

# PRINCIPALS OF RECOMMENDED NUTRITION

- Quantitative aspect
- Qualitative aspect
- **Special components of diet**
- Aesthetic aspect
- Socio-economic aspect

# WATER, VITAMINS, MINERALS IN NUTRITION

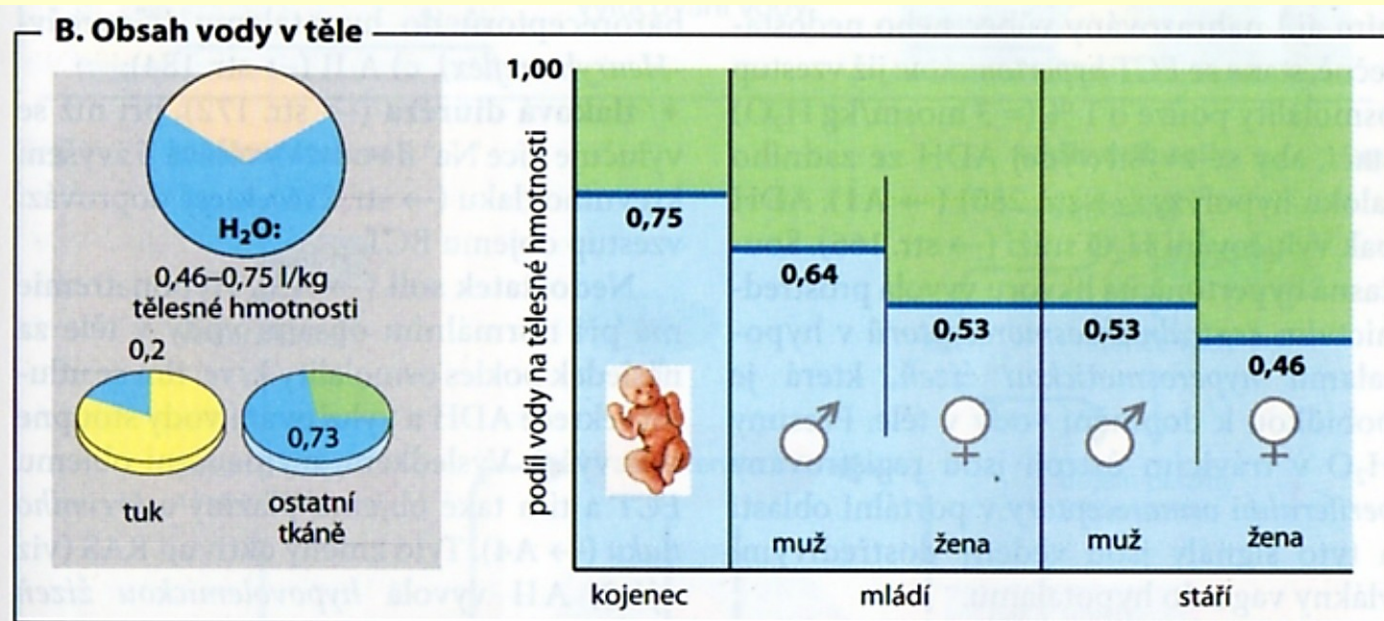
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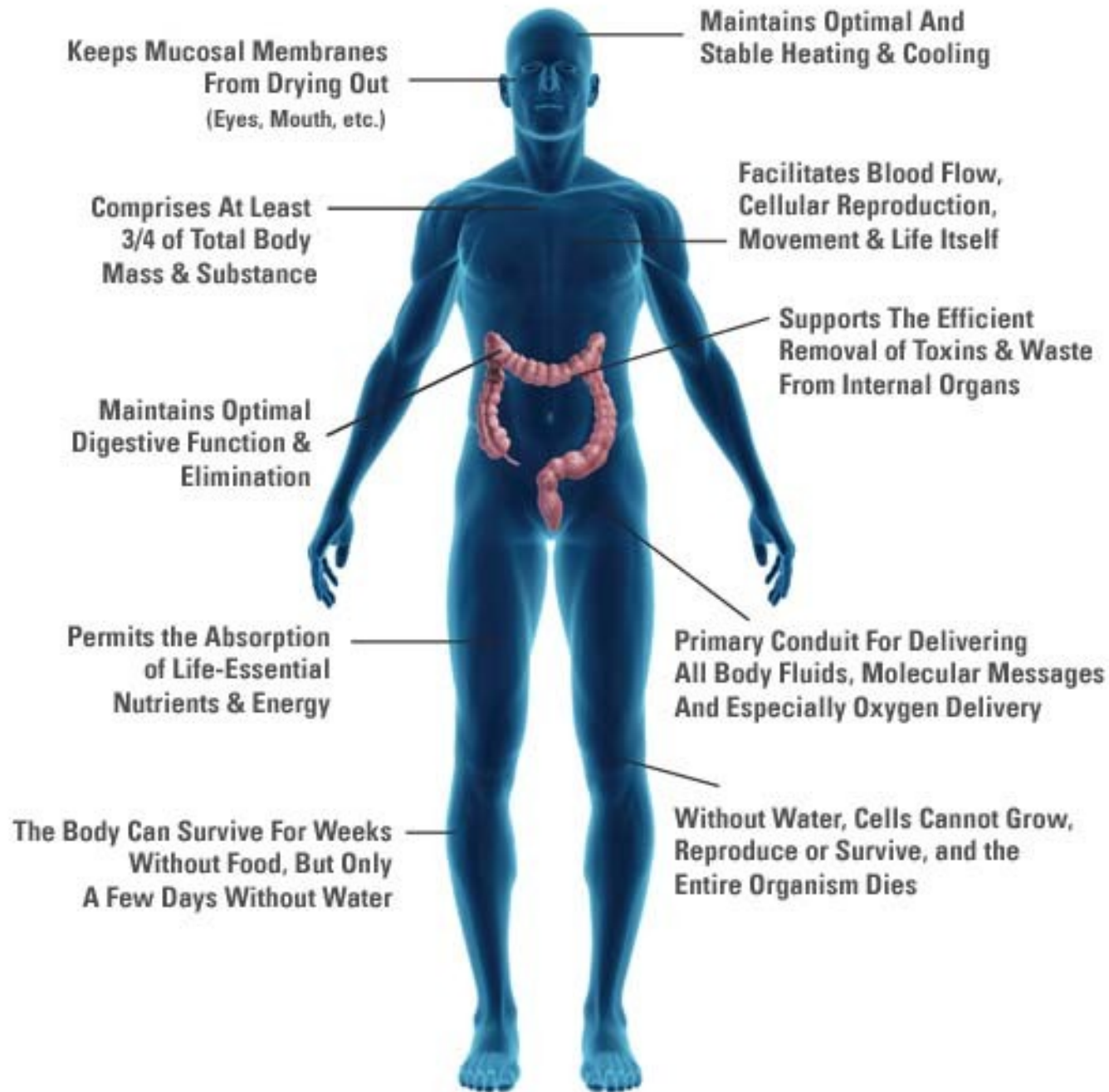
## WATER

- 50-70% of body mass, newborns
- 2/3 intracellularly, 1/3 extracellularly
- metabolism
- compartmentalisation
- phylogenetic view

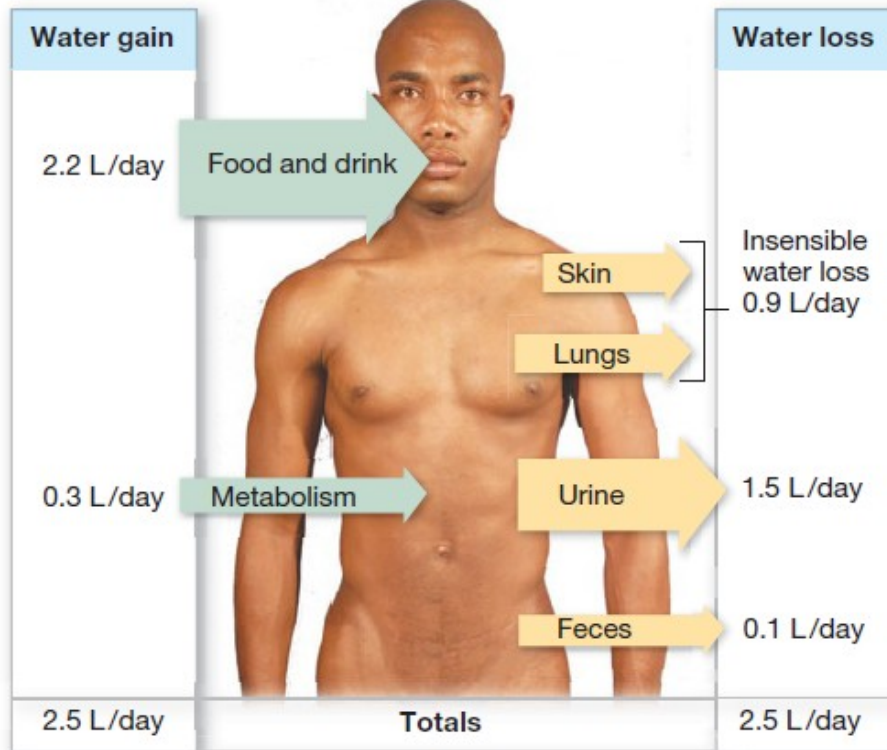
# Water and its functions in the human body

- The transport medium, solvent, wetting and protection of the mucous membranes
- Age, sex, weight





## WATER BALANCE IN THE BODY



$$\begin{array}{r} \text{Intake} \\ 2.2 \text{ L/day} \end{array} + \begin{array}{r} \text{Metabolic production} \\ 0.3 \text{ L/day} \end{array} - \begin{array}{r} \text{Output} \\ 2.5 \text{ L/day} \end{array} = 0$$

