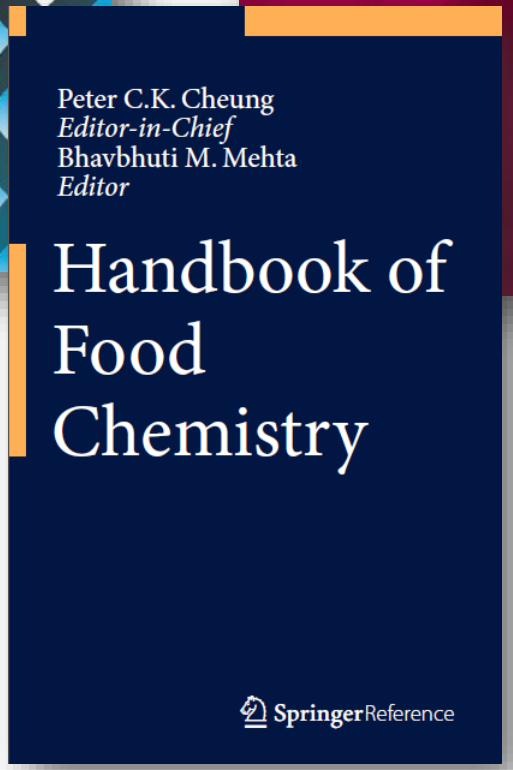

Encyclopedia
of Food Chemistry
Editors
Peter Varelis, Laurence Melton and Fereidoon Shahidi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Chemistry
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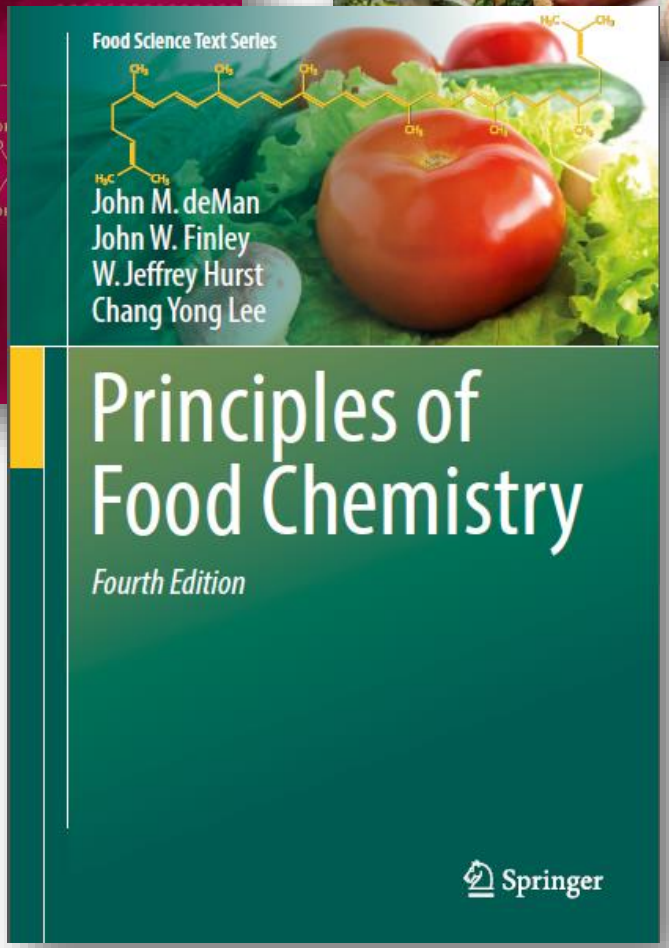
Food Science Text Series
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John W. Finley
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Fourth Edition
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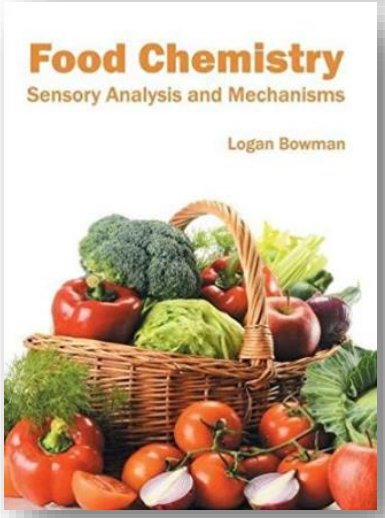

Food Chemistry
Sensory Analysis and Mechanisms
Logan Bowman

LECTION 1

Introduction to Nutritional Chemistry

Dr. Tetiana Tatarchuk

OUTLINES

1. Introduction to Nutritional Chemistry.
2. The Elements of Life.
3. Food Composition.
4. Functions of food nutrients
5. 10 “SMART” Healthy Eating Goals.

OUTLINES

1. **Introduction to Nutritional Chemistry.**
2. **The Elements of Life.**
3. **Food Composition.**
4. **Functions of food nutrients**
5. **10 “SMART” Healthy Eating Goals.**

- Nutrition has played a significant role in our life, even from before our birth.

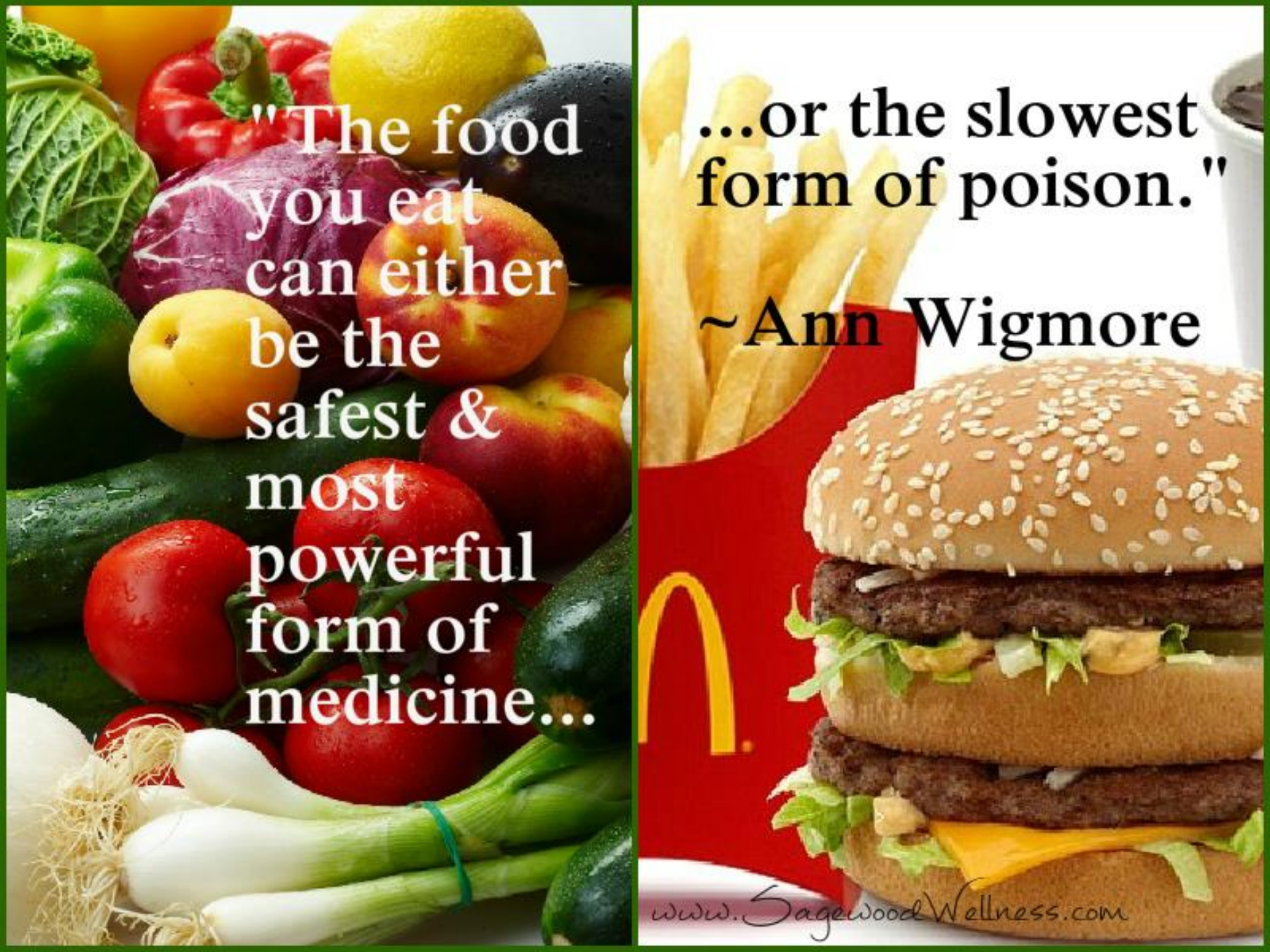
- Many people are concerned only with food that relives their hunger or satisfies their appetite .

- But in many times, these foods don't supply their bodies with all the component of good nutrition.


