

Disorders of Nutrition Nutrition in Dentistry

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2023/2024

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Nutrition

- Provision of energy to organism (in the form of chemical energy)
 - 1 kcal - 4,186 kJ

nutrient	kJ/g
proteins	17,2
lipids	38,9
saccharides	17,2

- Provision of organic and anorganic substances for the body development

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Energy expenditure

- Basal metabolism - basal metabolic rate
 - energy expended daily at rest (transport mechanisms, biosynthesis, thermoregulation, functioning of the vital organs)
 - 5 900 - 8 400 kJ/day

organ	% of BMR
liver	26%
brain	18%
heart	9%

- Metabolism during physical activity

activity	kJ/h
watching TV	250
cleaning	1090
cleaning of the windows	1130
sex	1600
swimming	2800
running	3750

- Thermogenesis

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Necessary food components

- saccharides
- lipids
- proteins

- vitamins
- minerals - Na, K, Ca, Cl, Mg, P
- trace elements - Fe, Zn, Cr, Cu ...
- fibre
- water

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Optimal nutrition

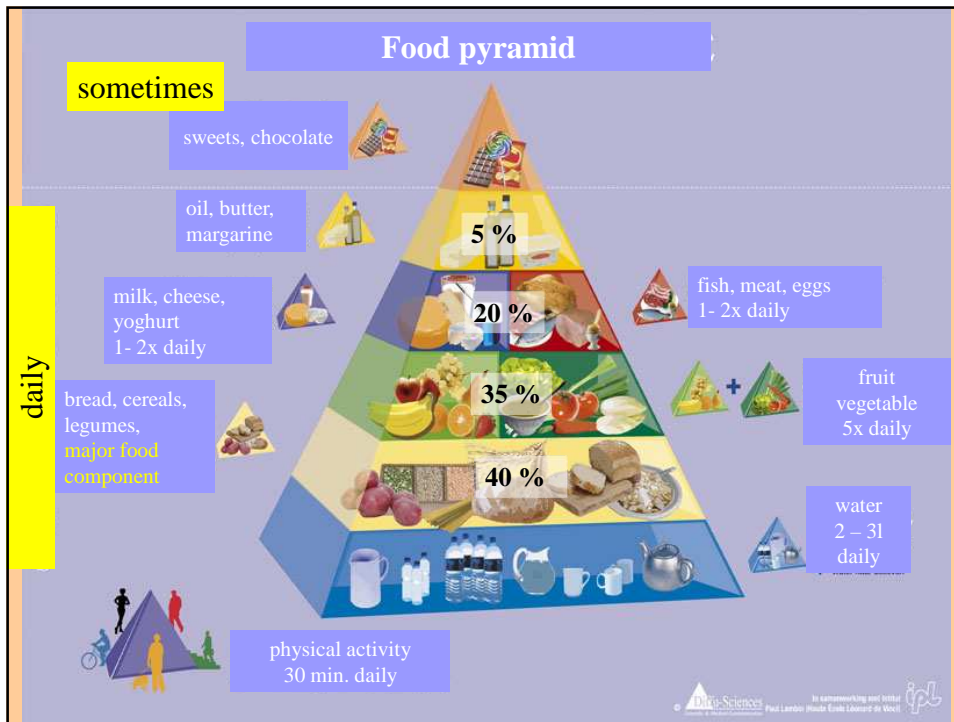
- Optimal energy intake
 - Depends on age, gender, lifestyle (intensity of physical activity at work, at home, in free time), health state (body size, healthy vs. acute/chronic disease, reconvalescence...) other factors (intensive growth period, pregnancy, lactation, climate...)
- Optimal basic nutrients ratio - proteins, lipids (↑ PUFA, ↓ cholesterol), carbohydrates
- Optimal intake of fibre (25-35 g/day)
- Optimal intake of vitamins and minerals (3-5 portions of fruits a 3-5 portions of vegetable/day)
- Lower intake of salt (3 - 5g/day)

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Recomended energy intake

- 55 - 60 % - saccharides
- max. 30 % - lipids
 - cca 10 % - saturated fatty acids
 - cca 10 % - monounsaturated fatty acids
 - cca 10 % - polyunsaturated fatty acids
(n-6 and n-3 polyunsaturated FA)
 - lower than 300 mg/day - cholesterol
- 10 - 15 % - proteins

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Disorders of nutrition



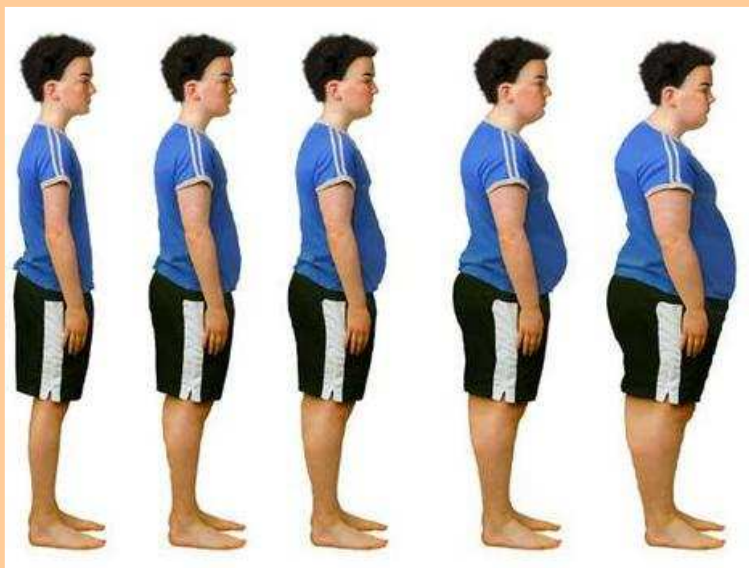
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Inadequate nutrition

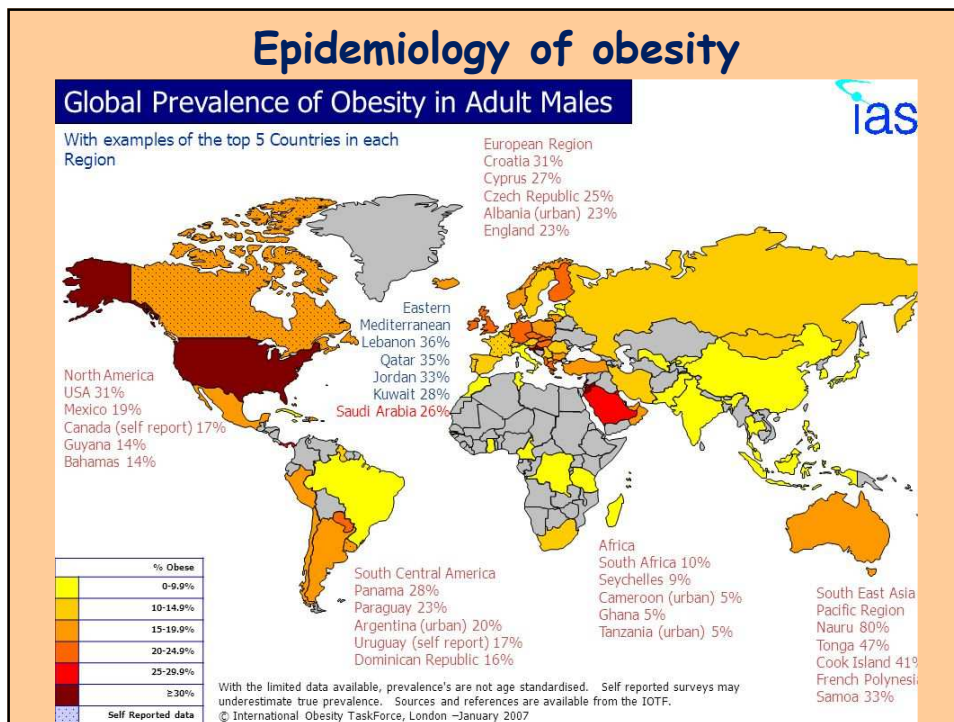
- **Overnutrition**
 - obesity (adiposity)
 - vitamin excess
- **Undernutrition**
 - quantitative - starvation
 - chronic undernutrition
 - qualitative - kwashiorkor
 - vitamin deficiency
 - trace elements deficiency