# The water content in different tissues (male, 70 kg)

	% of water
blood	83%
muscle tissue	76%
skin	72%
bones	22%
fats	10%
tooth enamel	2%

## Your very own body of water

The average human body is composed of about 55% water. The average adult male is about 60% water, the average adult female about 50% water.\*

### How much water is that?

An average adult male with a weight of 80 kg (about 176 lbs) and a water content of 60%, would contain 48 kg or 48 L of water, equal to eight cases of standard-size bottled water.\*\*



### Where is all of that water?

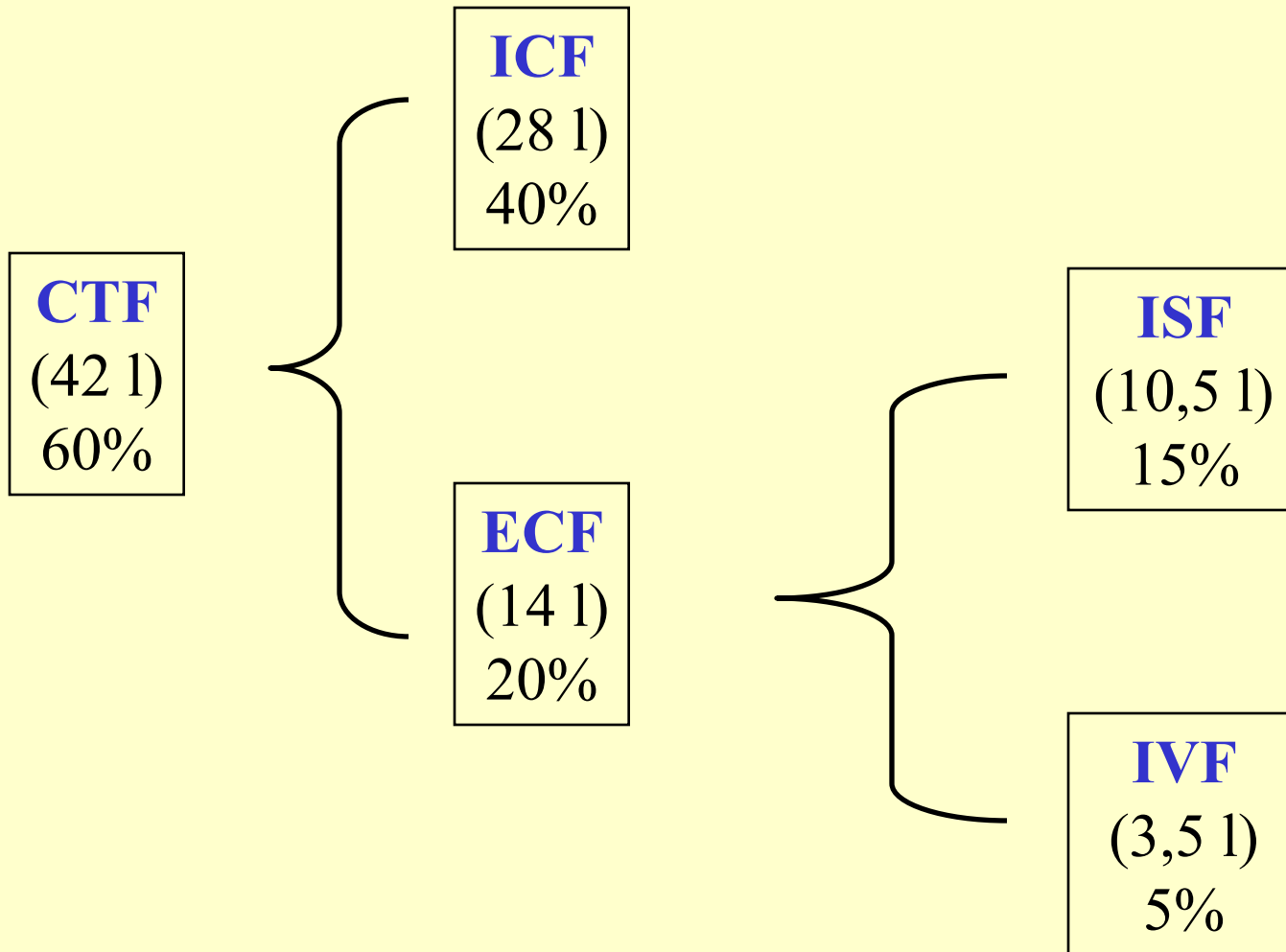
All parts of the body contain some water. Here are some of the more "watery" parts.

-  Lungs: **90%** water
-  Blood: **82%**
-  Skin: **80%**
-  Muscle: **75%**
-  Brain: **70%**
-  Bones: **22%**

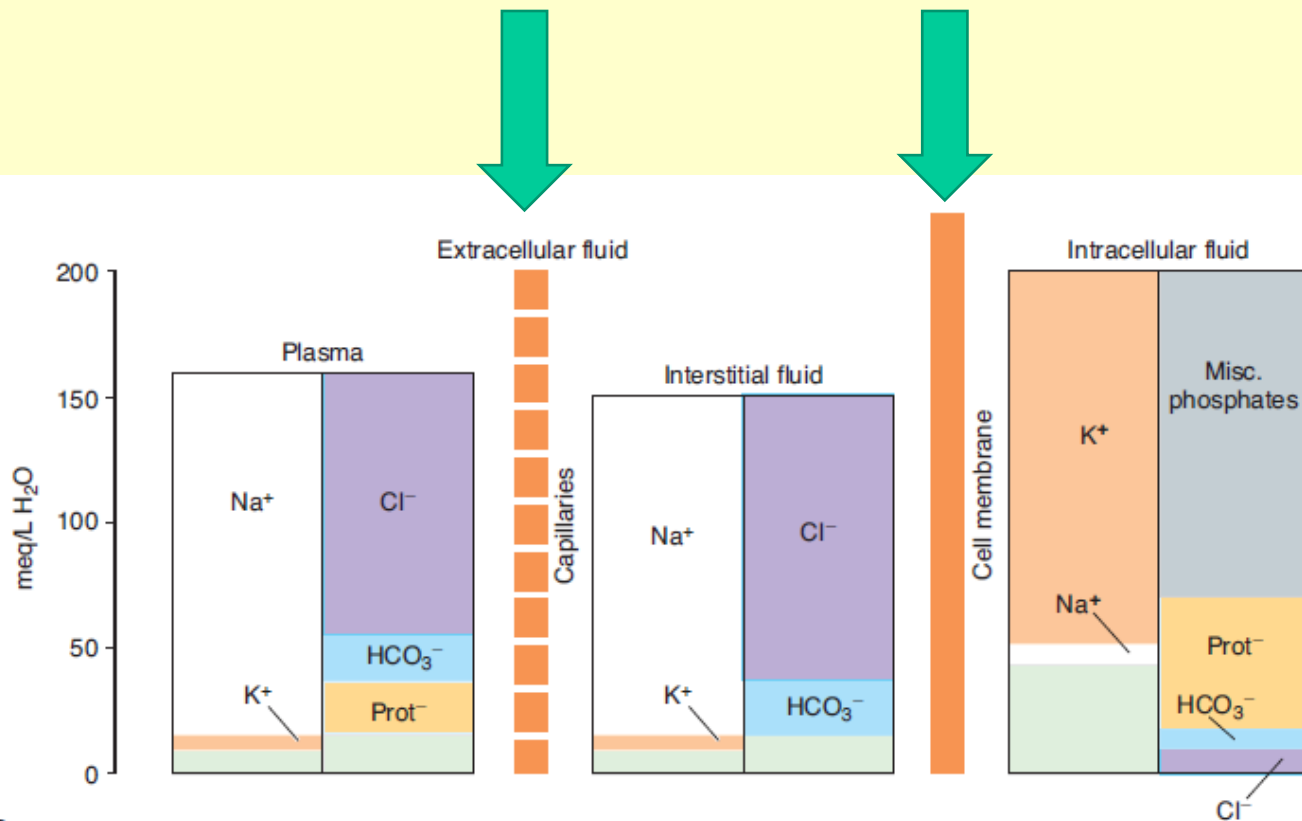
\* Muscle contains more water than fat does. Males generally have higher muscle content than females.

\*\* 1 litre of water weighs 1 kilogram. A standard size container of bottled water is 500 mL.