"Today, more than 95%
of all chronic disease is caused by food choice, toxic food ingredients, nutritional deficiencies and lack of physical exercise."
- Mike Adams, the Health Ranger
NaturalNews.com
Natural Health, Natural Living, Natural News

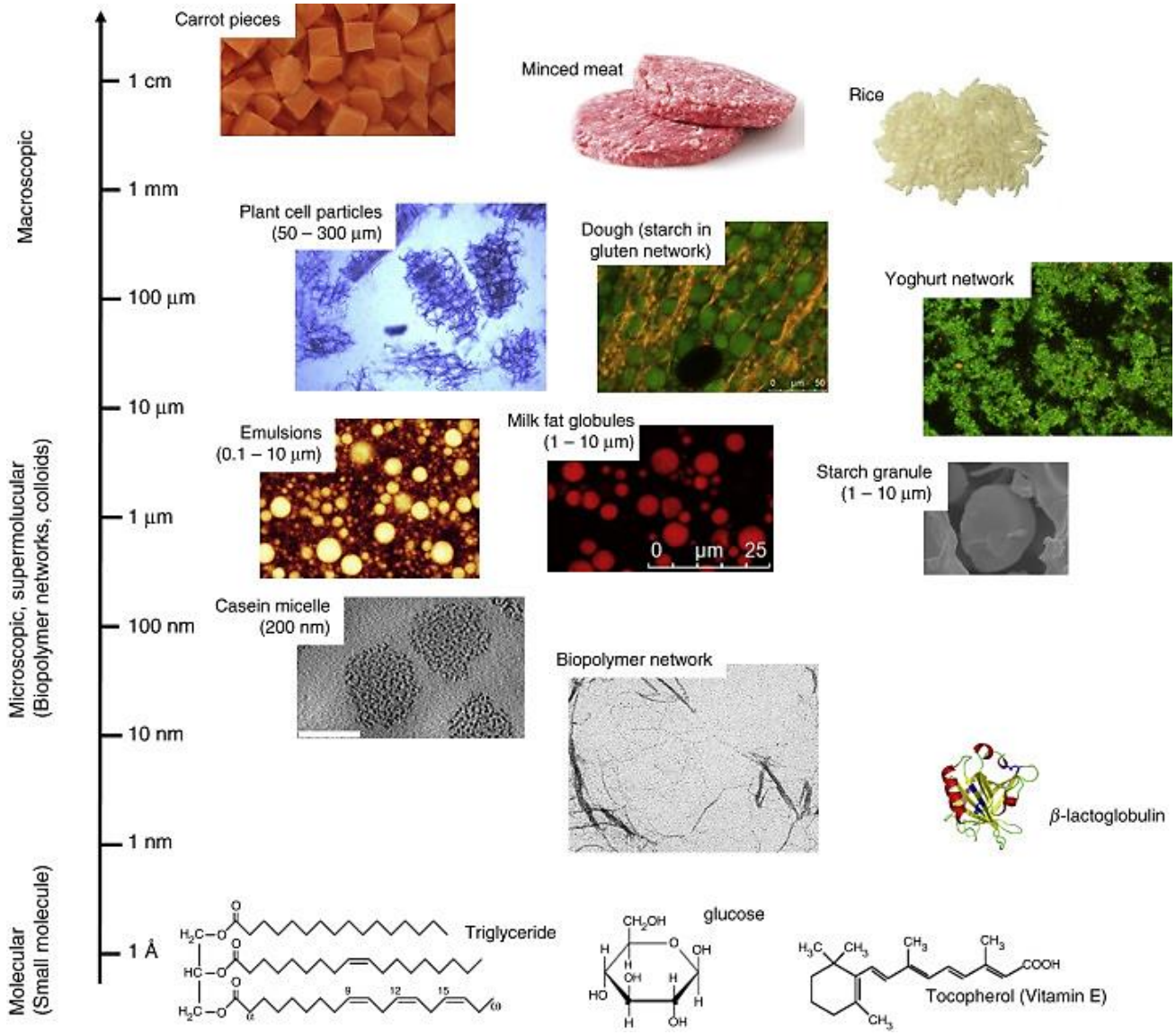
“ We do not live to eat but eat to live ” (Socrates)

“We are what we eat” (Hippocrates)


"The food you eat can either be the safest & most powerful form of medicine...
...or the slowest form of poison."
~Ann Wigmore
www.SagewoodWellness.com


JUNK FOOD

Structures that are relevant to food properties can be considered at different length scales :



1. At the smallest scale is the **molecular structure**: water, minerals, vitamins, flavor components, fatty acids, lipids and protein monomers, etc.

2. The next level up is the **microscopic level**: aggregation of molecules and their assembly into components, colloids and networks, which are typically measured between nanometers and micrometers. A range of classic supermolecular structures in food are casein micelles, milk fat globules, starch granules, biopolymer network/gels such as the gluten structure in dough, pectin gel, etc.

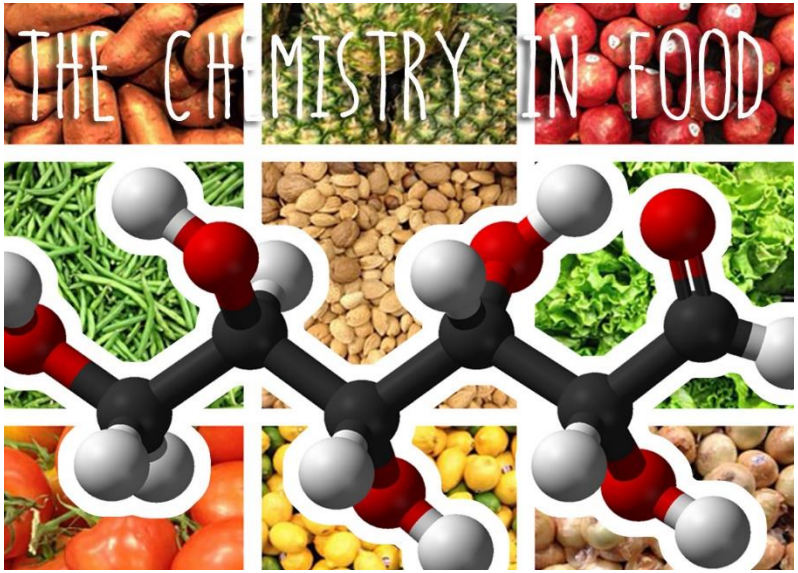
3. The **macroscopic level** of structure considers those features that are perceived by human senses, such as texture and taste. They are often associated with specific types of foods by consumers, for example, tomato paste or fruit purees, recombined meat such as burgers and sausages, porous structures such as cakes and biscuits, and different types of grains, etc.

Fig.1. The length scale of structures and examples of representative molecules, food components, networks, and food structures.

Are Nutritional and Food chemistry the same thing?

Nutritional chemistry - is the science of components of food that are of benefit to the human body.

- ✓ Nutritional chemistry is a process of analyzing the biochemistry of your body.
- ✓ Understanding your unique biochemistry is the first step in solving health problems.
- ✓ Body chemistry indicators, such as acid/alkaline balance, metabolic rate, stage of stress, immune system function, adrenal, hormone, and thyroid activity, mental and emotional balances, are all important to consider before starting on any nutrition or supplement program.



Are Nutritional and Food chemistry the same thing?

Food chemistry is the study of chemical processes and interactions of all biological and non-biological components of foods.

The biological substances include such items as meat, poultry, lettuce, beer, and milk as examples. It is similar to biochemistry in its main components such as carbohydrates, lipids, and protein, but it also includes areas such as water, vitamins, minerals, enzymes, food additives, flavors, and colors. This discipline also encompasses how products change under certain food processing techniques and ways either to enhance or to prevent them from happening.
An example of enhancing a process would be to encourage fermentation of dairy products with microorganisms that convert lactose to lactic acid;
an example of preventing a process would be stopping the browning on the surface of freshly cut Red Delicious apples using lemon juice or other acidulated water.

The Nutritional Chemistry and Food Chemistry are similar but :

- food chemistry is the study of chemical processes and interactions of all biological and non-biological components of foods ;
- nutritional chemistry explores the biochemistry of the body in conjunction with food.

OUTLINES

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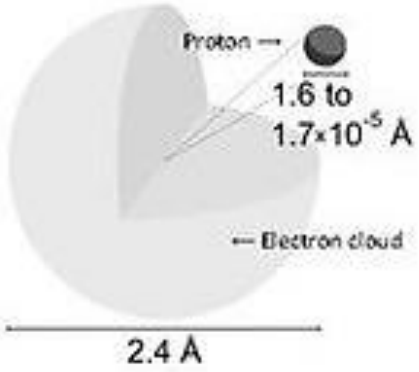
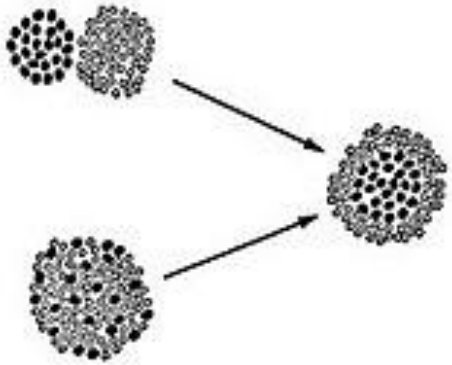
Atom
(Leucippus, 450BC)



Molecule
(Gassendi, 1649)

Cell-as-molecule
(Harrison, 1993)



Human-as-molecule
(Sales, 1789)

IUPAC Periodic Table of the Elements

1																	18
1 H hydrogen 1.008 [1.0078, 1.0082]	2		Key: atomic number **Symbol** name conventional atomic weight standard atomic weight									13	14	15	16	17	2 He helium 4.0026
3 Li lithium 6.94 [6.938, 6.997]	4 Be beryllium 9.0122											5 B boron 10.81 [10.806, 10.821]	6 C carbon 12.011 [12.009, 12.012]	7 N nitrogen 14.007 [14.006, 14.008]	8 O oxygen 15.999 [15.999, 16.000]	9 F fluorine 18.998	10 Ne neon 20.180
11 Na sodium 22.990	12 Mg magnesium 24.305 [24.304, 24.307]	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 26.982	14 Si silicon 28.085 [28.084, 28.086]	15 P phosphorus 30.974	16 S sulfur 32.06 [32.059, 32.076]	17 Cl chlorine 35.45 [35.446, 35.457]	18 Ar argon 39.948
19 K potassium 39.098	20 Ca calcium 40.078(4)	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	31 Ga gallium 69.723	32 Ge germanium 72.630(8)	33 As arsenic 74.922	34 Se selenium 78.971(8)	35 Br bromine 79.904 [79.901, 79.907]	36 Kr krypton 83.798(2)
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224(2)	41 Nb niobium 92.906	42 Mo molybdenum 95.95	43 Tc technetium	44 Ru ruthenium 101.07(2)	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60(3)	53 I iodine 126.90	54 Xe xenon 131.29
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49(2)	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23(3)	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38 [204.38, 204.39]	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesson