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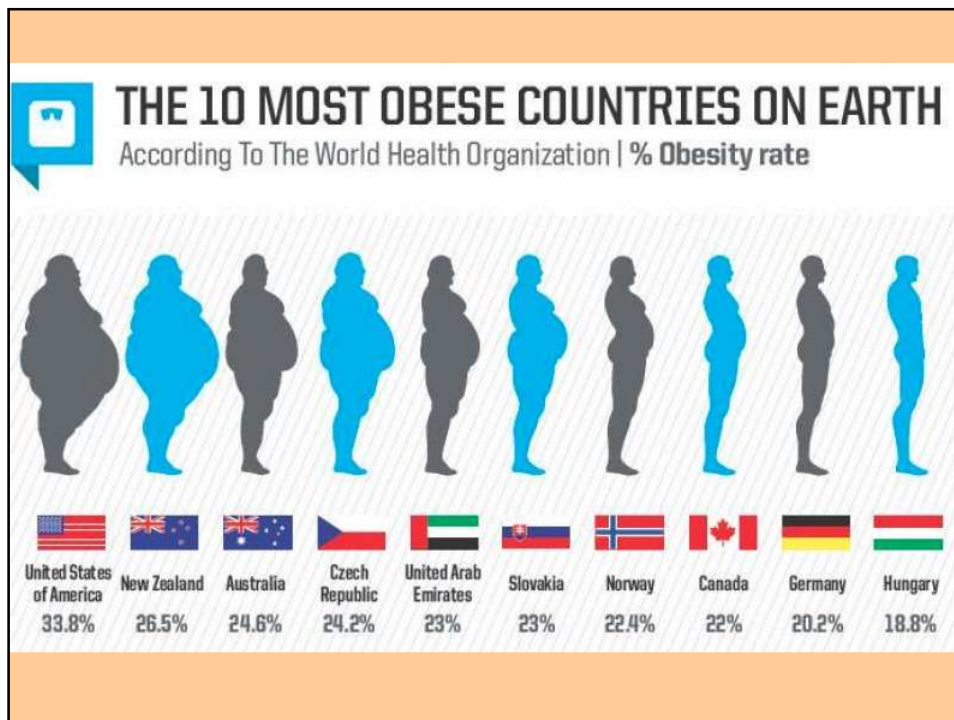
Obesity



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Definition

Obesity (adiposis, fatness) is a complex, multifactorial metabolic disorder defined as an excess of fat mass with an impact on health.



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Definitions

- **Obesity (adiposity, fatness):** accumulation of fat tissue



- **Overweight:** weight increased above the normal values

(BMI increased - fat, but also muscles, water, baby...)



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Etiology of obesity

1. Disequilibrium between energy intake and expenditure

- High calorie diet

- WHO - average energy intake
 - 1963 - 9660 kJ
 - 1971 - 10 250 kJ
 - 1992 - 11 420 kJ
 - 2010 - 12 200 kJ

- Sedentary lifestyle

2. Obesogens

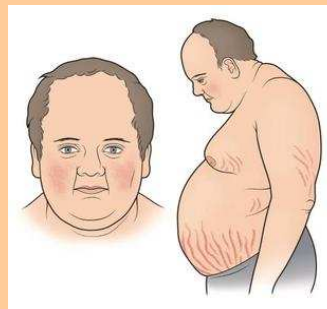
- chemical compounds that have effect to lipid metabolism and accumulation, and can lead to obesity
 - drugs (steroids [glucocorticoids], antidiabetics, antidepressants, antiepileptics, antihistamines, contraceptives)
 - substances occurring naturally in certain foods (e.g. phytoestrogens such as genistein found in soya)
 - substances added to foods (glucose-fructose syrup),
 - substances released into foods from plastics (phthalates),
 - pesticides (e.g. tributyltin)

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Etiology

3. Endocrine diseases (rare)

- Cushing's syndrome,
- hypothyroidism,
- hypogonadism,
- growth hormone deficiency,
- insulinoma



Cushing's syndrome

4. Hypothalamic obesity (rare in humans)

- weight gain after hypothalamic damage

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Etiology

5. Other factors

- Easy availability of food
- Social, economic, cultural, psychical factors
- Ethnicity

Race and obesity in USA (2002 - 2007)				
	White	Black	Hispanic	Asian
Average BMI	27	28.6	27.6	24
% of obese	24.5	36	28.6	7

- Eating disorders - binge eating, night binge eating
- Stress
- Virus infection - adenoviruses (by affecting adipocyte growth and differentiation, glucose uptake by cells, and inhibiting leptin production by adipose tissue)
- Sleep deprivation (reduction of leptin production and increase of ghrelin and orexin levels, leading to appetite stimulation, increased food intake, and subsequent obesity).

6. Inherited obesity ???

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Genetics of obesity

I can't blame myself for being fat. I's FTO gene.



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Monogenic obesity

- Obesity caused by single gene mutation
- Extremely rare
- Mutations of genes of the leptin/melanocortin axis → abnormality in food intake regulation
- Severe obesity, early onset

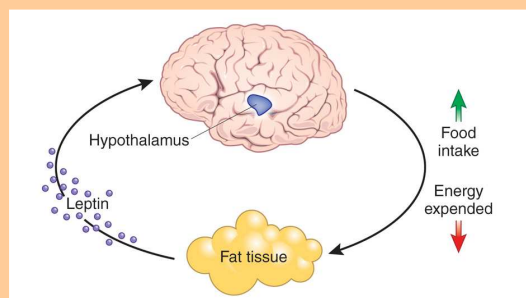
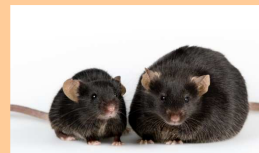
Examples

- Mutation of leptin gene
- Mutation of leptin receptor gene
- Mutation of proopiomelanocortin gene
- Mutation of proconvertase 1 gene
- ...