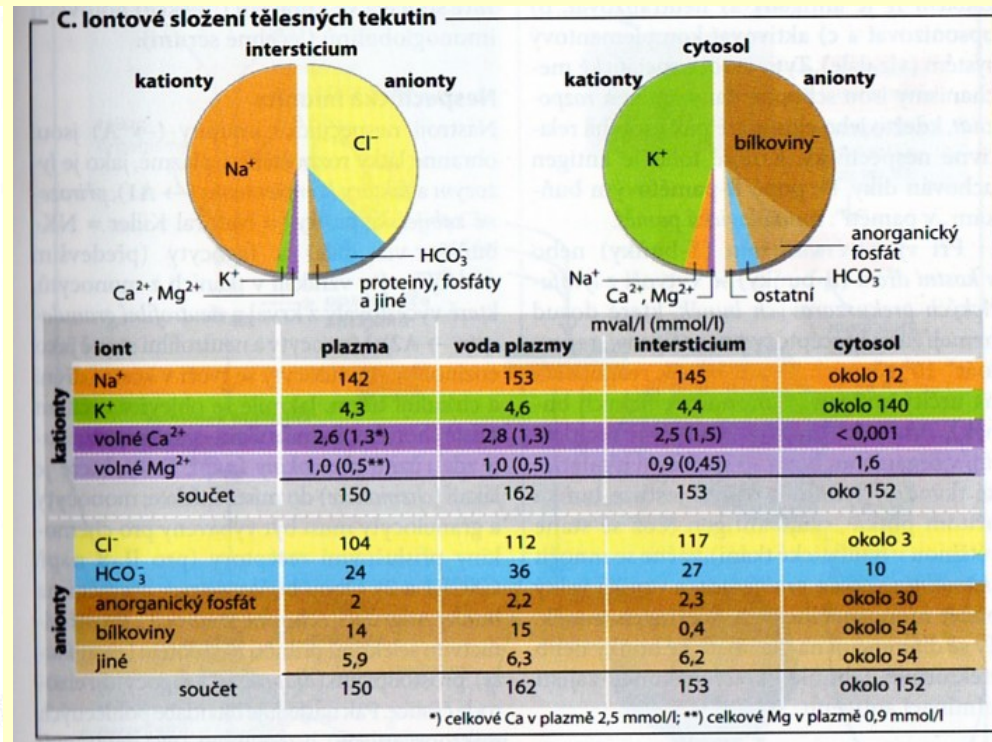
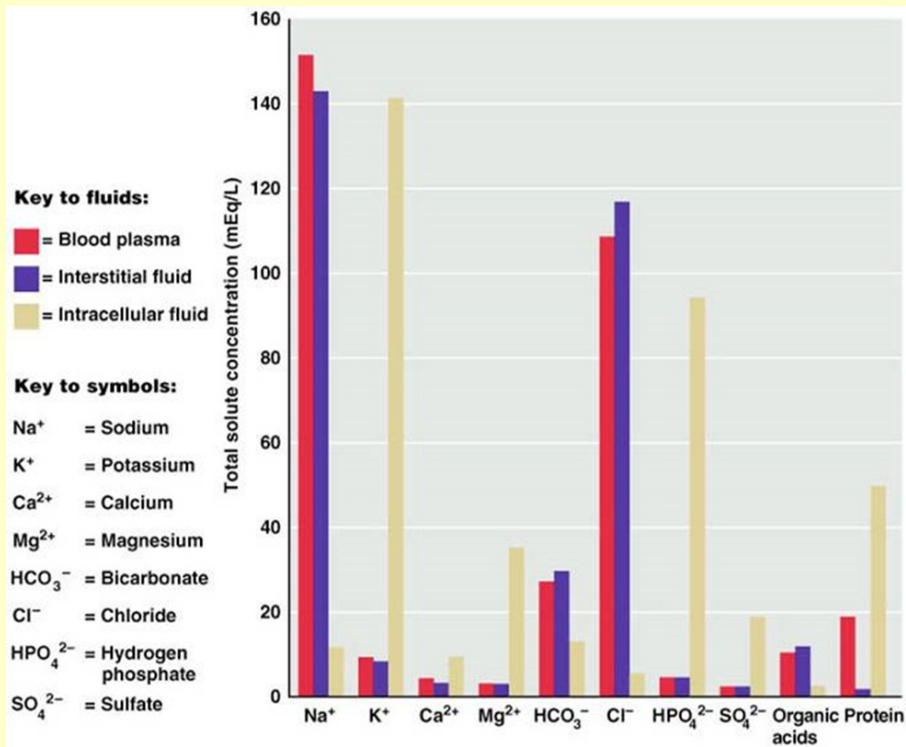
**Clinical examination:** evaluation of extracellular (plasmatic) levels of electrolytes (Na, K)

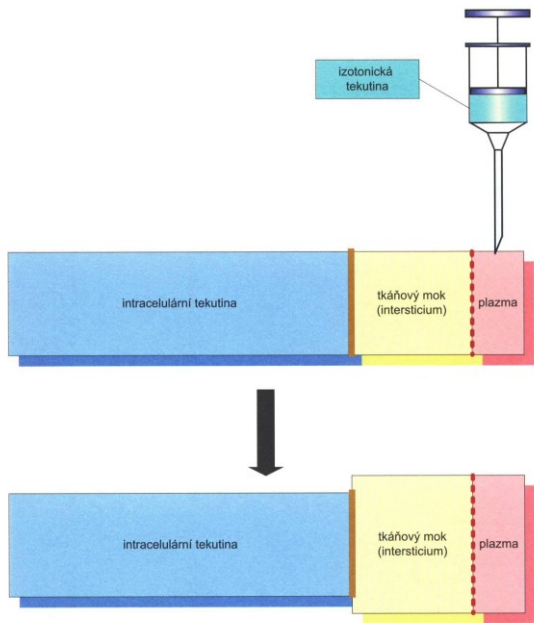


B

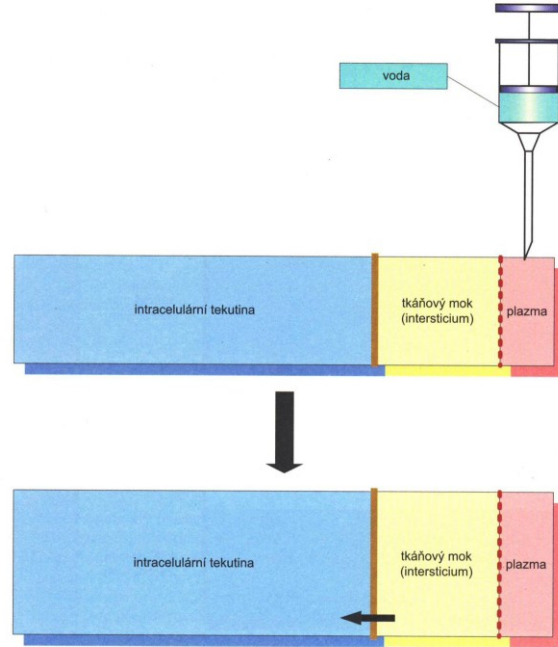
**FIGURE 1-1** Organization of body fluids and electrolytes into compartments. **A)** Body fluids are divided into Intracellular and extracellular fluid compartments (ICF and ECF, respectively). Their contribution to percentage body weight (based on a healthy young adult male; slight variations exist with age and gender) emphasizes the dominance of fluid makeup of the body. Transcellular fluids, which constitute a very small percentage of total body fluids, are not shown. Arrows represent fluid movement between compartments. **B)** Electrolytes and proteins are unequally distributed among the body fluids. This uneven distribution is crucial to physiology. Prot<sup>-</sup>, protein, which tends to have a negative charge at physiologic pH.



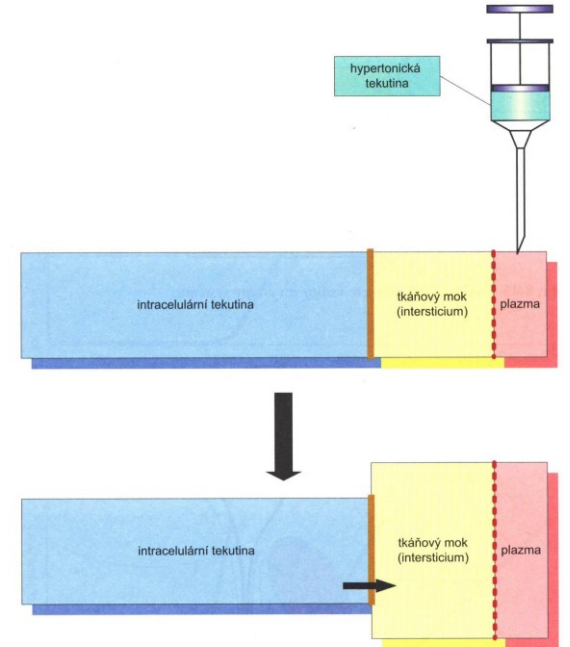




**Obr. 8.42** Při příjmu izotonické tekutiny se tekutina rozprostře mezi intravaskulární a extravaskulární část extracelulárního kompartmentu, do intravaskulárního kompartmentu tekutina nepřechází, protože bariéra je pro ionty nepropustná, a voda nepřechází, protože obě strany bariéry jsou izotonické



**Obr. 8.43** Při příjmu čisté vody se voda rozprostře do všech kompartmentů, aby vyrovnala jejich osmolaritu



**Obr. 8.44** Při příjmu hypertonické tekutiny přechází voda do extracelulárního prostoru z prostoru intracelulárního, aby vyrovnala osmolaritu obou kompartmentů

Body Fluid Compartment	Fraction of TBW*	Markers Used to Measure Volume	Major Cations	Major Anions
TBW	1.0	Tritiated H <sub>2</sub> O D <sub>2</sub> O Antipyrène		
ECF	1/3	Sulfate Inulin Mannitol	Na <sup>+</sup>	Cl <sup>-</sup> HCO <sub>3</sub> <sup>-</sup>
Plasma	1/12 (1/4 of ECF)	RISA Evans blue	Na <sup>+</sup>	Cl <sup>-</sup> HCO <sub>3</sub> <sup>-</sup> Plasma protein
Interstitial	1/4 (3/4 of ECF)	ECF-plasma volume (indirect)	Na <sup>+</sup>	Cl <sup>-</sup> HCO <sub>3</sub> <sup>-</sup>
ICF	2/3	TBW-ECF (indirect)	K <sup>+</sup>	Organic phosphates Protein

\*Total body water (TBW) is approximately 60% of total body weight, or 42 L in a 70-kg man. ECF = extracellular fluid; ICF = intracellular fluid; RISA = radioiodinated serum albumin.

# HOMEOSTASIS

- **Izoionia** – concentration of ions
- **Izotonia** – osmotic concentration
- **Izohydria** – ratio between acids and bases
- **Izovolemia** – ECL volume (volumoreceptors or baroreceptors, RAS, ADH)

- Izovolemia
- **Hypovolemia (dehydration)**
- Hypervolemia (hyperhydration)

Cause – result  
Complex disorders!