57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium	62 Sm samarium 150.36(2)	63 Eu europium 151.96	64 Gd gadolinium 157.25(3)	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
89 Ac actinium	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

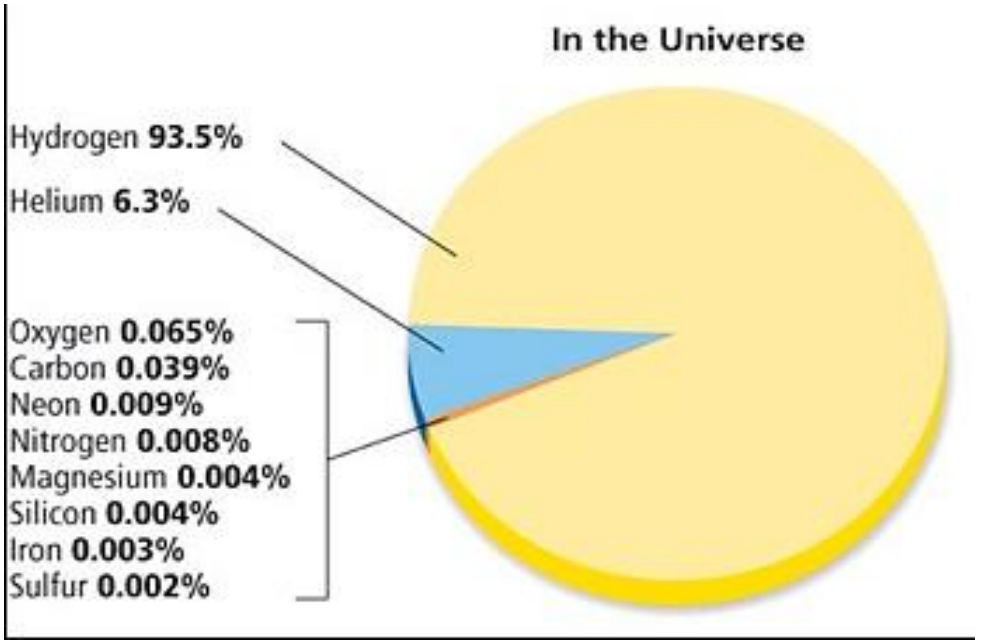
INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

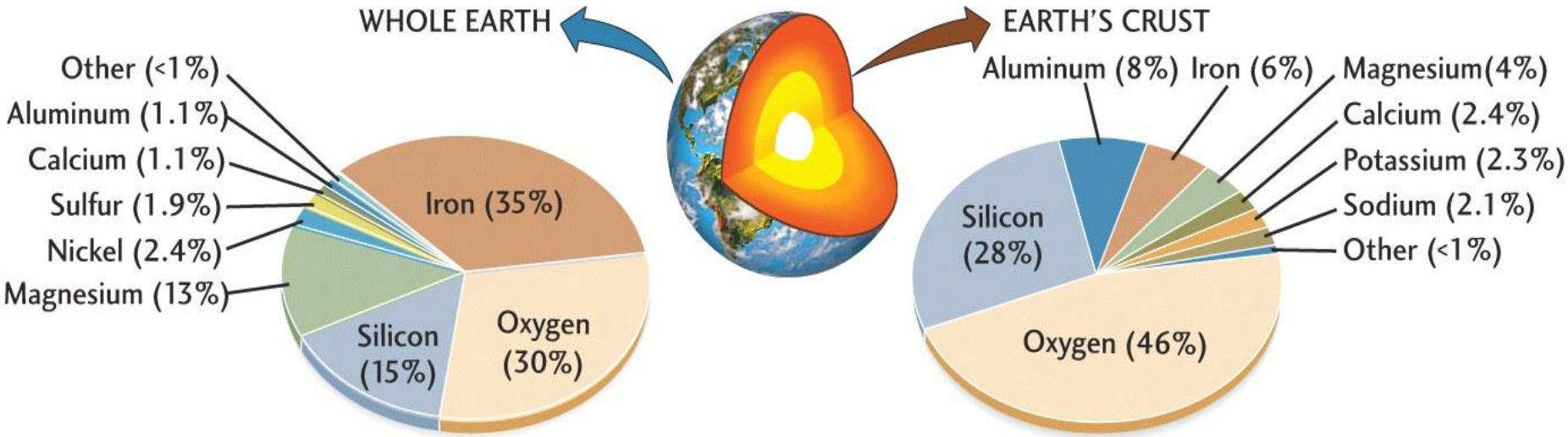
For notes and updates to this table, see www.iupac.org. This version is dated 28 November 2016.

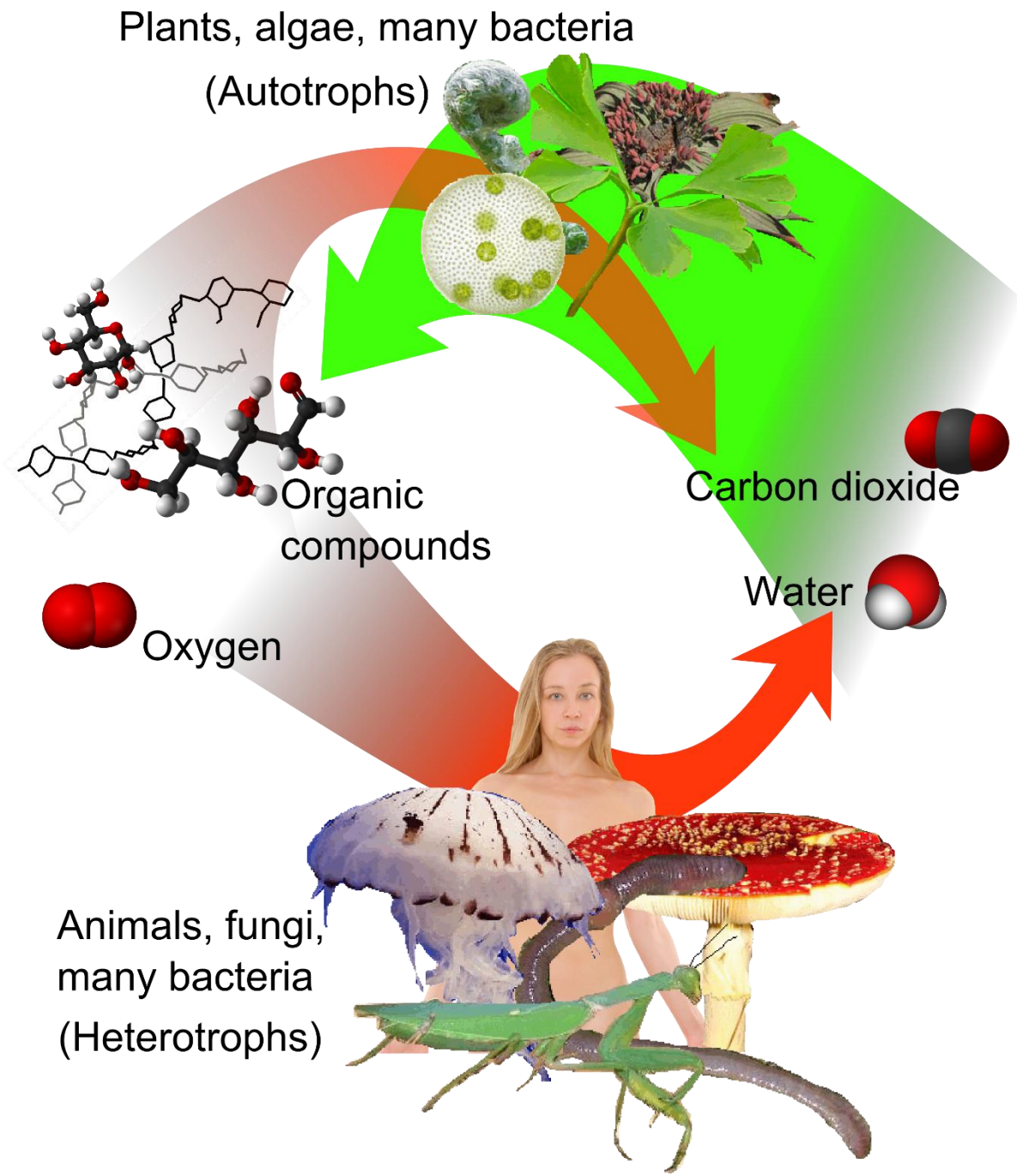
The periodic table contains 118 elements. Only 90 of these elements occur naturally in the environment, and still fewer elements comprise the living world.

From bacteria to higher vertebrates and humans, nature has repeatedly selected for all life forms a basic group of only six elements.