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Leptin

- Hormon produced mainly by white adipose tissue
 - Encoded by the *Ob(Lep)* gene on ch7
 - Receptor *LEP-R* located mainly in hypothalamus
- Leptin is produced by adipose tissue (much adipose tissue - much leptin) → binding to receptors in hypothalamus → inhibits hunger and increases basal metabolism and spontaneous physical activity → reduction of adipose tissue



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Syndromic obesity

- Obesity associated with genetic syndromes
- Very rare
- Severe obesity associated with additional phenotypes (mental retardation, dysmorphic features, organ abnormalities...)

Examples

- Prader-Willi syndrome
- Bardet-Biedl syndrome
- Cohen syndrome
- Alström syndrome
- Fragile X syndrome
- Down sy, Turner sy, Klinefelter sy, achondroplasia... - ↑ tendency to obesity
- ... other more than 100 syndromes

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Prader-Willi syndrome

- Genetic disease that affects hypothalamic-pituitary axis

Causes

- > 75% - deletion of long arm of paternal chromosome 15
- < 25% - uniparental disomia of maternal ch15, defect of imprinting

Signs

- Obesity
- Hypotonia
- Hypogonadism
- Mild intellectual disability
- Prominent nasal bridge, small hands and feet with tapering of fingers, soft skin, which is easily bruised, thin upper lip, downturned mouth



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Bardet-Biedl syndrome

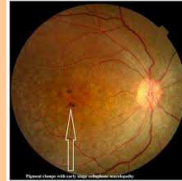
- Genetic disease that affects many organ systems
- Frequency 1:150 000

Causes

- AR inherited mutation of one from BBS genes (14 genes)
- Damage of structure or function of cilia

Signs

- Obesity + insulin resistance, hypertension, hypercholesterolemia
- Retinitis pigmentosa - night blindness, loss of vision, strabismus, cataract
- Polydactyly - sometimes brachydactyly, syndactyly
- Hypogonadism + renal failure, defects of urinary tract



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Genetics of common obesity

- Polygenic - genetic predisposition + environmental factors
- Majority of obesity

Examples of candidate genes

- FTO gene
- MC4R, TMEM18, KCTD15and many many other

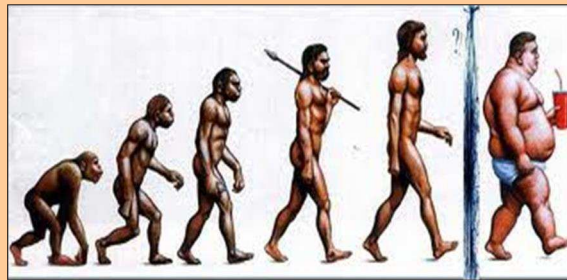
FTO gene

- Fat mass and obesity-associated gene - chromosome 16
- Protein alpha-ketoglutarate-dependent dioxygenase
- Function in regulation of food intake - satiety, appetite, overeating
- Increased risk of obesity - heterozygotes weigh on average 1.2 kilograms more than people with no copies, homozygotes weigh 3 kilograms more
- Increased risk of diabetes mellitus type 2, metabolic syndrome, dyslipidemia, Alzheimer's disease

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Thrifty gene hypothesis

- The **thrifty gene hypothesis** - connections between low quality fetal and infant growth followed by diabetes mellitus type 2 and metabolic syndrome caused by poor nutrition during early childhood, produces permanent effects in glucose-insulin metabolism.
- Genes which predispose to diabetes (called 'thrifty genes') were historically advantageous, but they became detrimental in the modern world. Thrifty genes are genes which enable individuals to efficiently collect and process food to deposit fat during periods of food abundance.



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Classification of obesity



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Classification of obesity

(according to localization of subcutaneous adipose tissue)



Abdominal obesity

- Belly fat, central obesity, android obesity, apple type, men type
- Much frequent visceral obesity

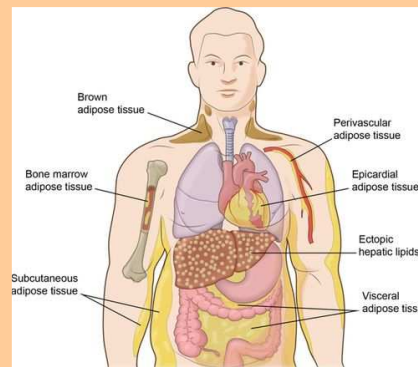
Gynoid obesity

- Lower body obesity, gluteal-femoral obesity, pear type, female type

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Adipose tissue

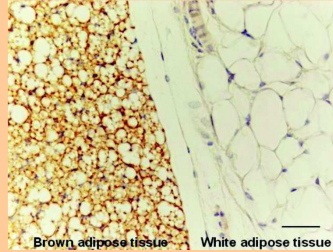
- Fat tissue, type of connective tissue
- **Structure**
 - Adipocytes, vascular endothelial cells, fibroblasts, adipocyte progenitors, leukocytes, macrophages
- **Localisation**
 - Subcutaneous - 80 % (abdominal, gluteo-femoral)
 - Between muscular fibres
 - Visceral - around the digestive organs (mesenteric and omental) and the retroperitoneal depot (kidney)
 - In bone marrow



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Adipose tissue

- Types of adipose tissue
 - White adipose tissue
 - Brown adipose tissue
 - Beige adipose tissue



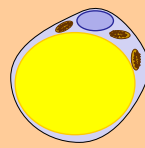
- Function
 - Energy storage
 - Body insulation
 - Thermoregulation
 - Endocrine function - production of adipokines and cytokins →
 - Insulin resistance and diabetes mellitus
 - Metabolic syndrome
 - Chronic inflammation
 - Cancers

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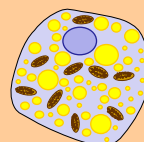
Types of adipose tissue

White

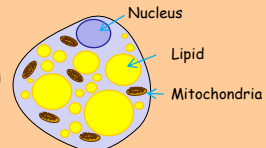
- Function
 - Fat storage
- Location
 - Subcutaneous, visceral



White



Brown



Beige

Brown




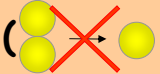
- Function
 - Thermogenesis
- Location
 - Newborn - interscapular, perirenal area
 - Adult - cervical, subclavicular, axillary, paravertebral, suprarenal areas

Beige

- Function
 - As brown adipose tissue
- Location
 - In subcutaneous white adipose tissue

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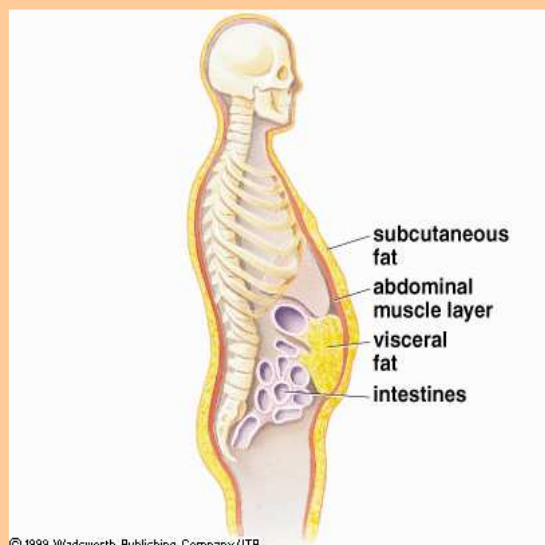
Growth of adipose tissue

- hypertrophy  ( possible)
- hyperplasia  ( impossible)

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Localisation of white adipose tissue

- Subcutaneous
- Visceral



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Visceral fat

- Intraabdominal white adipose tissue

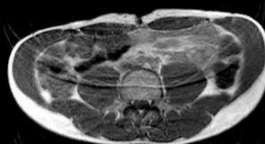
Amount of visceral fat and subcutaneous/visceral fat ratio depends on:

- Genetic predisposition
- Gender
 - Men in any age (testosterone)
 - Women after menopause
- Age
 - Older people
- Total amount of fat in organism
- Energy intake

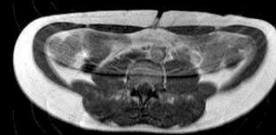
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Visceral fat

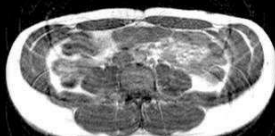
Variation in visceral fat content in men with the same waist circumference.