## EXAMINATIONS AT HYDRATATION DISORDERS

1. **Anamnesis** – diseases of kidneys, GIT, DM, DI, drugs, intake and output=balance, body mass changes, etc.
2. **Laboratory examinations:** electrolytes, blood osmolality, RBCC, total plasmatic proteins; Astrup examination

## OBJECTIVE EXAMINATIONS

1. Skin changes
2. Body mass changes
3. Diuresis changes (oliguria, anuria, polyuria)
4. Respiration disorders (respiratory acidosis, alkalosis; secondary changes – Kussmaul breathing)
5. CNS disorders (changes of reflexes, muscle tonus, paresthesias, changes of consciousness, coma)
6. Central venous pressure changes (filling of neck veins)
7. Circulation changes: dehydration – tachycardia, hypotonia

# CAUSES OF HYDRATATION DISORDERS

1. Disturbance of normal **intake** of water and ions
2. Disturbance of normal **circulation** of water and ions between  
ECL and GIT
3. Disturbance of **cell metabolism**
4. Disturbance of **loss** of water and ions
5. Excessive **loss** of water (and ions) by **skin**



# DEHYDRATATION

= decreased volume of body fluids accompanied by lack of sodium

**HYPERTONIC DEHYDRATATION** = loss of (only) water

Bigger lack of water than sodium. Disorders of intake and big losses.  
Cell dehydration.

Thirst. Decreased skin turgor. CNS symptoms.

Hydratation.

**IZOTONIC DEHYDRATATION** = isonatremic

Causes – bleeding, diuretics, „blind spaces“

Hypovolemic syndrome: decreased diuresis, symptoms of dehydration.

**HYPOTONIC DEHYDRATATION**

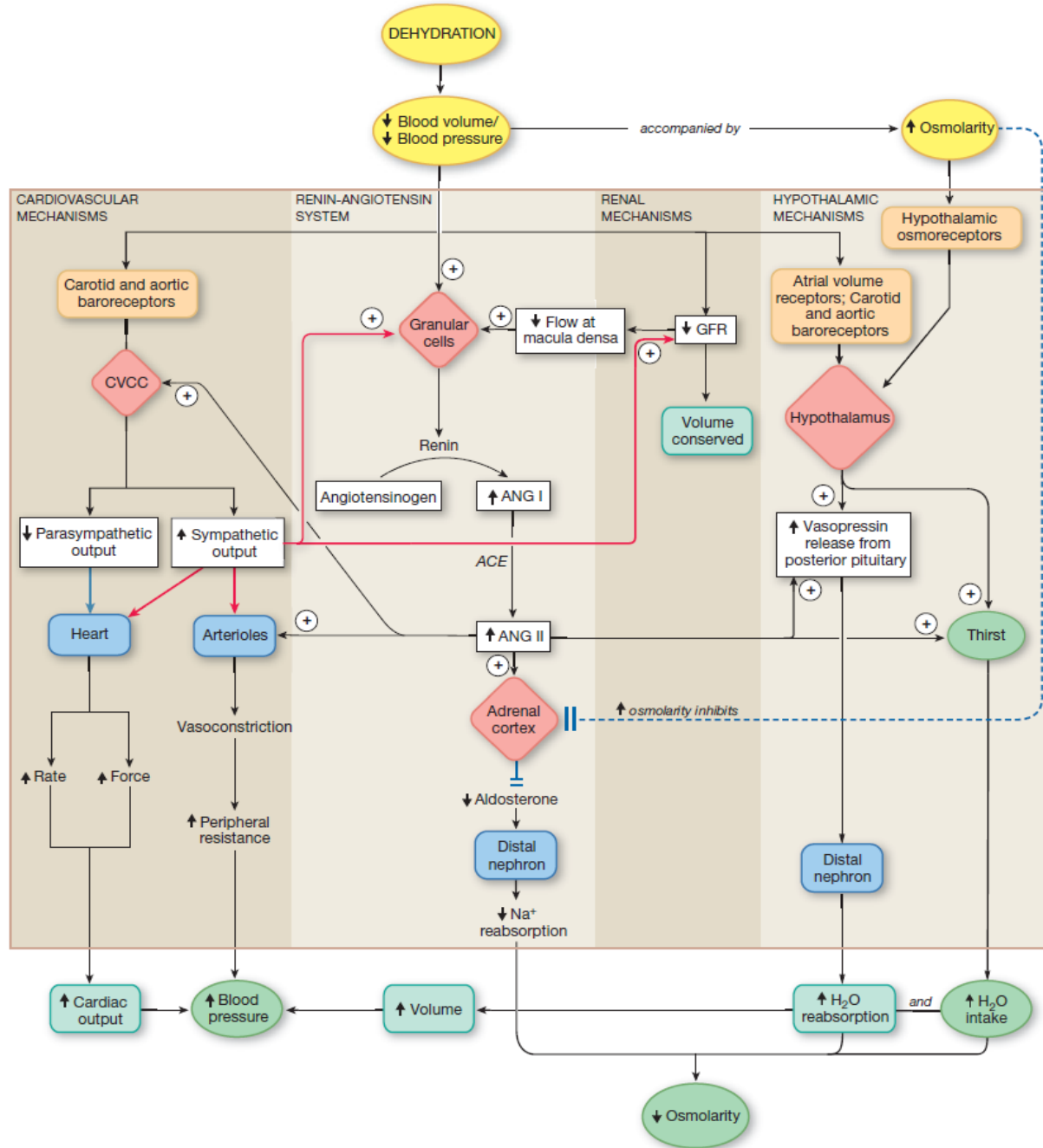
Always bigger deficiency of sodium than water.

Cell hyperhydratation.

Losses by GIT, kidneys.

Hypovolemic syndrome, CNS symptoms.

# HOMEOSTATIC COMPENSATION FOR SEVERE DEHYDRATION



# HYPERHYDRATATION

= increased volume of extracellular fluid

## **HYPOTONIC HYPERHYDRATATION – water intoxication**

Cell hyperhydration. Decreased osmolality.

Excessive intake of liquids (dialysed patient, patient with kidney disorders), hyperproduction of ADH

## **IZOTONIC HYPERHYDRATATION**

Increased volume of ECF. Osmolality stable.

Heart failure, nephrotic syndrome, liver cirrhosis.

Oedemas and water withholding in serose cavities.

## **HYPERTONIC HYPERHYDRATATION = hypernatremic**

Rare. Increase of ECF caused by sodium abundance. Osmolality increases.

Primary hyperaldosteronism.

t a b l e

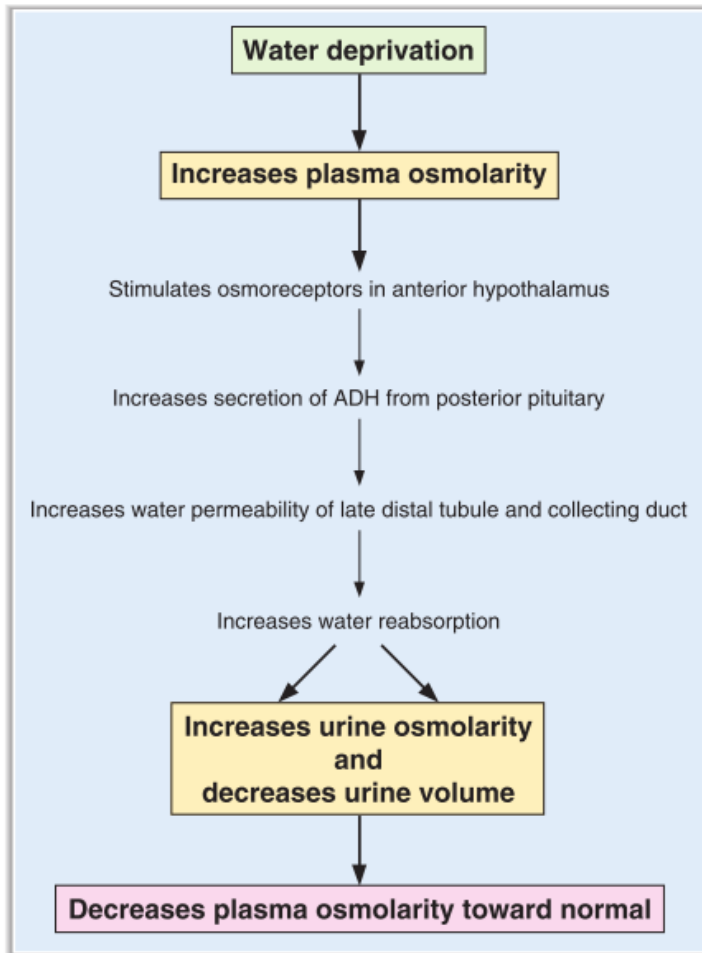
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## Changes in Volume and Osmolarity of Body Fluids