ABUNDANCE OF ELEMENTS IN THE UNIVERSE AND ON EARTH



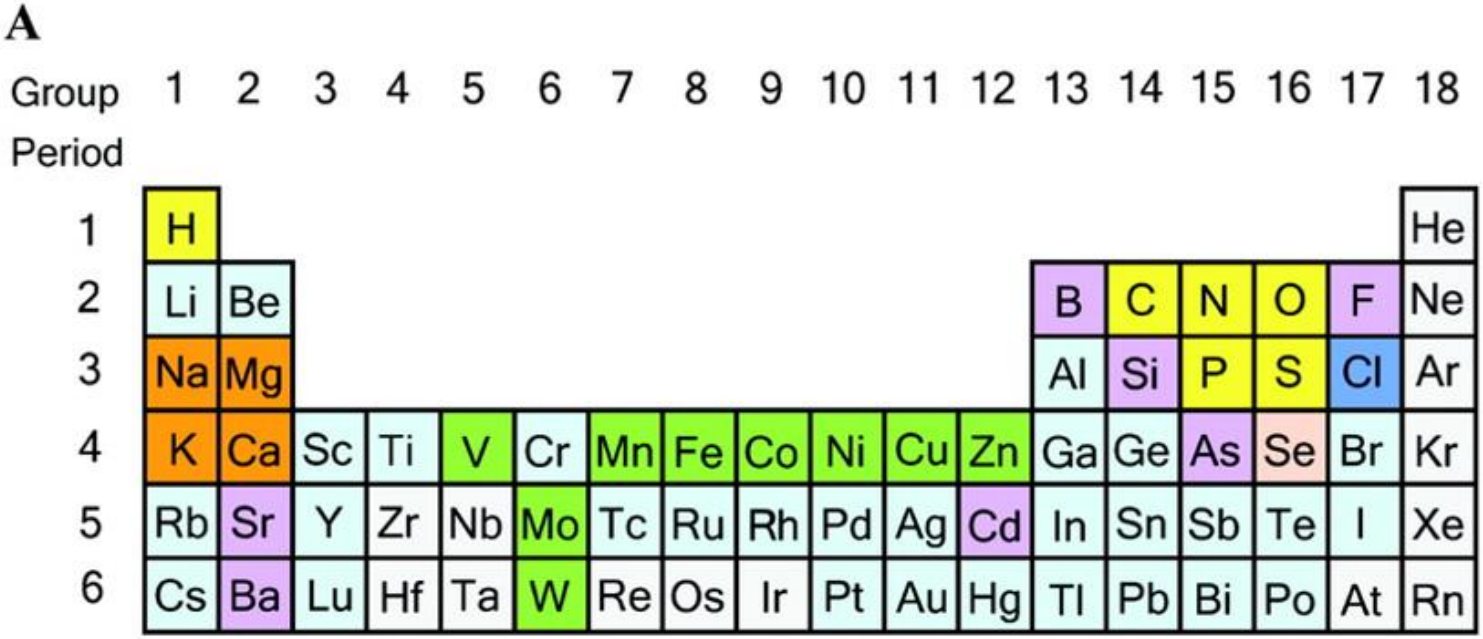




Cycle between autotrophs and heterotrophs.

Autotrophs use light, carbon dioxide (CO_2), and water to form oxygen and complex organic compounds, mainly through the process of photosynthesis (green arrow). Both types of organisms use such compounds via cellular respiration to both generate ATP and again form CO_2 and water (two red arrows).

DISTRIBUTION OF ELEMENTS IN THE HUMAN BODY



H, C, N, O, P, S

organic cluster

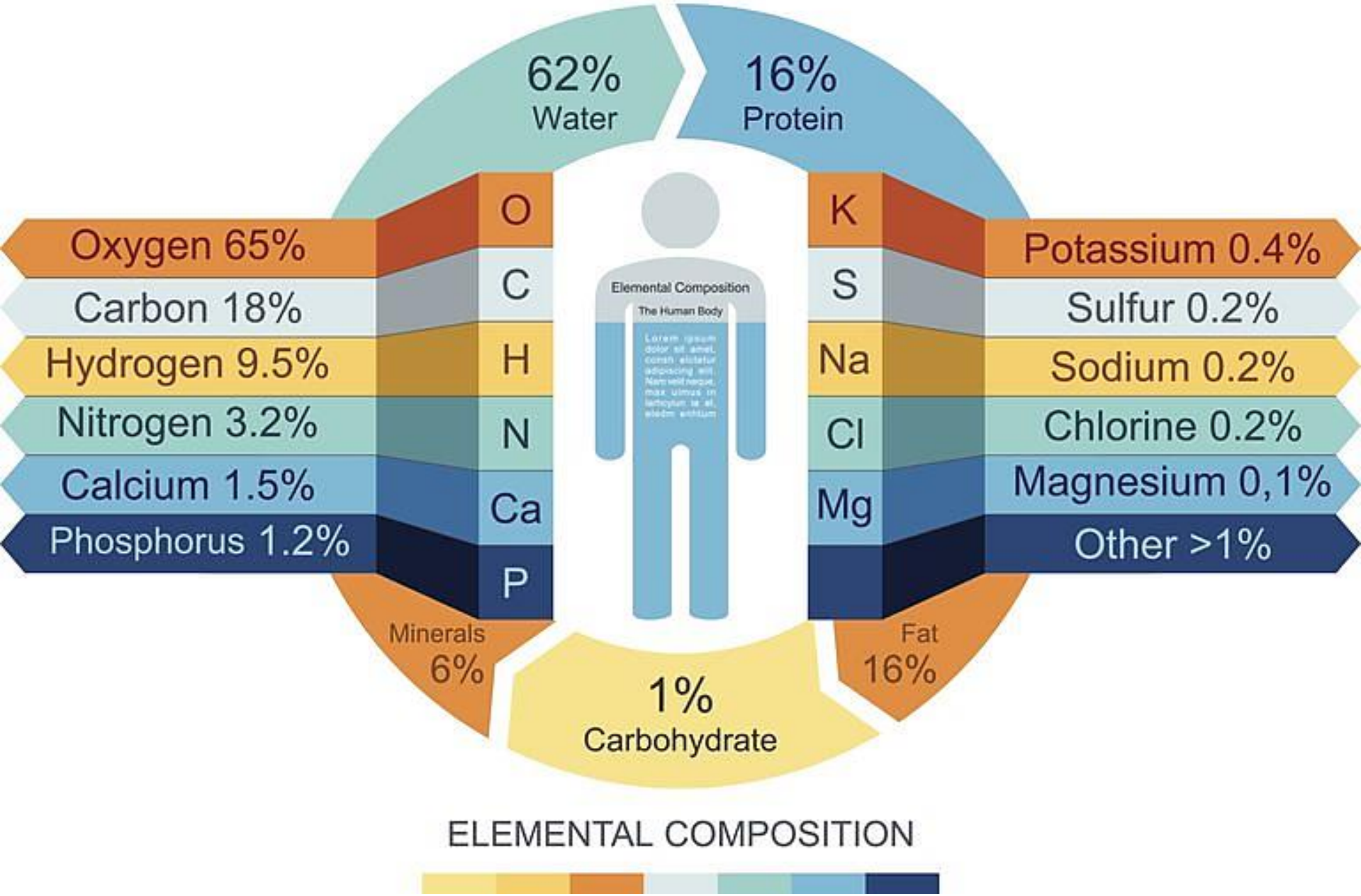
Key:

- Major, essential, all life
- Major, cations, all life
- Major, anion, all life
- Essential, trace, all life
- Specialized uses, some life
- Transported, reduced and/or methylated, some microbes
- Inert or unknown biological function
- Major biological transition metals

These six relatively small elements universally comprise most of the structural organization of the nutrients: ***proteins, carbohydrates, lipids, and vitamins****.*

In addition, they make up most of the structural forms of the ***nucleic acids, deoxyribonucleic (DNA), and ribonucleic acids (RNA), and all the metabolic intermediates of metabolism****.*

THE HUMAN BODY



ELEMENTAL COMPOSITION

Potassium K

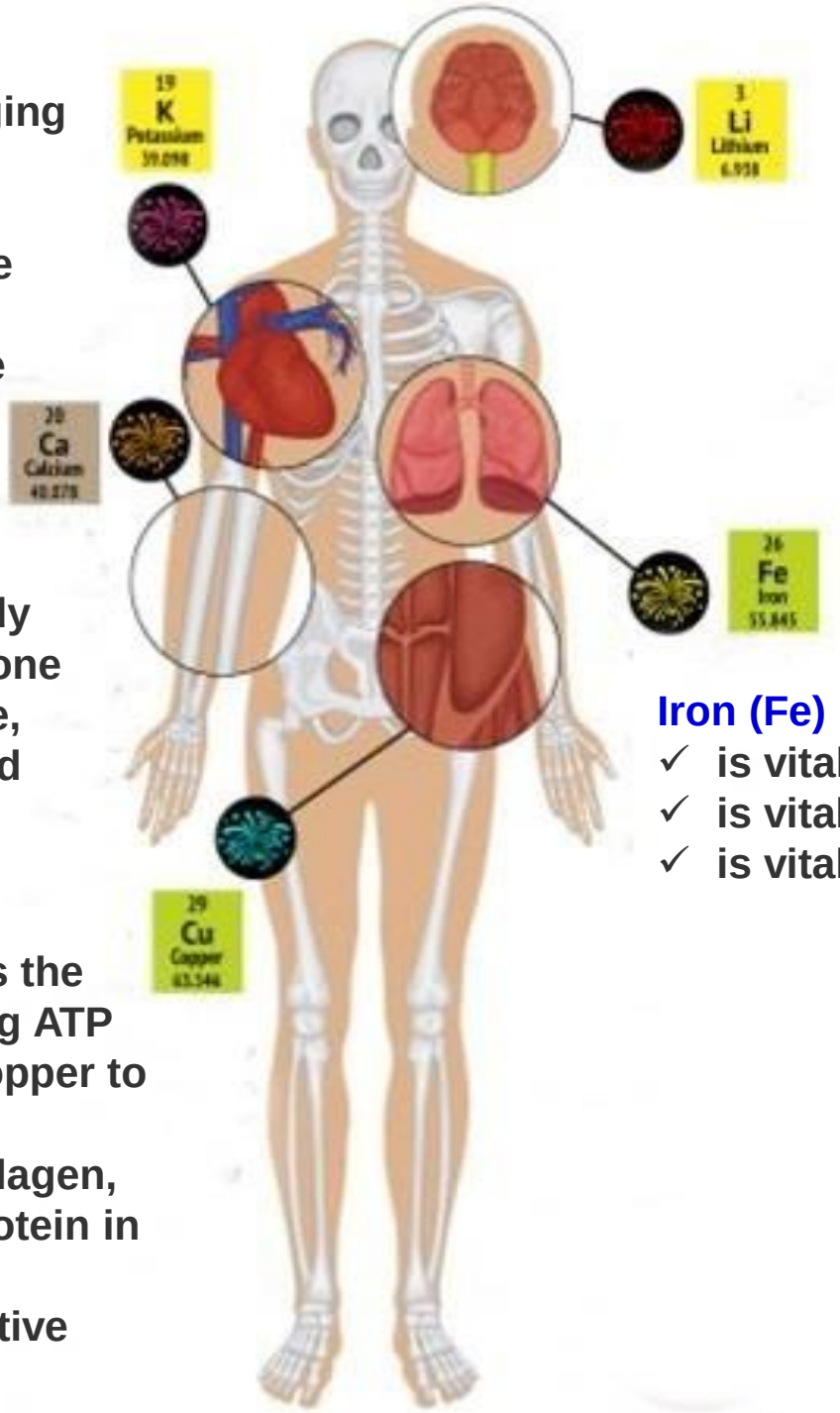
- ✓ plays a role in managing heart rhythm
- ✓ it balances water and mineral content in the body
- ✓ helps to build muscle
- ✓ controls blood pressure.