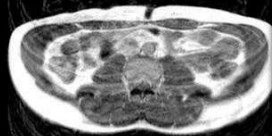
Visceral fat = 0.5 L



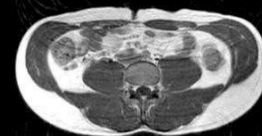
Visceral fat = 1.1 L



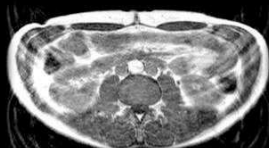
Visceral fat = 1.2 L



Visceral fat = 1.3 L



Visceral fat = 1.7 L



Visceral fat = 1.8 L



Visceral fat = 4.2 L



Visceral fat = 4.3 L

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„Metabolic obesity“

- Metabolically obese, normal-weight (MONW) people
 - Normal BMI, suffer from metabolic complications (diabetes mellitus type 2) found in obese people
- Metabolically healthy obese (MHO) people
 - BMI > 30 kg/m², without metabolic complications typical for obese people

The main risk factor of metabolic complications is **visceral fat**

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Why is visceral fat risky?

- Increased lipolytic activity - leads to hyperlipidemia
- Causes hyperinsulinemia and insulin resistance
- Produces hormones and cytokines

consequently

- Visceral fat is risk factor of:
 - Cardiovascular diseases
 - Diabetes mellitus type 2
 - Some cancers - cancer of endometrium, prostate...

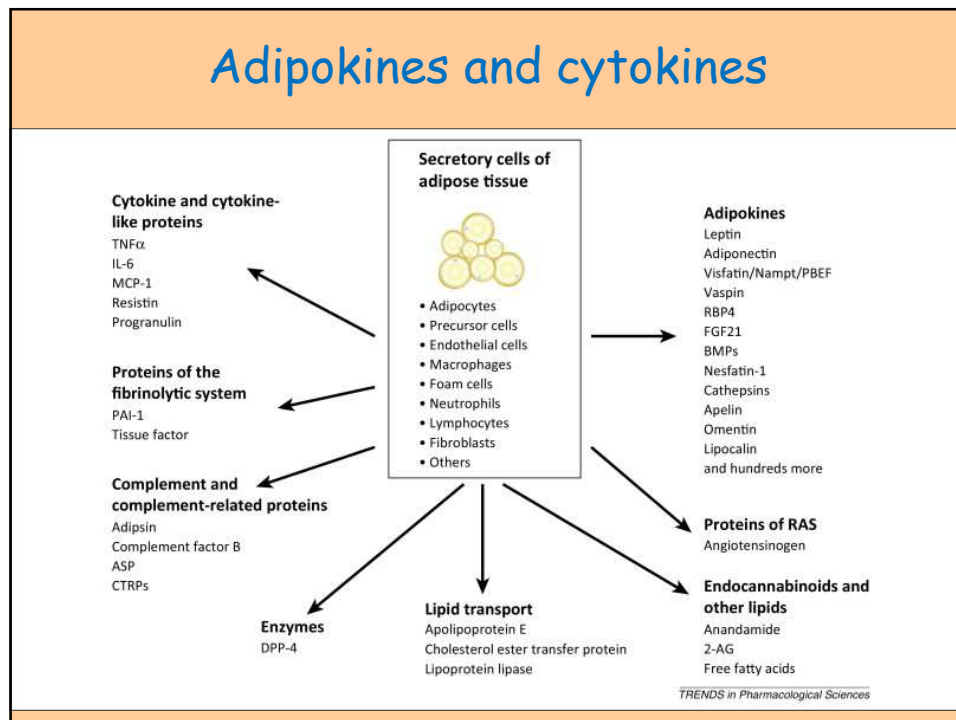
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Hormones produced by adipose tissue

- **Leptin**
 - regulation of adipose tissue mass through central hypothalamus mediated effects on hunger, food energy use, physical exercise and energy balance
 - contraregulation hormone is **ghrelin** („hunger hormone“), hormone produced by ghrelin cells in stomach when stomach is empty
- **Adiponektin**
 - regulates glycemia, and oxidation of fatty acids
 - enhances energy metabolism and fatty acid oxidation by activating peroxisome proliferator-activated receptor (PPAR γ)
 - promotes fatty acid combustion and promotes insulin sensitivity by activating AMP-activated protein kinase
 - decreased in obesity, type-2 diabetes, and coronary artery disease
 - increased in anorexia
- **Estrogens**
- **Angiotenzinogen** - promotes the development of hypertension in obese people (produced mainly in liver)

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Adipokines and cytokines



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Metabolic syndrome

metabolic syndrome X, syndrome X, insulin resistance syndrome, Reaven's syndrome

Metabolic syndrome is a combination of medical disorders that increase the risk of developing cardiovascular disease and diabetes. It affects one in five people, and prevalence increases with age.

Signs and symptoms

- Fasting hyperglycemia — diabetes mellitus type 2 or impaired fasting glucose, impaired glucose tolerance, or insulin resistance
- High blood pressure
- Central obesity
- Decreased HDL cholesterol
- Elevated triglycerides

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Metabolic syndrome

New classification - Berlin 2005

At least three of the following signs:

✦ **Abdominal obesity**
waist circumference
men > 94 cm
women > 80 cm

✦ **Elevated triglycerides**
TAG > 1,7 mmol/l

✦ **Reduced HDL-cholesterol**
men < 0,9 mmol/l
women < 1,1 mmol/l

✦ **Elevated blood pressure**
> 130/85 mmHg
or use of medication for hypertension

✦ **Elevated fasting glucose**
> 5,6 mmol/l
or use of medication for diabetes



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Measurement of obesity

- **Body mass index**

$$\text{BMI} = \frac{\text{mass in kg}}{(\text{height in m})^2}$$

Classification	BMI Category (kg/m ²)	Risk of Developing Health Problems
Underweight	< 18.5	Increased
Normal Weight	18.5 – 24.9	Least
Overweight	25.0 – 29.9	Increased
Obese		
Class I	30.0 – 34.9	High
Class II	35.0 – 39.9	Very High
Class III	≥ 40.0	Extremely High