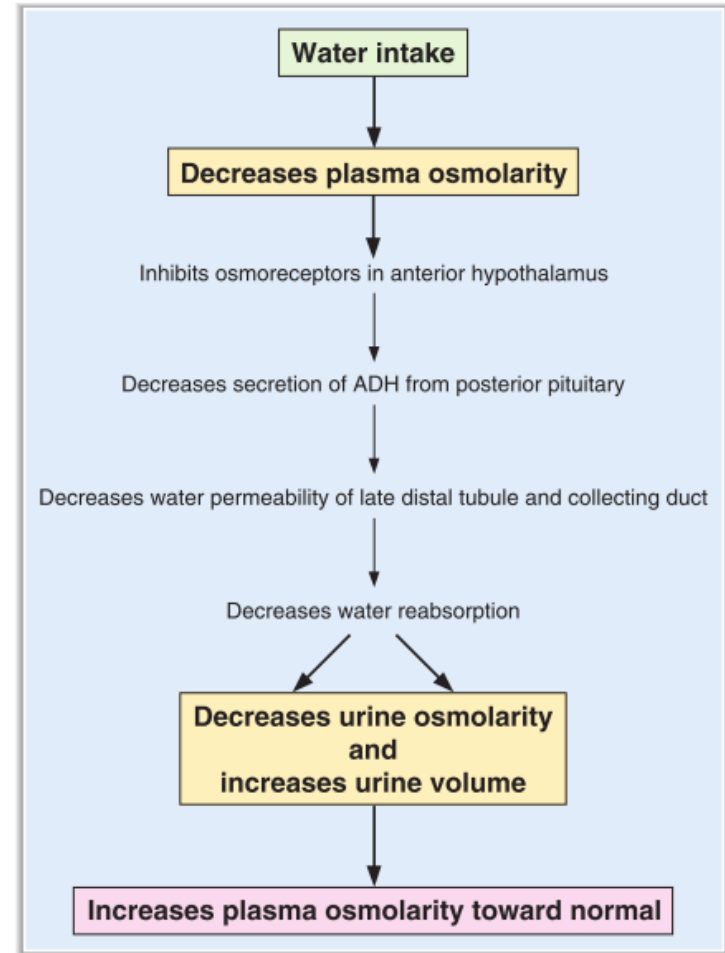
Type	Key Examples	ECF Volume	ICF Volume	ECF Osmolarity	Hct and Serum [Na <sup>+</sup> ]
Isosmotic volume expansion	Isotonic NaCl infusion	↑	No change	No change	↓ Hct –[Na <sup>+</sup> ]
Isosmotic volume contraction	Diarrhea	↓	No change	No change	↑ Hct –[Na <sup>+</sup> ]
Hyperosmotic volume expansion	High NaCl intake	↑	↓	↑	↓ Hct ↑ [Na <sup>+</sup> ]
Hyperosmotic volume contraction	Sweating Fever Diabetes insipidus	↓	↓	↑	–Hct ↑ [Na <sup>+</sup> ]
Hyposmotic volume expansion	SIADH	↑	↑	↓	–Hct ↓ [Na <sup>+</sup> ]
Hyposmotic volume contraction	Adrenal insufficiency	↓	↑	↓	↑ Hct ↓ [Na <sup>+</sup> ]

– = no change; ECF = extracellular fluid; Hct = hematocrit; ICF = intracellular fluid; SIADH = syndrome of inappropriate antidiuretic hormone.

SIADH = syndrome of inappropriate antidiuretic hormone secretion)



**FIGURE 5-14** Responses to water deprivation. ADH = antidiuretic hormone.



**FIGURE 5-15** Responses to water intake. ADH = antidiuretic hormone.

# VITAMINS

= all organic compounds of diet, necessary for life, health and growth; NO source of energy

HYPOVITAMINOSIS (AVITAMINOSIS)  
HYPERVITAMINOSIS

1. Decrease supply in diet
2. Food intake disorders
3. Absorption disorders
4. Increased consumption
5. Store organ diseases

1. Increased supply in diet – usually **iatrogenic**

## SOLUBLE

in water: diffusion, D, J; vit. **B**<sub>12</sub> - I

in lipids: deficient absorption in disorders of lipids absorption (pancreatic enzymes or bile missing)

Vitamin		Place of absorption	Transport mechanism	Maximal absorption capacity in humans / day	Daily dose
<b>C</b>		Ileum	Active	>5000mg	<50mg
<b>Biotin</b>		Small intestine	Active	?	?
<b>Cholin</b>		Small intestine	Facilitated diffusion	?	?
<b>Folic acid (pteroylglutamate)</b>		Jejunum	Facilitated diffusion	> 1000µg (dose)	100-200µg
<b>Folic acid (5-methyltetrahydrofolate)</b>		Jejunum	Diffusion	> 1000µg (dose)	100-200µg
<b>Nicotinic acid</b>		Jejunum	Facilitated diffusion	?	10-20mg
<b>Pantothenic acid</b>		Small intestine	?	?	(?)10mg
<b>B<sub>6</sub> (pyridoxine)</b>		Small intestine	Diffusion	> 50mg (dose)	1-2mg
<b>B<sub>2</sub> (riboflavin)</b>		Jejunum	Facilitated diffusion	10-12mg (dose)	1-2mg
<b>B<sub>1</sub> (thiamine)</b>		Jejunum	Active	8-14mg	Approx. 1mg
<b>B<sub>12</sub></b>		<b>Distal ileum</b>	<b>Active</b>	<b>6-9µg</b>	<b>3-7µg</b>



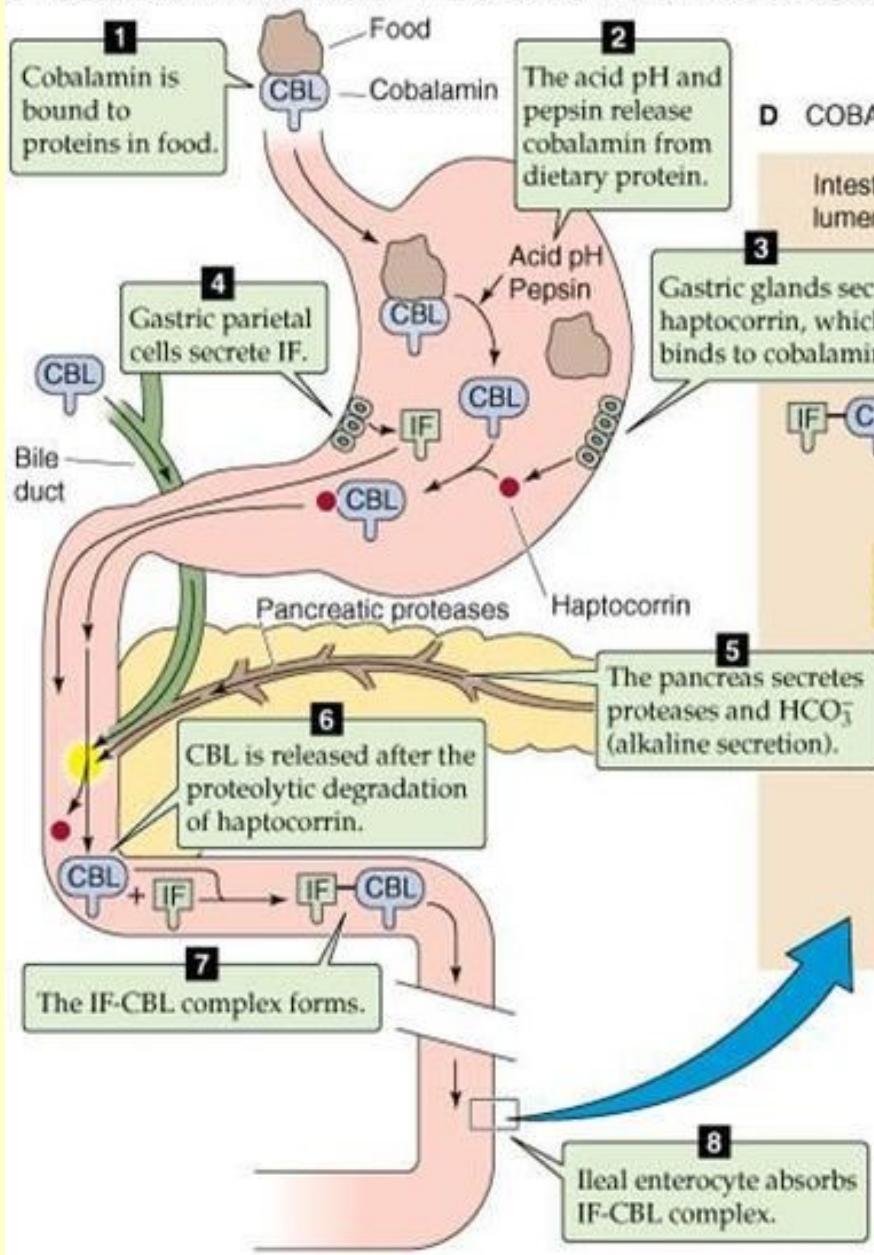
# VITAMIN B<sub>12</sub>

- Daily dose is close to absorption capacity
- Synthesised by bacteria in colon – BUT there is not absorption mechanism
- Store in liver (2-5mg)
- In bile 0,5-5µg / day, reabsorbed
- Daily loss – 0,1% of stores → stores will last for 3-6 years