Calcium (Ca)

- ✓ enables a range of body functions, including bone and tooth maintenance, muscle contraction and heartbeat regulation.

Copper (Cu)

- ✓ the protein that makes the body's energy-carrying ATP molecules requires copper to function
- ✓ necessary to form collagen, the most abundant protein in humans and the main component of connective tissue.



Lithium (Li)

- ✓ to affect the release of the chemical messenger serotonin;
- ✓ is used to treat bipolar disorder and depression.

Iron (Fe)

- ✓ is vital to immune function
- ✓ is vital to energy production
- ✓ is vital to oxygen transport

OUTLINES

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Food – is any substance that can be metabolized by an organism to give energy and build tissue.

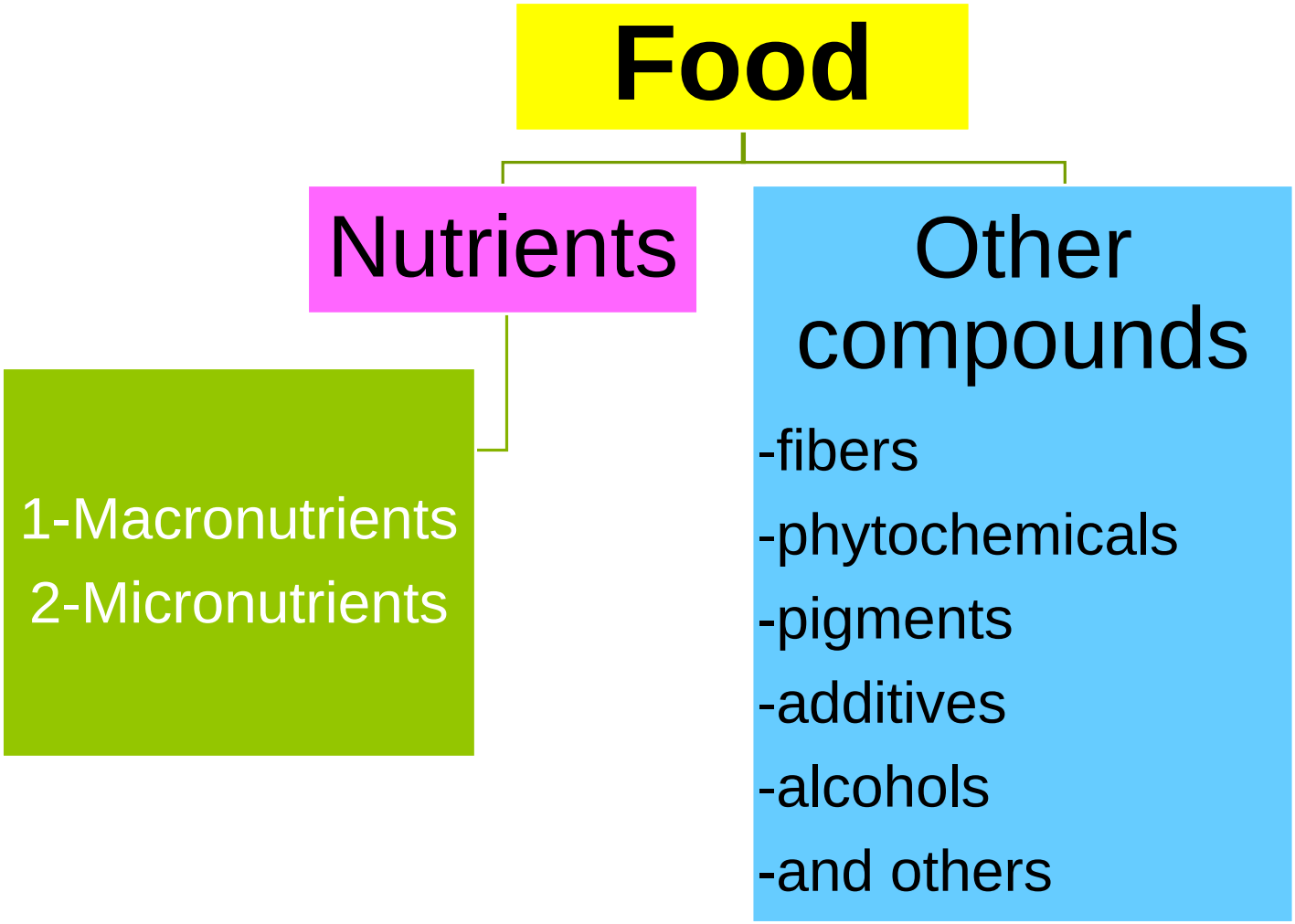
Diet is the foods and beverages a person eats and drinks.

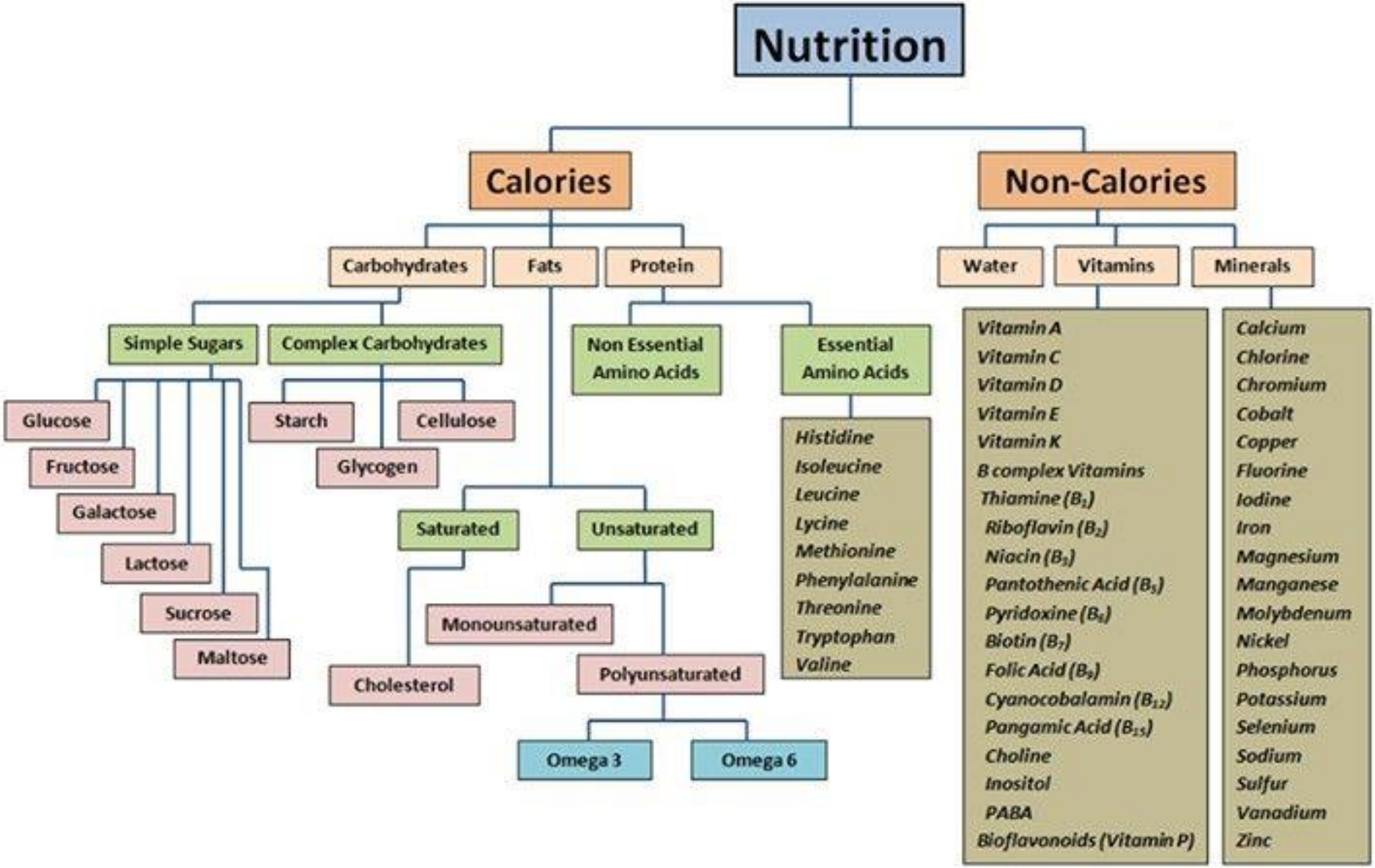
Nutrition is the science of foods, nutrients and other substances they contain their actions within the body (including ingestion, digestion, absorption, transport, metabolism and excretion).

Nutritional requirements - the amounts of nutrient which are needed for covering the human needs to be healthy depend on sex, age and few other factors.

Essential nutrients – are nutrients a person must obtain from food because the body cannot make them for itself insufficient quantity to meet physiological needs. Also called **indispensable nutrients**.