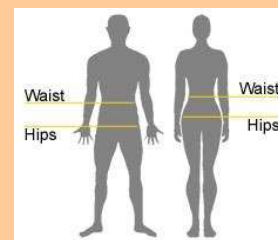
- **Brocc's index (old)**
Normal weight = height in cm - 100
Ideal weight = (height in cm - 100) - 10-15%
- **Skin fold**
(biceps, triceps, subscapular, suprailiacal...)
Fat: men 10 - 20% of body weight
women 20 - 30% of body weight



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Measurement of obesity

- **Waist to hip ratio (WHR)**
WHR > 1,0 in men is abdominal obesity
> 0,8 in women



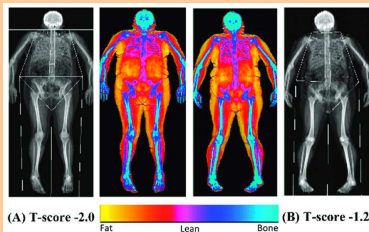
- **Waist circumference**
Men > 94 cm, women > 80 cm - increased risk
Men > 102 cm, women > 88 cm - very increased risk



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Other methods

- Bioelectric Impedance (BIA)
- Underwater Weighing (Densitometry)
- Air-Displacement Plethysmography
- Dilution Method (Hydrometry)
- Dual Energy X-ray Absorptiometry (DEXA)
- Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI)



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Complications of obesity

- Metabolic complications
 - Insulin resistance - hyperinsulinemia - DM type 2
 - dislipidemia
 - hyperuricemia...
- Endocrine diseases
 - hypogonadism
 - Hyposecretion of growth hormone...
- CVS diseases
 - hypertension
 - ICHS
 - arrhythmias
- Respiratory diseases
 - Pickwick syndrome
 - Sleep apnoea syndrome...
- GIT and liver
 - gastroezofageal reflux
 - cholelithiasis
 - pankreatitis
 - liver steatosis...
- Gynecologic complications
 - oligomenhorhea
 - complications during pregnancy...
- Oncologic complications
 - Colorectal ca...
- Psychosocial complications
 - social discrimination
 - depression
 - eating disorders
- Other

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Malnutrition



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Causes

- **exogenous**
 - inadequate intake of nutrients (starvation, loss of appetite, mental anorexia)
- **endogenous**
 - disorders of digestion
 - disorders of absorption
 - disorders of metabolism
 - increased nutrient requirements (hyperthyroidism, gravidity, lactation, convalescence...)
 - loss of body fluids (bleeding)
 - loss of proteins (nephrotic syndrome)

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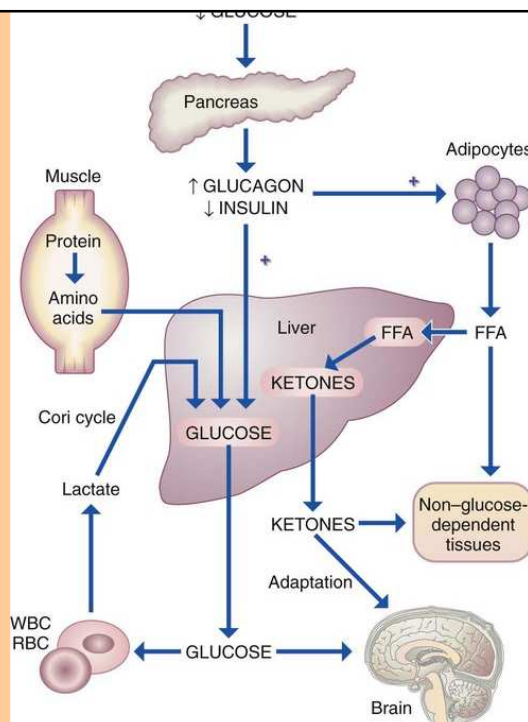
Higher risk of malnutrition



- poor people
- sucklings and children
- adolescents in period of accelerated growing
- old people
- people on radical diet
- vegetarians
- alcoholics a people on drugs
- patients with AIDS
- patients with chronic GIT, liver, kidney diseases

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Starvation



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Metabolic changes during starvation

The body mobilizes reserves

- The stores of glycogen are converted to glucose (12 - 24 h)
- Glucose is produced by gluconeogenic pathway in liver
- ↓ concentration of glucose
↓
- ↓ concentration of insulin, ↑ concentration of glucagon
↓
- ↑ lipolysis and β-oxidation of fatty acids
↓
- Hyperlipidaemia, ketoacidosis
- After using of fatty stores - catabolism of proteins

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Protein Energy Malnutrition PEM

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Marasmus

- inadequate intake of all nutrients
- cause: poorness, psychic disease, starvation...



Clinical signs

- in children: weight loss, muscle atrophy, weakness, fatigue, decreased immune function, anaemia, delayed wound healing
- in adults: cachexia

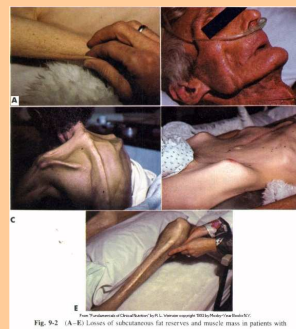
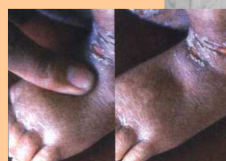


Fig. 9-2 (A-E) Losses of subcutaneous fat reserves and muscle mass in patients with marasmus.

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Kwashiorkor

- protein malnutrition (adequate energy supply - saccharides)
- signs: oedema, growth retardation, weight loss, skin and hair depigmentation, thin and sensitive skin, diarrhea, anaemia, apatia, muscle atrophy, immunodeficiency, low serum protein concentration



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Cachexia

- extreme thinness, extreme skinny
- Wasting syndrome



Causes

- Undernutrition (marasmus, anorexia...)
- Cancers
- AIDS
- Chronic diseases - COPD
- ...

Mechanisms

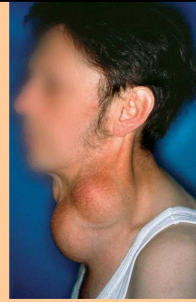
- Not fully understood
- Changes in metabolism (cytokines e.g. TNF)
- Changes in appetite regulation (leptin)

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Specific (qualitative) malnutrititions

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- protein deficiency - kwashiorkor
- iodine deficiency - endemic goiter
- vitamin A deficiency - xerostomia, xeroftalmia
- Fe, folic acid, vit. B₁₂ deficiency - anaemias
- vitamin D, Ca, Mg, P deficiency - osteopaties (rickets, osteomalacia, osteoporosis)
- thiamin deficiency - beri-beri
- riboflavin deficiency - oral cavity inflammation
- niacin deficiency - pelagra
- vitamin C - scurvy