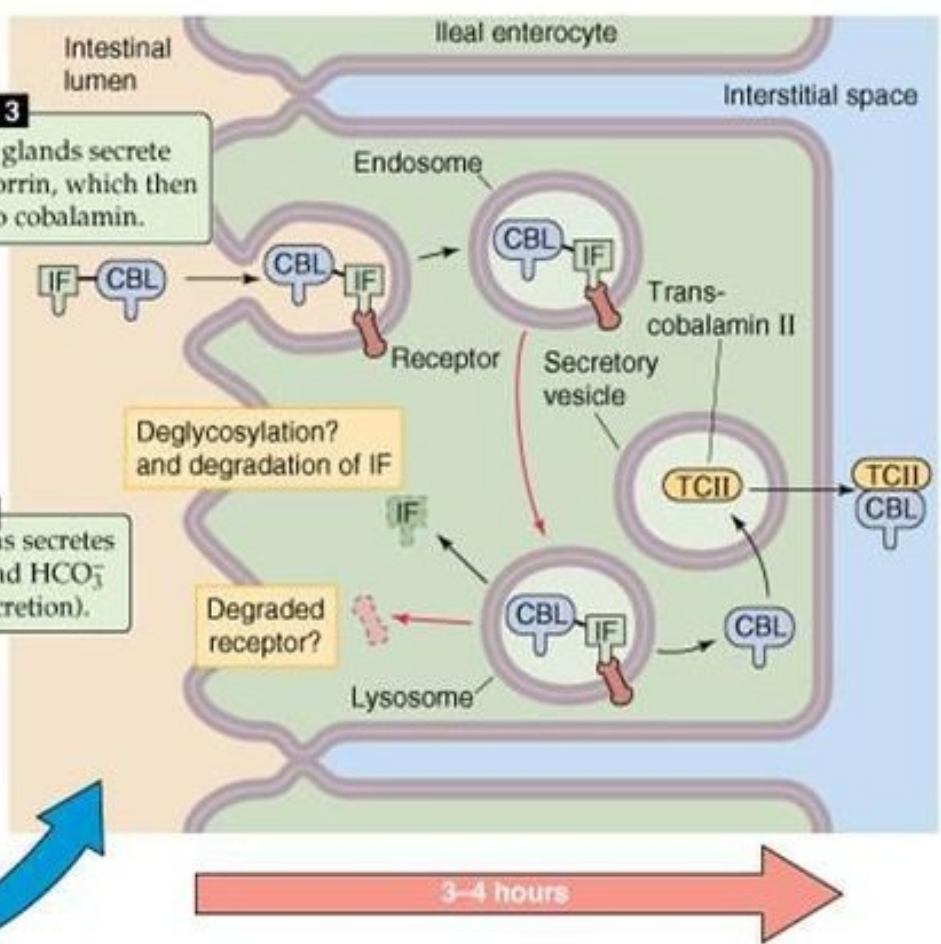
## ABSORPTION

- 1. Gastric phase:** B<sub>12</sub> is bound to proteins, low pH and pepsin release it; bound to glycoproteins – **R-proteins** (saliva, gastric juice), almost pH-undependable; intrinsic factor (**IF**) – parietal cells of gastric mucosa; most of vitamin bound to R-proteins
- 2. Intestinal phase:** pancreatic proteases, cleavage of R-B<sub>12</sub>, bound to IF (resistant to pancreatic proteases)

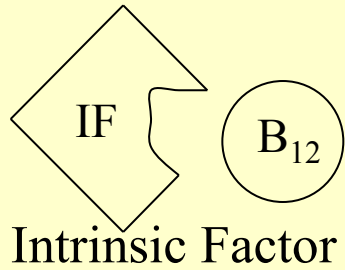
**C COBALAMIN HANDLING BY THE STOMACH AND PROXIMAL SMALL INTESTINE**



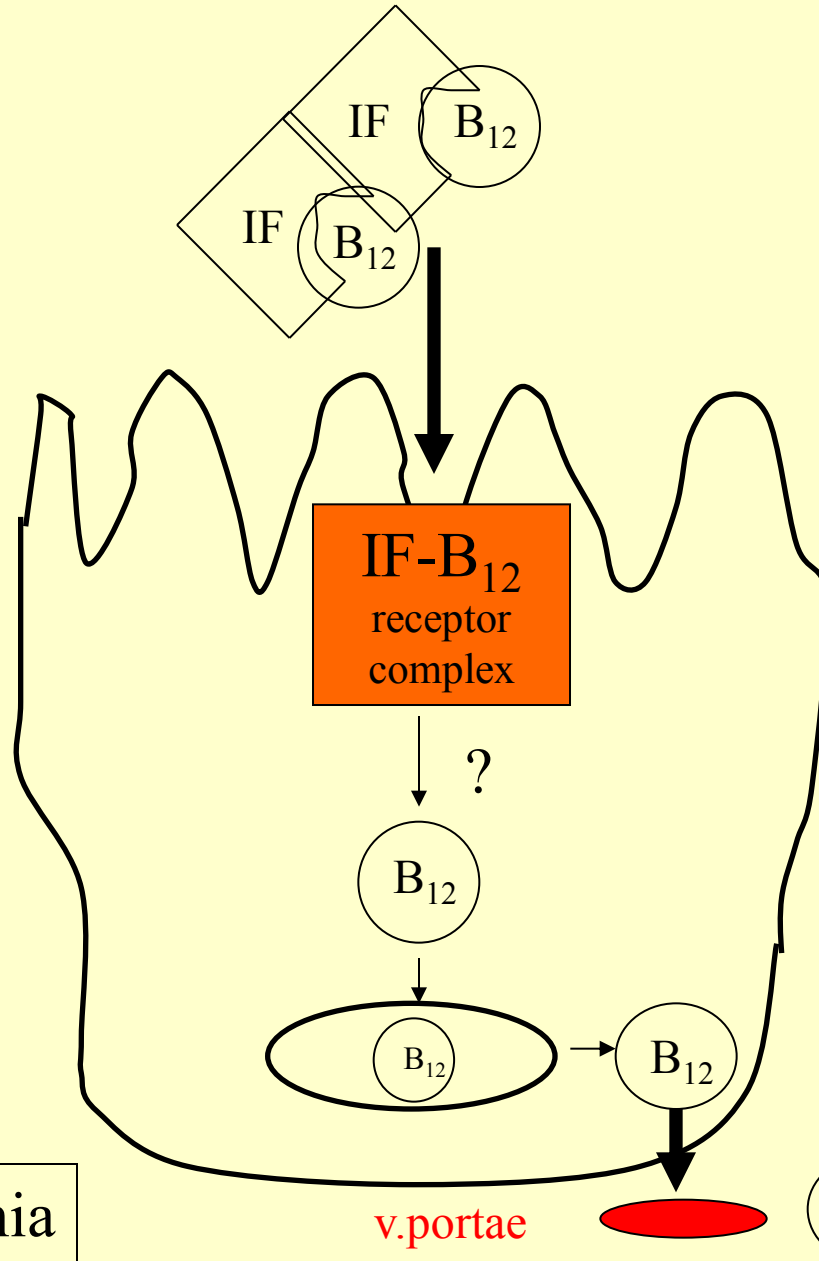
**D COBALAMIN ABSORPTION BY ILEAL ENTEROCYTE**



# ABSORPTION OF B<sub>12</sub> VITAMIN

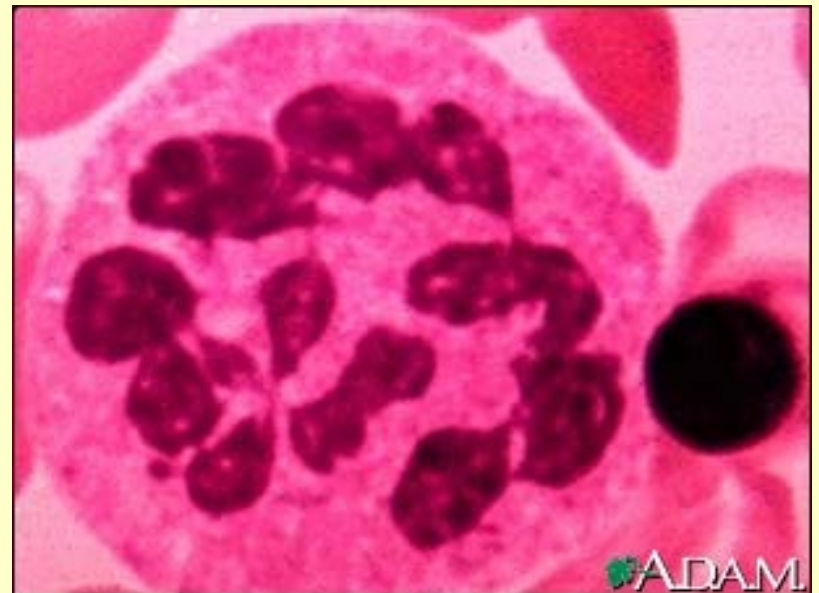
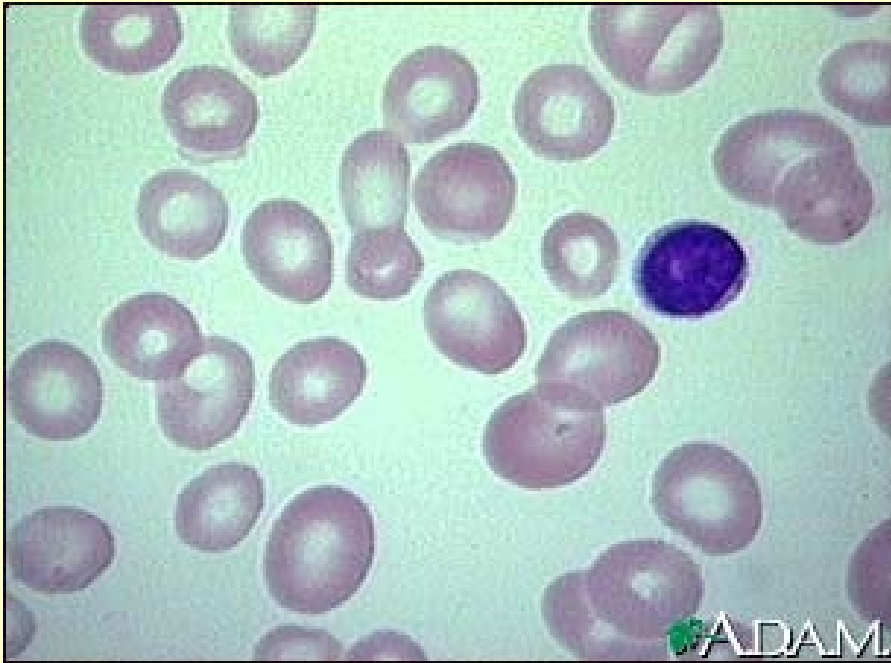