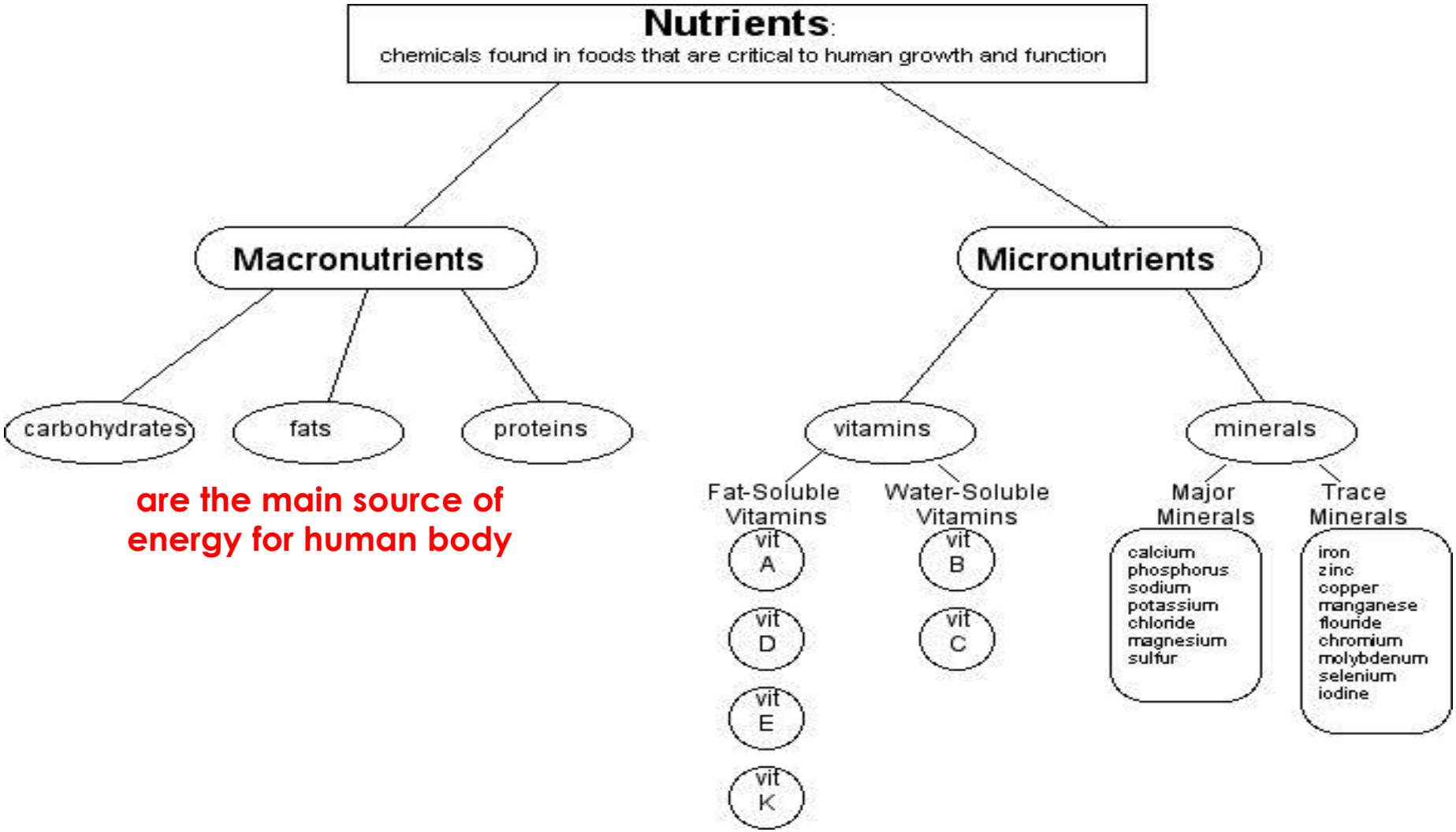
Food composition




Nutrition
Calories
Non-Calories
Carbohydrates
Fats
Protein
Water
Vitamins
Minerals
Simple Sugars
Complex Carbohydrates
Non Essential Amino Acids
Essential Amino Acids
Glucose
Fructose
Galactose
Lactose
Sucrose
Maltose
Starch
Cellulose
Glycogen
Saturated
Unsaturated
Monounsaturated
Polyunsaturated
Cholesterol
Omega 3
Omega 6
Histidine
Isoleucine
Leucine
Lycine
Methionine
Phenylalanine
Threonine
Tryptophan
Valine
Vitamin A
Vitamin C
Vitamin D
Vitamin E
Vitamin K
B complex Vitamins
Thiamine (B1)
Riboflavin (B2)
Niacin (B3)
Pantothenic Acid (B5)
Pyridoxine (B6)
Biotin (B7)
Folic Acid (B9)
Cyanocobalamin (B12)
Pangamic Acid (B15)
Choline
Inositol
PABA
Bioflavonoids (Vitamin P)
Calcium
Chlorine
Chromium
Cobalt
Copper
Fluorine
Iodine
Iron
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Sodium
Sulfur
Vanadium
Zinc

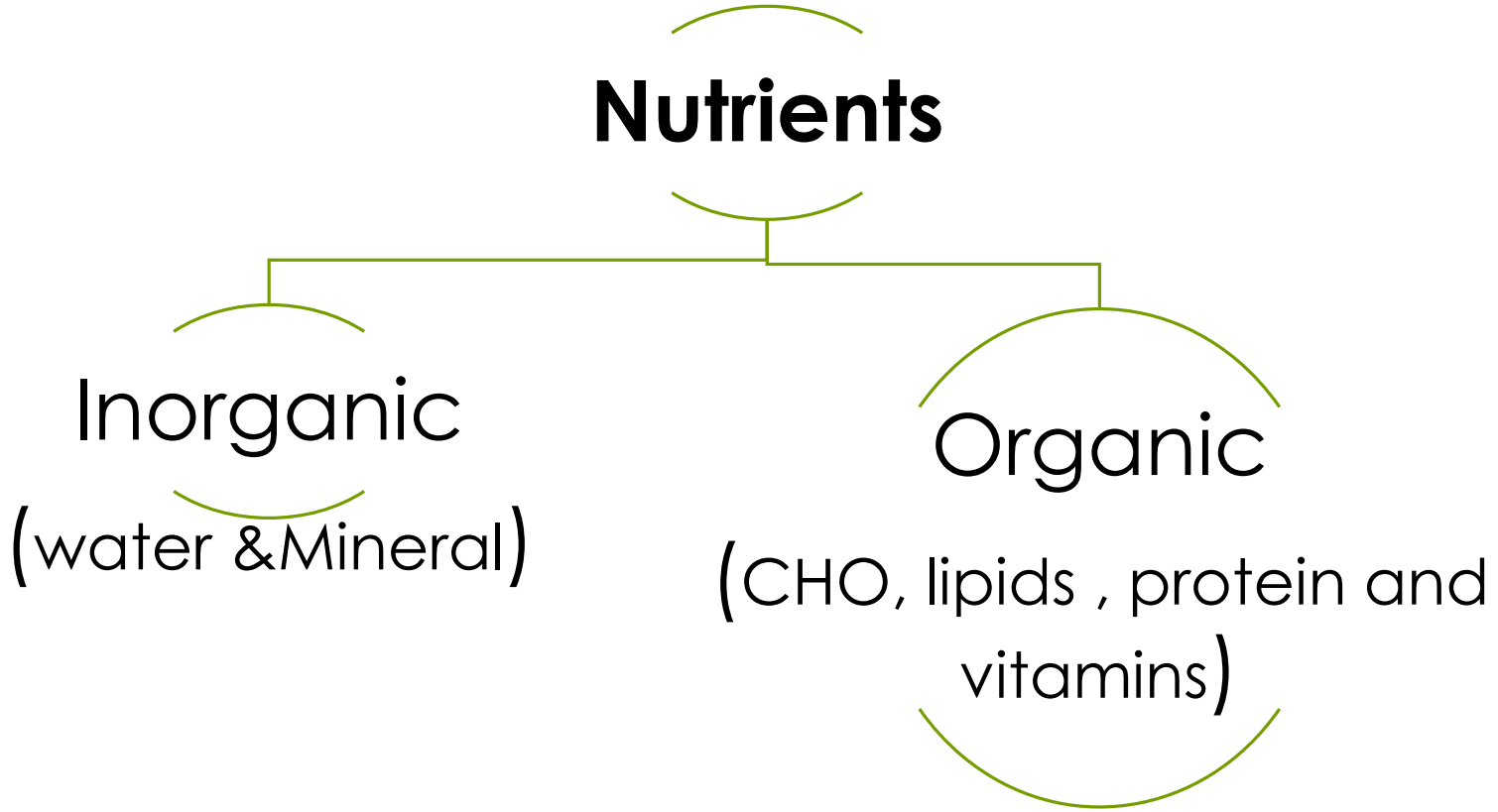
Nutrients

Chemical substances obtained from foods used in the body to provide energy, structure materials, regulating agents to support growth, maintenance, repair of body's tissues and may also reduce the risks of some diseases.



are the main source of energy for human body

Chemical composition of the nutrients



→**Organic nutrients**: substance that contain carbon atom.
→**Inorganic nutrients**: substances that do not contain carbon atoms.

Chemical components of foods

- ✓ **Carbohydrates** - composed of C, H, O.
- ✓ **Proteins** - composed of C, H, O and N.
- ✓ **Lipids** - composed of C, H, O. Are not soluble in water.
- ✓ **Minerals**
  - **Macro-minerals** - the minerals that are required >1.0 g per day in the body
  - **Micro-minerals**- the minerals that are required <1.0 g per day in the body.
- ✓ **Moisture** - Its the water.
- ✓ **Vitamins**
  - **Water-soluble vitamins -** are B complex vitamins and vitamin C.
  - **Fat-soluble vitamins** - are ADE and K.