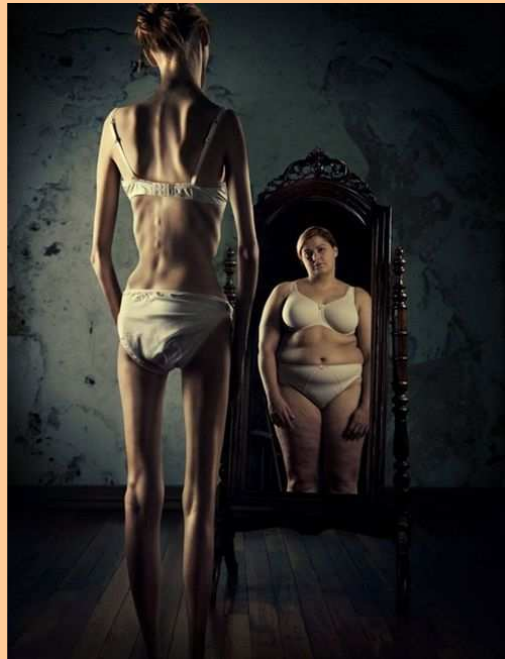
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Eating disorders



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Mental anorexia



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Anorexia (gr.) - lack of desire to eat

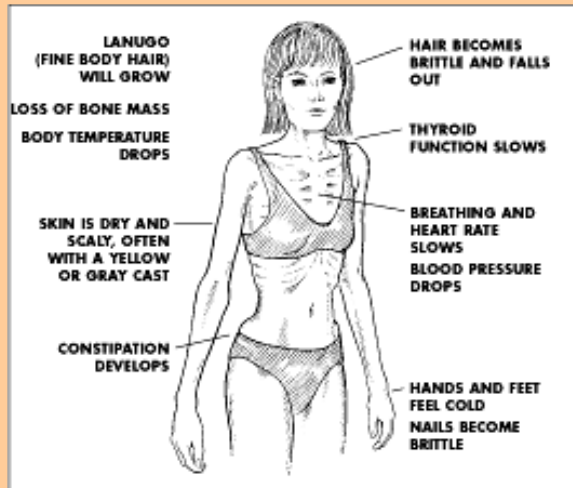
- Anorexia nervosa - eating disorder characterized by extreme weight control

Diagnostic criteria

- obsessive fear of gaining weight, control body weight through voluntary starvation, excessive exercise, diet pills...
- pathological fear of being obese
- amenorrhoea in women

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Symptoms



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Mental bulimia

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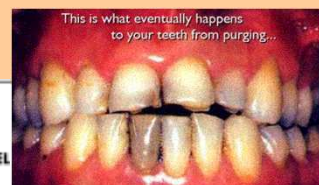
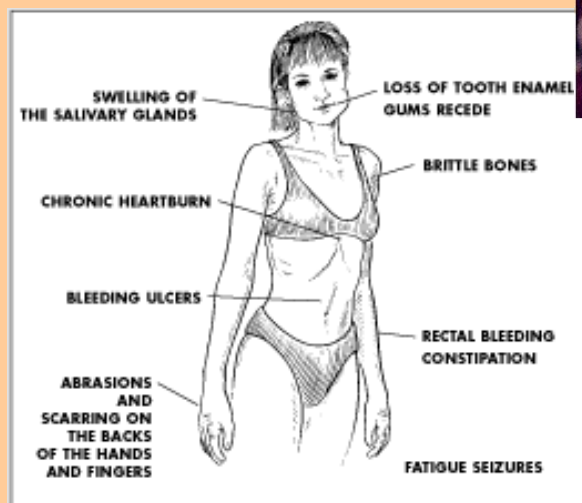
- Mental bulimia - eating disorder characterized by repeated episodes of overeating followed by exaggerated weight control

Diagnostic criteria

- strong desire to eat (big amount and strange combination)
- to avoid being fat - vomiting, laxatives abuse, diuretics abuse, episodes of starvation,
- pathological fear to be obese

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Symptoms



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Other eating disorders

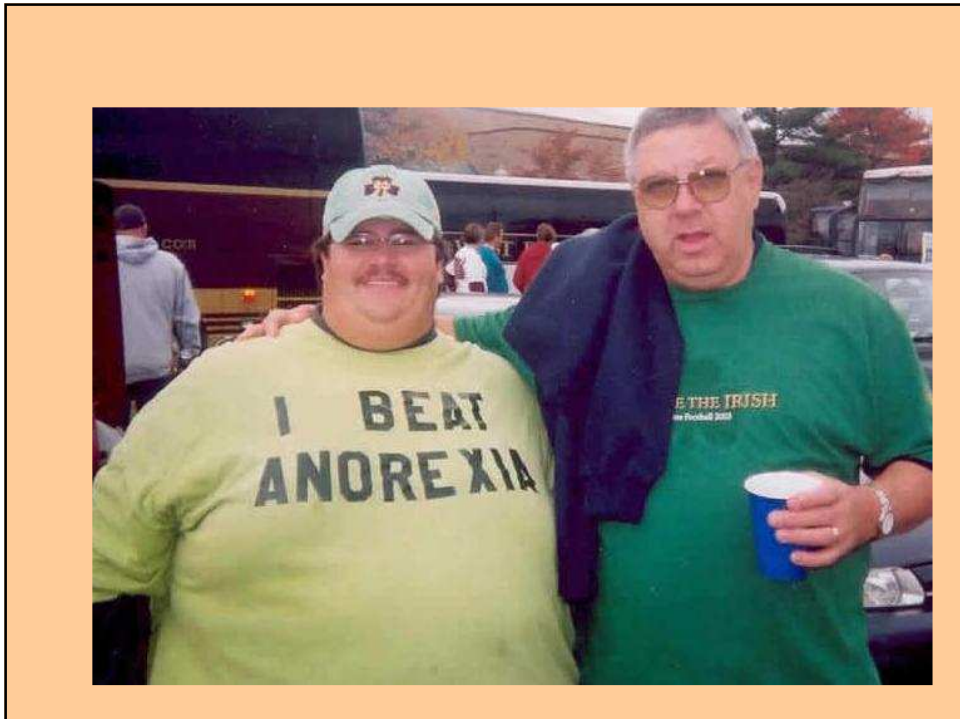
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Binge eating, an eating disorder with episodes of uncontrollable eating. During these episodes, a person rapidly consumes an excessive amount of food. They try to hide this behaviour from others, and often feel ashamed about being fat or depressed about their overeating. Eating binges can be followed by so-called compensatory behaviour: purging, fasting and heavy exercising.

Night eating syndrome, an eating disorder, parasomnia, characterized by a pattern of late-night binge eating.



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Nutrition in dentistry

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Eating disorders

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- **Erosion and damage of enamel** - caused by vomiting
- **Xerostomia** - dryness of oral mucous - vomiting, starvation, undernutrition, dehydration
- **Caries** - mainly teeth with damaged enamel (vomiting)
- **Gingivitis** - caused by dryness of mucous and undernutrition
- **Swollen parotid salivary glands** - bilateral painless swelling of parotid salivary glands caused by frequent vomiting
- **Degenerative arthritis of temporomandibular joint** - vomiting, undernutrition
- **Bleeding in oral cavity** - vit. C carency



The image contains four clinical photographs illustrating oral complications of eating disorders:

- Top left: Close-up of upper teeth showing significant enamel erosion and yellowish discoloration.
- Top right: Close-up of the tongue and oral mucosa showing dryness and redness, characteristic of xerostomia.
- Middle: Close-up of the lower teeth showing significant dental caries (tooth decay) and enamel damage.
- Bottom left: Frontal view of a person's face showing bilateral, painless swelling of the parotid salivary glands.
- Bottom right: Close-up of the lower teeth showing bleeding in the oral cavity.