TERMINAL  
ILEUM



Pernicious anaemia

transcobalamin II



## **HYPOVITAMINOSES**

Folic acid – disorders of embryo development (clefts)

B<sub>12</sub> – pernicious anaemia

C – scurvy (scurbutus)

D – rickets (rhachitis, English disease, English sickness)

E – fertility problems

K - haemorrhage

## **HYPERVITAMINOSES**

A – teratogenic effects

D – kidney failure

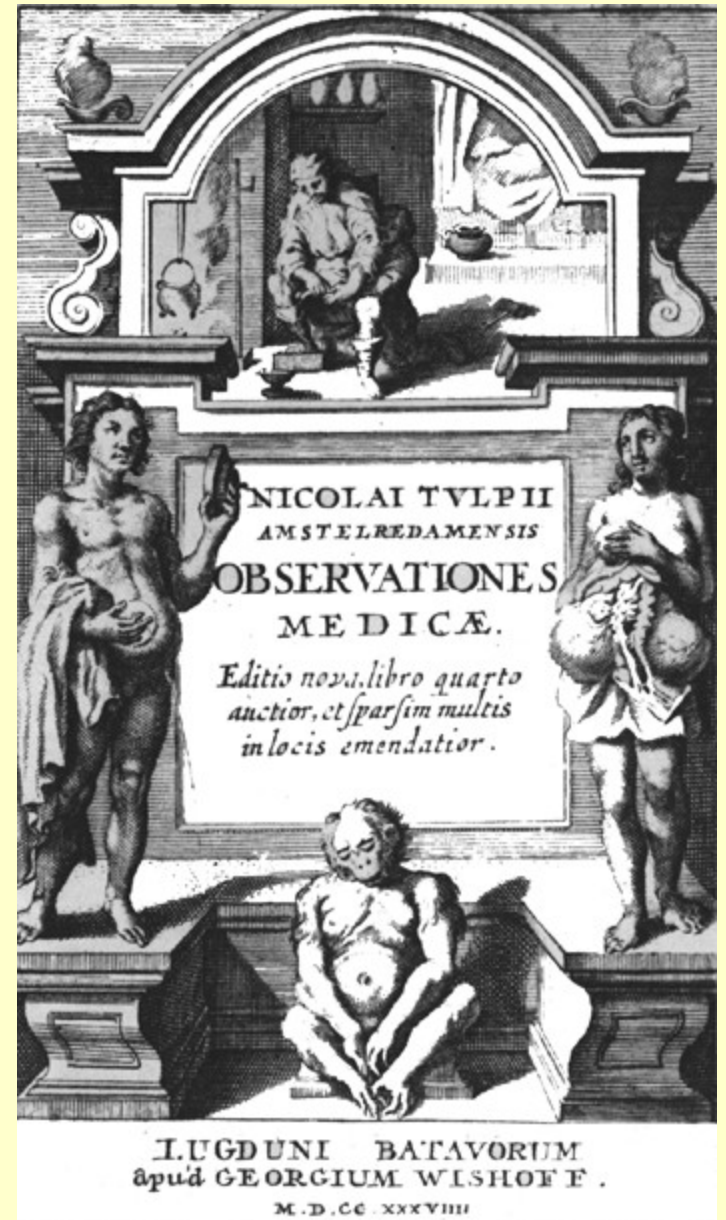
K – anaemia, GIT disorders

B<sub>6</sub> – peripheral polyneuropathy

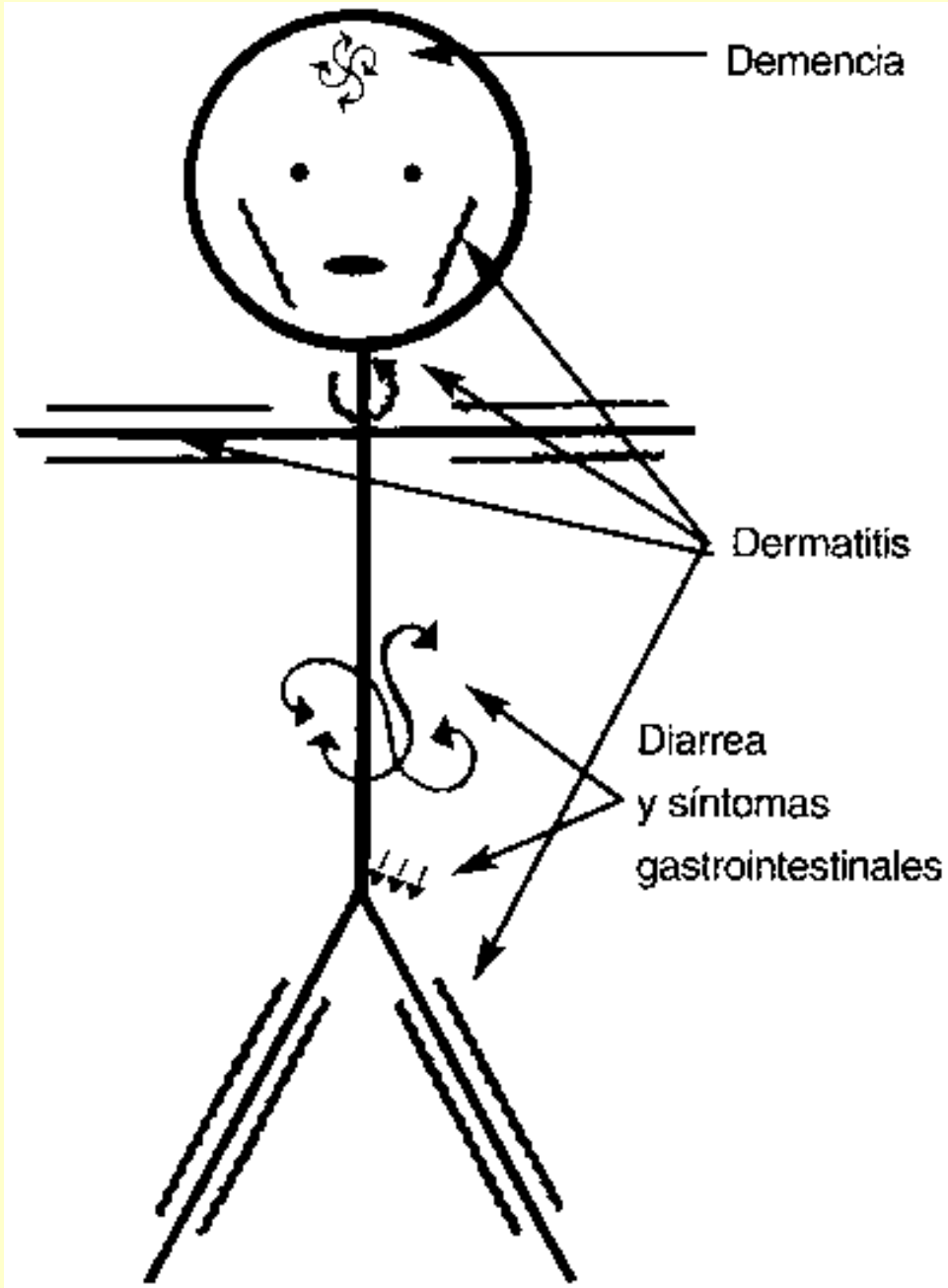


# BERI-BERI (B<sub>1</sub>)

"The first clinical descriptions of beriberi were by Dutch physicians, Bontius (1642) and Nicolaas Tulp (1652). Tulp treated a young Dutchman who was brought back to Holland from the East Indies suffering from what the natives of the Indies called beriberi or "the lameness." Tulp's description of beriberi was a detailed one, but he had no clues that it was a dietary deficiency disease. This discovery came more than two hundred years later. Nicholaas Tulp (1593-1674) is best remembered as the central figure in Rembrandt's famous painting, "The Anatomy Lesson" (1632).