Food structure and rheology











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Nutrition assessment of individual

Evaluation of person's nutrition

1- Historical information (socioeconomic status, drug use, diet and person's family history).

2-A=Anthropometric data (height and weight).

3- B= biochemical data (Laboratory tests).

4-C=clinical assessment(Physical examinations)

5-D=Dietary assessment

Functions of food nutrients

1-Provide energy sources

2-Build tissues

3-Regulate metabolic process

1-Provide energy sources

- The major carbohydrates in the human diet are starch, sucrose, fructose and glucose.
- Dietary carbohydrate (starches and sugars) provided the body's primary source of fuel for energy.
- Oxidation of carbohydrates to CO_2 and H_2O in the body produces approximately 4 kcal/g.
- They also maintain the back-up store of quick energy as glycogen (animal starch).

2-Build tissues

- ✓ Proteins are composed of amino acids that are joined to form linear chains.
- ✓ The digestive process breaks down proteins to their constituent to amino acids, which enter the blood.
- ✓ The primary function of protein is tissue building and repairing body tissues.
- ✓ Dietary protein provides amino acids, amino acids are the building unit necessary for construction and repairing body tissues.
- ✓ Muscle protein is essential for body movement.
- ✓ Other proteins serve as enzymes.
- ✓ Other nutrients such as minerals and vitamins used in tissue building and maintaining tissue.

- Minerals are also found in the fluids of the body and influence their properties.

- There are 13 different vitamins, one vitamin enables the eyes to see in dim light,
  protect the lungs from air pollution
  make the sex hormones,
  stop the bleeding,
  helps repair the skin,
  replace old blood cells and lining of the digestive tract.

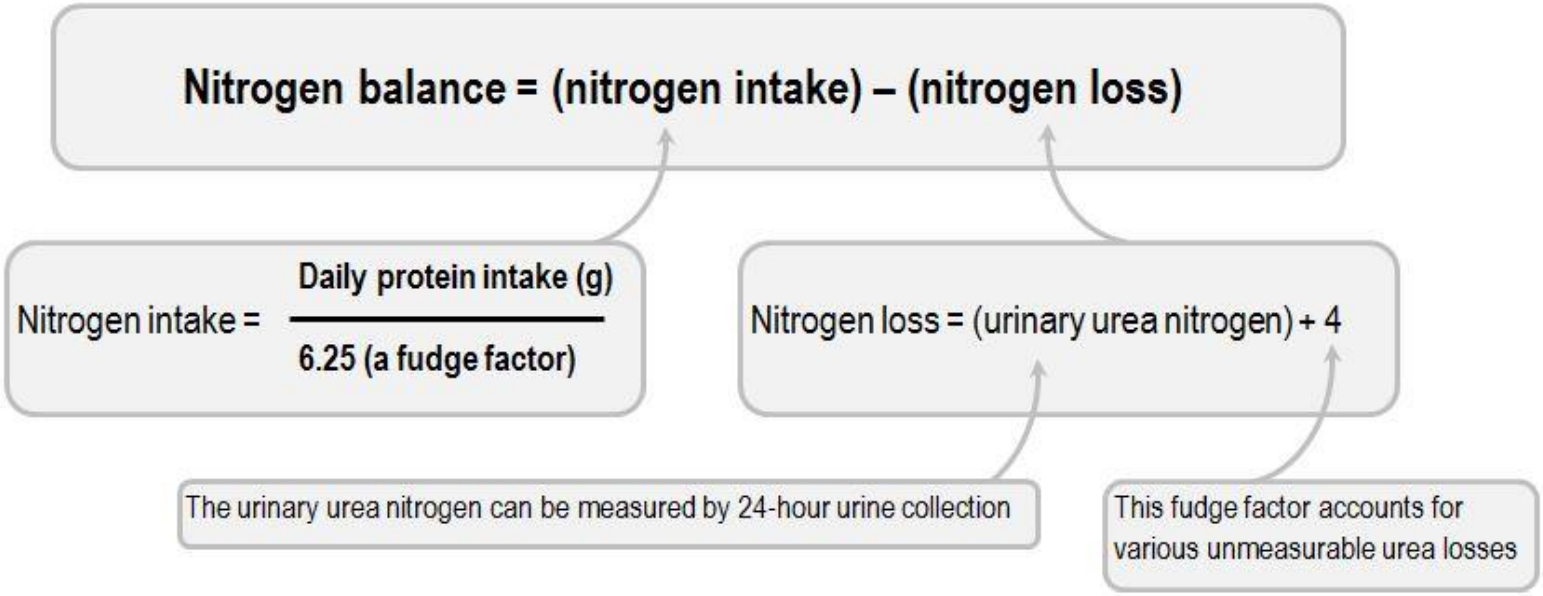
3-Regulate metabolic process

- ✓ Many vitamins and minerals function as coenzymes factors in cell metabolism.
- ✓ Other nutrients (water and fibers), water provides the environment in which nearly all the body's activities.
- ✓ Also, in many metabolic reactions and supplies the medium for transporting vital materials to cells and waste products away from them.
- ✓ Dietary fibers help regulate the passage of food material through the gastrointestinal tract and influences absorption of various nutrients.

Nitrogen balance in the body

The proteins in the body undergo constant turnover (degraded to amino acids and resynthesized).

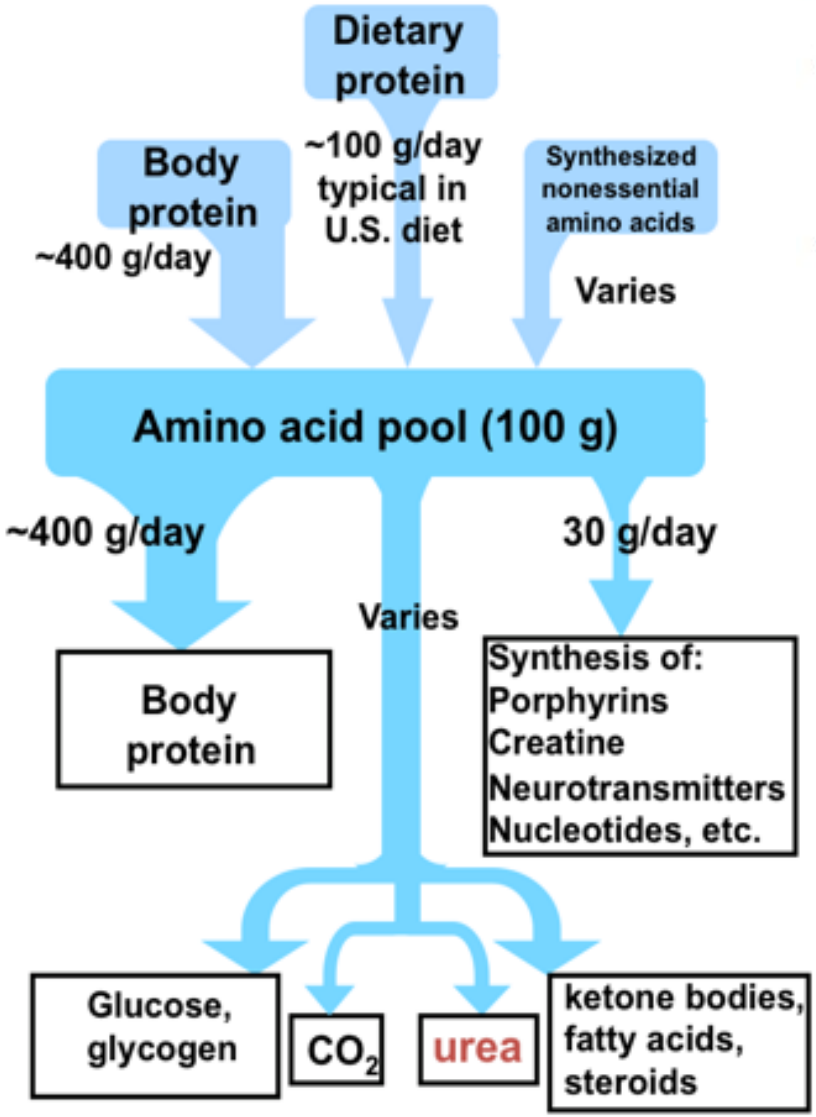
Nitrogen balance is the difference between the amount of nitrogen taken into the body each day and the amount of nitrogen in compounds lost.



- **if**: **1-** More nitrogen is ingested than excreted, a person is said to be in **positive nitrogen balance** (growing individual such as children and pregnant).
- **2-** Less nitrogen is ingested than is excreted (**negative nitrogen balance**, person eating either too little protein or protein is deficient in one or more of the essential amino acids, new protein cannot be synthesized and the unused amino acids will be degraded, body function will be impaired by the net loss of critical proteins.
- **3-** In contrast, healthy adults are in **nitrogen balance** and the amount of nitrogen consumed in the diet equals its loss in urine.

Nitrogen balance in the body

Nitrogen balance ~= nitrogen intake – nitrogen loss

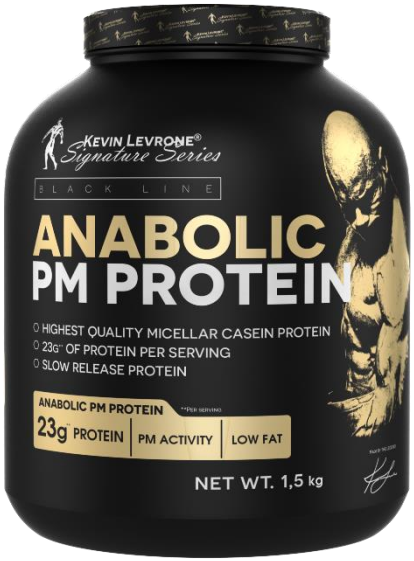


"0" Nitrogen in = Nitrogen out

"+" Nitrogen in > Nitrogen out
anabolic
e.g. growth

"-" Nitrogen in < Nitrogen out
catabolic
e.g. infection, severe trauma, wound healing

deficit of one or more essential amino acid



Sign of good nutrition

1. Well-developed body.
2. Ideal weight.
3. Good muscle development.
4. The skin is smooth and clear
5. The hair glossy and the eyes clear and bright.
6. Appetite, digestion and elimination are normal.
7. Have good resistance to infection.