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Vitamins

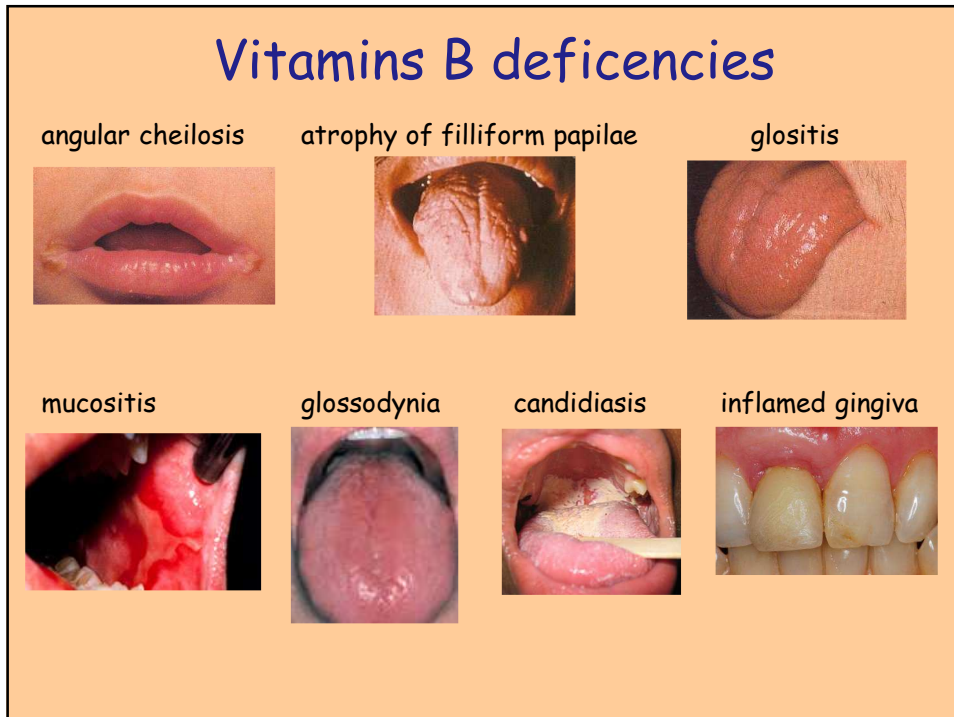
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Vitamin	Chemical name	Solub.	Deficiency disease	Overdose disease	Food sources
Vitamin A	Retinol, retinal, + carotenoids including beta carotene	Fat	Night-blindness Hyperkeratosis Keratomalacia	Abnormal softening of the skull bone Drowsiness Liver damage Skin and hair changes Vision changes ...	Liver, orange, ripe yellow fruits, leafy vegetables, carrots, pumpkin, squash, spinach, fish, soy milk, milk
Vitamin B ₁	Thiamine	Water	Beriberi Wernicke-Korsakoff syndrome		Pork, oatmeal, brown rice, vegetables, potatoes, liver, eggs
Vitamin B ₂	Riboflavin	Water	Ariboflavinosis Glossitis Angular stomatitis		Dairy products, bananas, popcorn, green beans, asparagus
Vitamin B ₃	Niacin, niacinamide	Water	Pellagra		Meat, fish, eggs, many vegetables, mushrooms, tree nuts
Vitamin B ₅	Pantothenic acid	Water	Paresthesia		Meat, broccoli, avocados
Vitamin B ₆	Pyridoxine, pyridoxamine, pyridoxal	Water	Anemia Peripheral neuropathy		Meat, vegetables, tree nuts, bananas

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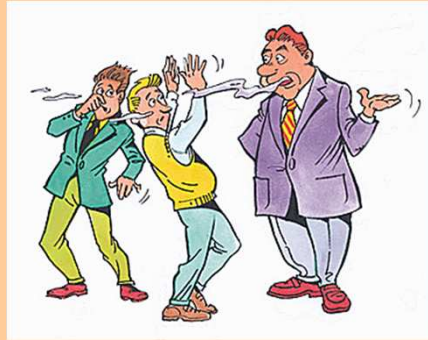
Vitamin	Chemical name	Solub.	Deficiency disease	Overdose disease	Food sources
Vitamin B ₇	Biotin	Water	Dermatitis enteritis		Raw egg yolk, liver, peanuts, leafy green vegetables
Vitamin B ₉	Folic acid folinic acid	Water	Megaloblastic anemia Birth defects	.	Leafy vegetables, pasta, bread, cereal, liver
Vitamin B ₁₂	Cyanocobalamin hydroxycobalamin methylcobalamin	Water	Megaloblastic anemia	Acne-like rash	Meat and other animal products
Vitamin C	Ascorbic acid	Water	Scurvy	Kidney stones	Many fruits and vegetables, liver
Vitamin D	Cholecalciferol (D3) Ergocalciferol (D2)	Fat	Rickets Osteomalacia	Irritability Constipation Muscle weakness Metastatic calcification of the soft tissues	Fish, eggs, liver, mushrooms
Vitamin E	Tocopherols tocotrienols	Fat	Sterility Abortions Mild hemolytic anemia in newborn infants	Increased congestive heart failure seen in one large randomized study	Many fruits and vegetables, nuts and seeds
Vitamin K	Phylloquinone menaquinones	Fat	Bleeding diathesis		Leafy green vegetables such as spinach, egg yolks, liver

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halitosis



xerostomia



aphtous ulcers



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Vitamin C

Oral signs and symptoms

- Deficiency: Scurvy - red swollen gingiva, gingival friability, periodontal destruction, increased tooth mobility and exfoliation, sore burning mouth, soft tissue ulceration, increased risk of candidiasis, malformed teeth (inadequate dentine)

Other symptoms

- Deficiency: fragility of vessel wall, impaired development of bones



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Vitamin A

Oral signs and symptoms

- Deficiency: impaired tissue healing and regeneration, desquamation of oral mucosa, keratosis, increases risk of candidiasis, gingival hypertrophy and inflammation, leukoplakia, decreased taste sensitivity, xerostomia, disturbed enamel development, increased caries risk
- Excess: impaired wound healing

Other symptoms

- Deficiency: night blindness, xerophthalmia, mucosa dryness
- Excess: hepatosplenomegalia, anaemia, hair loss

desquamation of oral mucosa



keratosis



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gingival hypertrophy and inflammation



leukoplakia



xerostomia



disturbed enamel development



caries



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Vitamin D

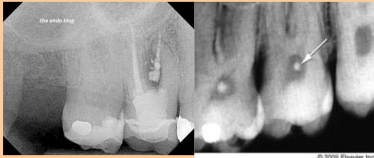
Oral signs and symptoms

- Deficiency: osteoporosis, osteomalacia, rickets, incomplete mineralisation of teeth
- Excess: pulp calcification, enamel hypoplasia