**PELAGRA**  
(3 D disease)  
(niacin)







# SCURVY

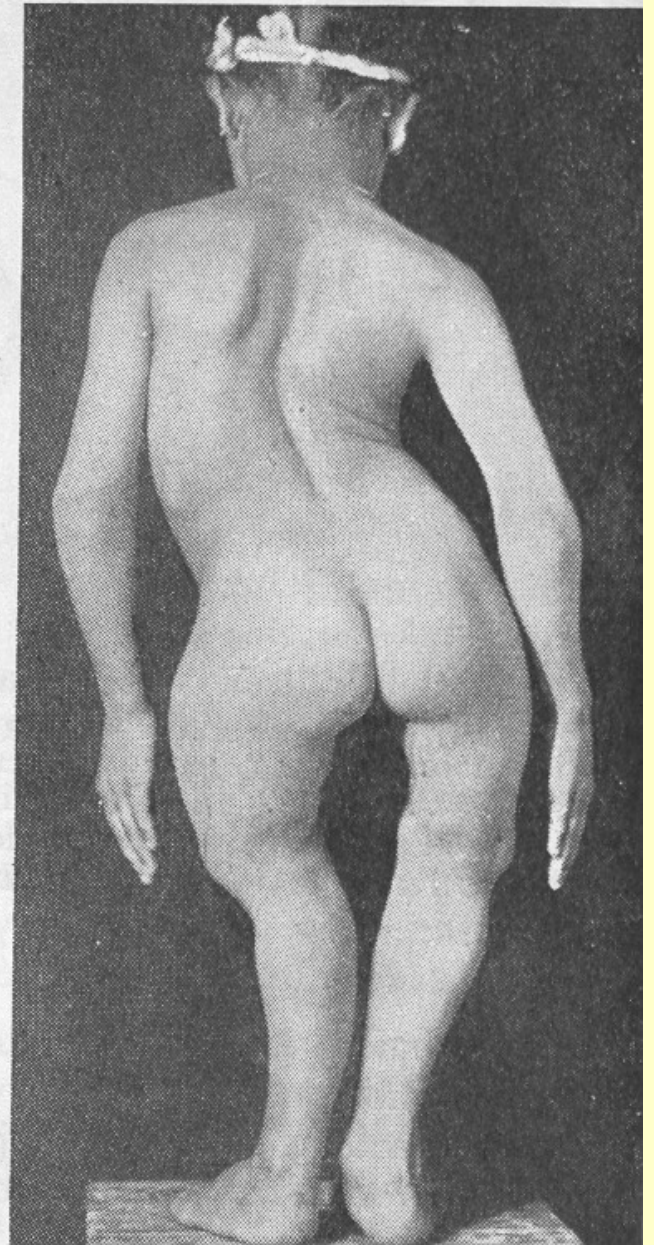
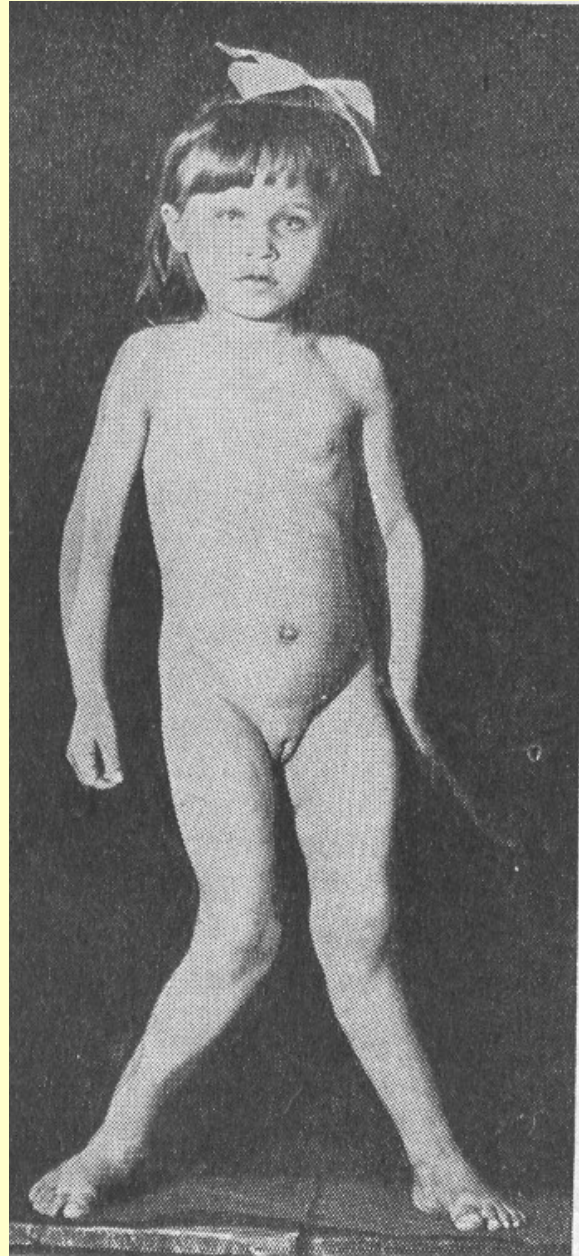


Scorbutic Gums





# RICKETS



Mineral	Daily need (dose)
Na	3,0 g
K	1,0 g
Cl	3,5 g
Ca	1,2 g
P	1,2 g
Fe	18,0 mg
J	150,0 µg
Mg	0,4 g
Co	?
Cu	?
Mn	?
Zn	15 mg

Coenzyme of metabolic reactions of saccharides; deficiency – increased irritability of CNS, peripheral vasodilatation, arrhythmias; excess – suppresses electrical activity of CNS and skeletal muscle

Part of enzymes (carboanhydrase in erythrocytes, lactatedehydrogenase, peptidases)

# MINERALS AND TRACE ELEMENTS

1. Arsenic
2. Chrome – experimental deficiency, glucose oral test is of diabetic character
3. Cobalt – part of enzymes, vit.B<sub>12</sub>; poisoning by cobalt (beer), cobalt cardiomyopathy
4. Copper – impairment of cytochromoxidase (experiment), melanoma – increase of radiosensitivity when copper is depleted; vessel wall damage
5. Fluorine
6. Iodine
7. Iron
8. Manganese – catalyses similar reactions as Mg, stored in mitochondria,  $\beta$ 1-globulintransmanganin
9. Molybdenum – in xantinoxidase and flavoproteins, defficiency in humans???
10. Nickell
11. Selenium – antioxidant, in diet bound to proteins (alcoholism, liver cirrhosis)
12. Silicon
13. Vanadium
14. Zinc – part of metalloenzymes, proteosynthesis (ribosomes);deficiency-Middle East (parasites, fytates in diet); testes atrophy, immune disorders; in DM 50% of stores Zn (insulin stored in pancreas together with Zn)

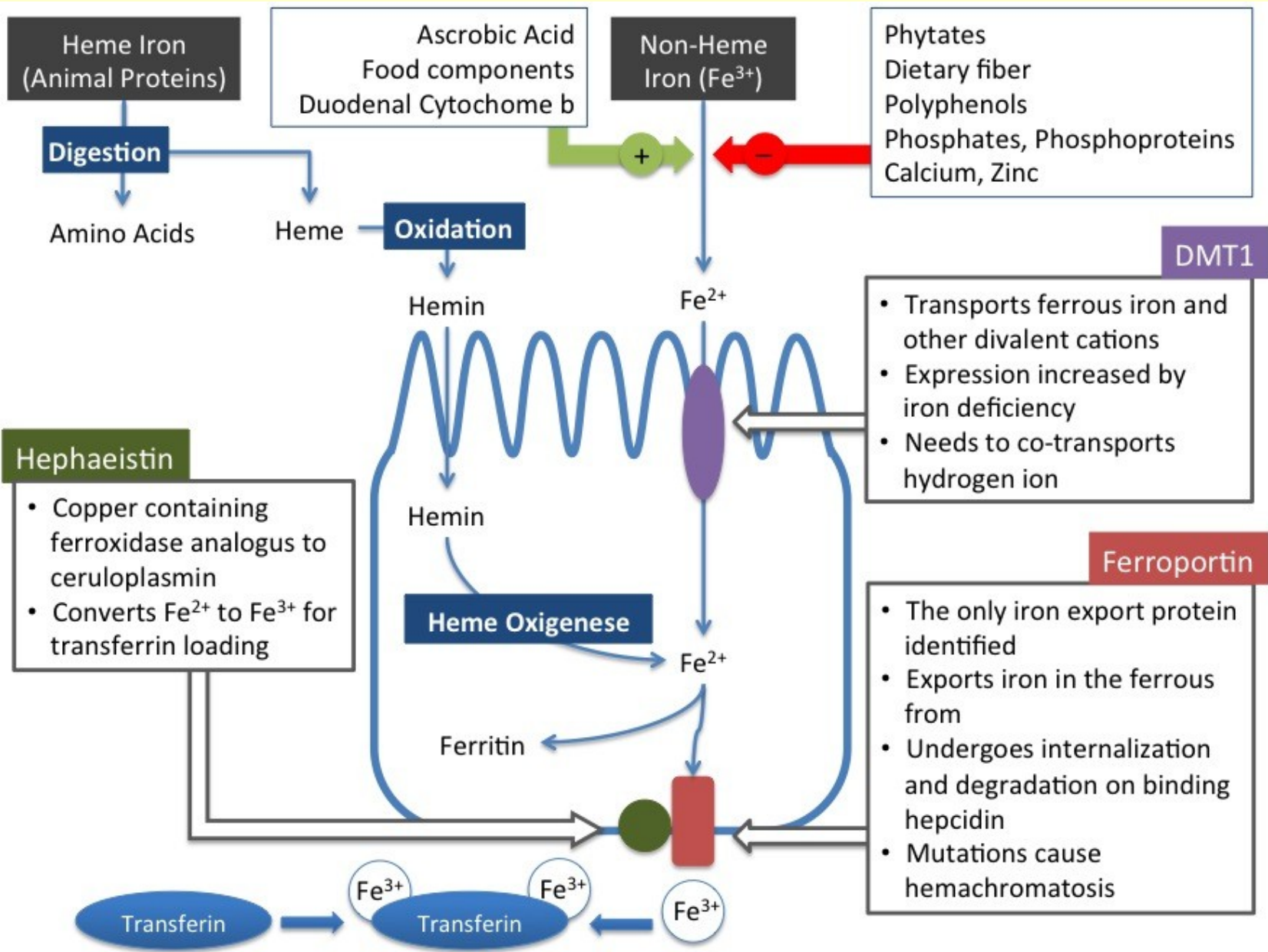


**HAPPY EASTER**

Veselé  
Velikonoce







# Iron: Factors Affecting Absorption

<b>Physical State (bioavailability)</b>	<b>heme &gt; Fe<sup>2+</sup> &gt; Fe<sup>3+</sup></b>
<b>Inhibitors</b>	phytates, tannins, soil/clay (pica), laundry starch, iron overload, antacids
<b>Competitors</b>	lead, cobalt, strontium, manganese, zinc
<b>Facilitators</b>	ascorbate, citrate, amino acids, iron deficiency, stomach acid, high altitude, exercise, pregnancy