Energy from food

- The amount of energy a food provide depends on how much CHO, fat, and protein contains.
- When completely broken down in the body :

1 g carbohydrates → 4 kcal of energy

1 g protein → 4 kcal of energy

1 g of fat → 9 kcal of energy

➔therefore fat has the greater energy density than either CHO or protein.

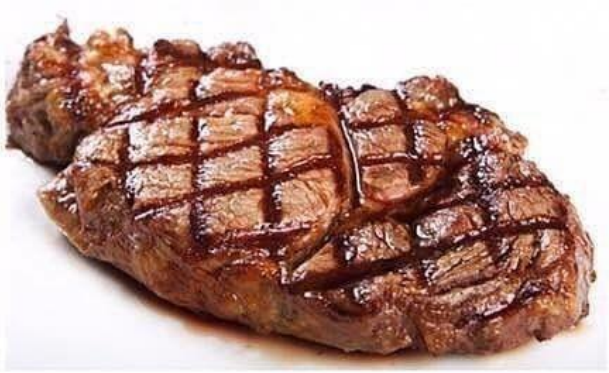
Calories

- The energy released from carbohydrates, proteins and fats can be measured in calories.
- A calorie is the amount of heat necessary to raise temperature of 1 gm of water by 1 C.
- 1000-calorie metric units are known as kilocalories (kcal).

Empty-kcalorie foods

a popular term used to denote foods contribute energy (from sugars, fat or both) but lack in protein, vitamins and minerals Example:(potato chips and candies).

Did You Know?



100 calories of steak

=

8g of protein

7.4g of fat

100 calories of broccoli

=

11g of protein

0.4g of fat

OUTLINES

1. Introduction to Nutritional Chemistry.
2. The Elements of Life.
3. Food Composition.
4. Functions of food nutrients
5. **10 “SMART” Healthy Eating Goals.**

10 “SMART” Healthy Eating Goals

Setting “SMART” healthy eating goals is a great way to make positive changes.

“SMART” stands for goals that are:

- **S**pecific
- **M**easurable
- **A**ction-oriented
- **R**ealistic
- **T**ime-framed

Use these 10 "SMART" goals below to get you inspired.

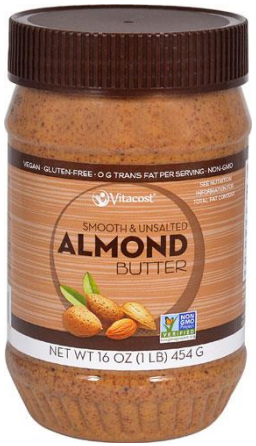
10 "SMART" Healthy Eating Goals

1. Do you skip breakfast? Try this goal:

Every day this week, I will eat breakfast that has a variety of:

- ✓ **whole grains,**
- ✓ **protein**
- ✓ **fruits**
- ✓ **vegetables**

- ❖ *a whole grain bagel with almond butter and apple slices,*
- ❖ *a breakfast burrito*
- ❖ *muesli or oatmeal topped with fruit and nuts.*



10 “SMART” Healthy Eating Goals

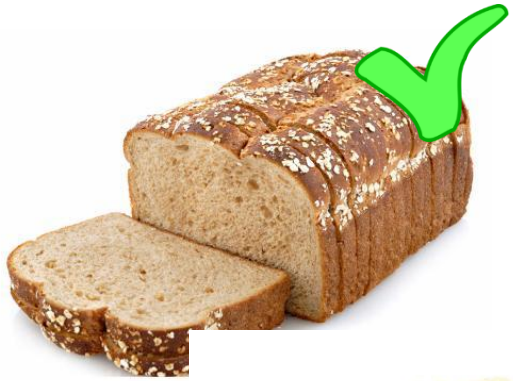
2. Are you trying to eat more fibre? Try this goal:

I will eat at least once this week:

- ✓ **brown rice,**
- ✓ **whole wheat pasta**
- ✓ **whole wheat bread**

instead of

- white rice
- white pasta
- white bread



10 "SMART" Healthy Eating Goals

3. Are you trying to eat more vegetables? Try this goal:

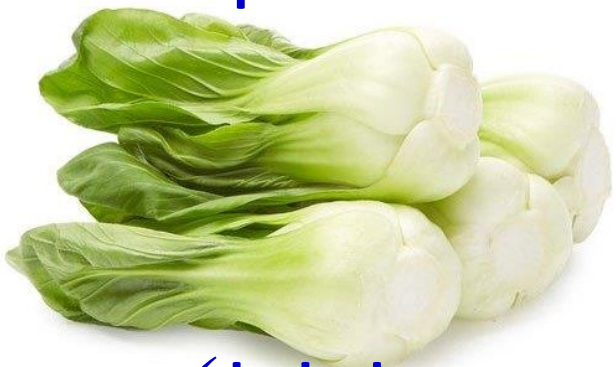
I will try a new recipe that uses a different kind of leafy green vegetable this week:

✓kale

✓ spinach

✓ Romaine lettuce

✓ Collards



✓ bok choy

✓ Swiss chard

10 “SMART” Healthy Eating Goals

4. Are you trying to cook and eat at home more? Try this goal:

I will cook a meal from scratch for dinner this week.
I will do this on Friday.

10 "SMART" Healthy Eating Goals

5. Interested in cooking a "meatless meal" with beans or plant-based protein more often? Try this goal:

This weekend I will find and try a new recipe using beans, lentils or tofu.

✓ kidney beans

✓ navy beans

✓ tofu

✓ pinto beans

✓ lentils

Tofu *– is bean curd, is a food prepared by coagulating soy milk and then pressing the resulting curds into solid white blocks of varying softness*

10 “SMART” Healthy Eating Goals

6. Trying to eat out less often? Try this goal:

I will pack my lunch from home 3 days this week instead of eating at a restaurant.

10 “SMART” Healthy Eating Goals

7. Want to be more organized with meal prep? Try this goal:

I will spend an hour on Sunday planning meals for the week and preparing ingredients.

10 “SMART” Healthy Eating Goals

8. Trying to eat healthier snacks? Try this goal:

I will have a piece of fruit (banana, apple, orange) or a handful of nuts (almonds, walnuts) instead of having cookies or candies as a snack during the week.






10 “SMART” Healthy Eating Goals

9. Want to make healthier meals at home? Try this goal:

I will use less fat when cooking
(like bake, broil, steam and stir-fry) this week.

10 “SMART” Healthy Eating Goals

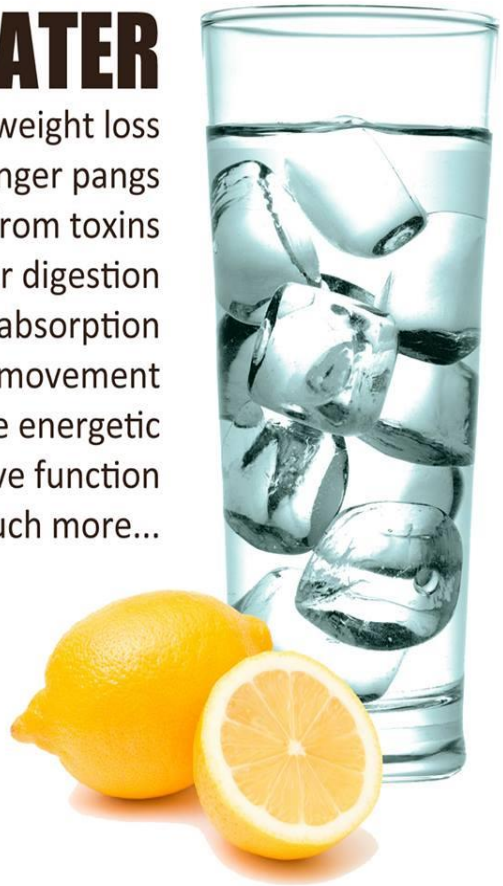
10. Want to make healthier drink choices? Try this goal:

I will choose water instead of soda at meals.

10 cubes
(1 cube = 4g sugar)

DRINKING WATER

Helps with weight loss
Stops hunger pangs
Purifies body from toxins
Better digestion
Better nutrient absorption
Healthy bowel movement
Makes you feel more energetic
Raises cognitive function
and much more...



SUGARY DRINKS

Trigger weight gain
Raise blood sugar
Higher risk of heart disease
Raise cholesterol
Raise inflammation
and much more...

You wouldn't eat 16 teaspoons of sugar - so why drink it?

600ml cola	500ml iced tea	600ml sports drink	250ml energy drink	600ml lemon squash	1100ml slushy
16	8	9	7	16	25
teaspoons sugar per bottle	teaspoons sugar per bottle	teaspoons sugar per bottle	teaspoons sugar per can	teaspoons sugar per bottle	teaspoons sugar per cup

10x HAPPY
Increase Serotonin

source: authenticdiscovery.com.au
rawforbeauty.com

Cayenne Peppers
relieves depression

Green Smoothie
energy boost, zap!

Walnuts – Omega 3
brain nutrients

Leaf Greens
boost energy

Epsom salt
calming

Almonds – Magnesium
brain food

Water Hydration
more energy less stress

Smiling releases
happy hormones

Spend time
in nature

Walking – clears mind
boosts serotonin

15 Foods For A Better Mood

http://adrianlupsa.wordpress.com/

EGGS

APPLES

BRUSSEL SPROUTS

WALNUTS

BANANAS

OATS

PEARS

SALMON

STRAWBERRIES

ORANGES

SPINACH

SWEET POTATOES

MILK

DARK CHOCOLATE

TURKEY

Thank you for attention !