Other symptoms

- Deficiency: osteoporosis, osteomalacia, rickets
- Excess: Ca mobilisation from bones, kidney stones

pulp calcification



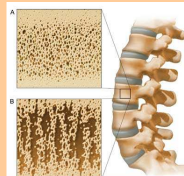
enamel hypoplasia



rickets



osteoporosis



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Vitamin K

- Phylloquinone, menaquinones
- Function - blood clotting

Oral signs and symptoms

- Deficiency: increased risk of bleeding



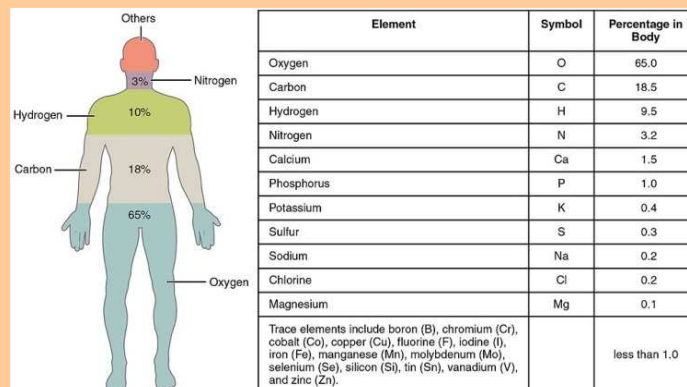
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Minerals

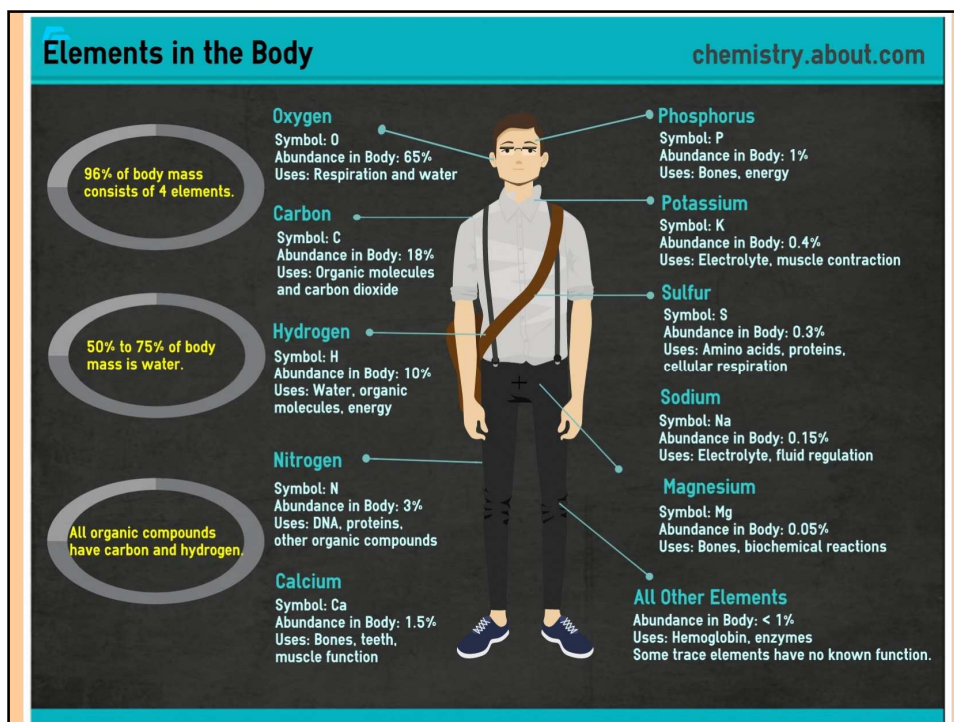
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Biogenic elements

Group		Elements
Basic elements		C, O, H, N, P, S
Electrolytes		Na, K, Ca, Mg, Cl
Trace elements	Metals	Fe, Cu, Zn, Sn, V, Cr, Mo, Mn, Co, Ni
	Nonmetals	I, F, S, Se, Si



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Iron

- Amount in human organism - 4 - 5g
- Daily intake - 10 - 15 mg
- Daily loss - 1 - 2 mg
- Heme complexes - hemoglobin, myoglobin, catalase, cytochromes
- Transport - transferrin
- Storage - ferritin
- Food sources: red meat, lentils, beans, poultry, fish, leaf vegetables, tofu...

Oral signs and symptoms

- Deficiency: angular cheilosis, pallor of lips and oral mucosa, sore, burning tongue, glossitis

Other symptoms

- Deficiency: microcytic anaemia
- Excess: hemochromatosis

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Calcium

- The most abundant mineral in the human body
- In the adult body - approximately 1 kg, 99% in the skeleton in the form of calcium phosphate salts.
- Plasma concentration - 2.5 mmol/l
- Functions:
 - bones, teeth structure
 - cellular signalization
 - coenzyme for clotting factors
 - activation of muscle contraction
- Food sources - milk, cheese, eggs, lentils, nuts...

Oral signs and symptoms

- Deficiency: incomplete mineralisation of teeth, rickets, osteomalacia, osteoporosis, bone fragility, increased tooth mobility and premature loss

Other symptoms

- Deficiency: rickets, osteomalacia, osteoporosis

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Zinc

- Function
 - \approx 300 enzymes
 - structural ion in transcription factors (Zinc fingers)
 - maturation of leucocytes
 - important for taste and olfactory receptors
 - important for insulin crystals structure
- Food sources - meat

Oral signs and symptoms

- Deficiency: loss of taste and tongue sensation, delayed wound healing, increased susceptibility to periodontal disease, candidiasis, xerostomia, caries

Other symptoms

- Deficiency: impaired immune function

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Fluoride

Source

- water fluoridation, products for oral hygiene

Oral signs and symptoms

- Deficiency: decreased resistance to caries
- Excess: enamel hypoplasia (fluorosis)



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Magnesium

Oral signs and symptoms

- Deficiency: alveolar bone fragility, gingival hypertrophy

Phosphorus

Oral signs and symptoms

- Deficiency: incomplete mineralisation of teeth, increased susceptibility to caries if deficient during tooth formation, increased susceptibility to periodontal disease

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Other nutrients

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Carbohydrate

Oral signs and symptoms

- Deficiency: decreased risk of caries
- Excess (except fibre): caries



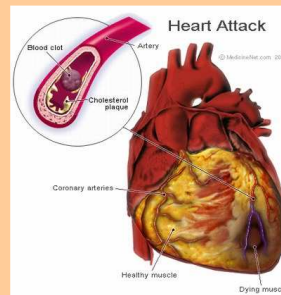
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Fats

Oral signs and symptoms

- Deficiency: angular cheilosis, pallor of lips and oral mucosa, sore burning tongue, atrophy of filiform papillae, increased risk of candidiasis, glossitis
- Excess: no effect

but



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Proteins

Oral signs and symptoms

- Deficiency: defect of tooth composition, eruption pattern, resistance to decay, increased susceptibility to soft tissue infraction, poor tissue healing and regeneration
- Excess: no effect

Water

Oral signs and symptoms

- Deficiency: dehydration and fragility of epithelial tissue, decreased muscle strength for chewing, xerostomia, burning tongue

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