

# WATER



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# Drinking water

## 5 water functions in human body:

### 1. Cell life

Water is a carrier, distributing essential nutrients to cells, such as minerals, vitamins and glucose.

### 2. Chemical and metabolic reactions

Water removes waste products including toxins that the organs' cells reject, and removes them through urines and faeces

### 3. Transport of nutrients

Water participates in the biochemical break-down of food.



# Drinking water

## 4. Body temperature regulation

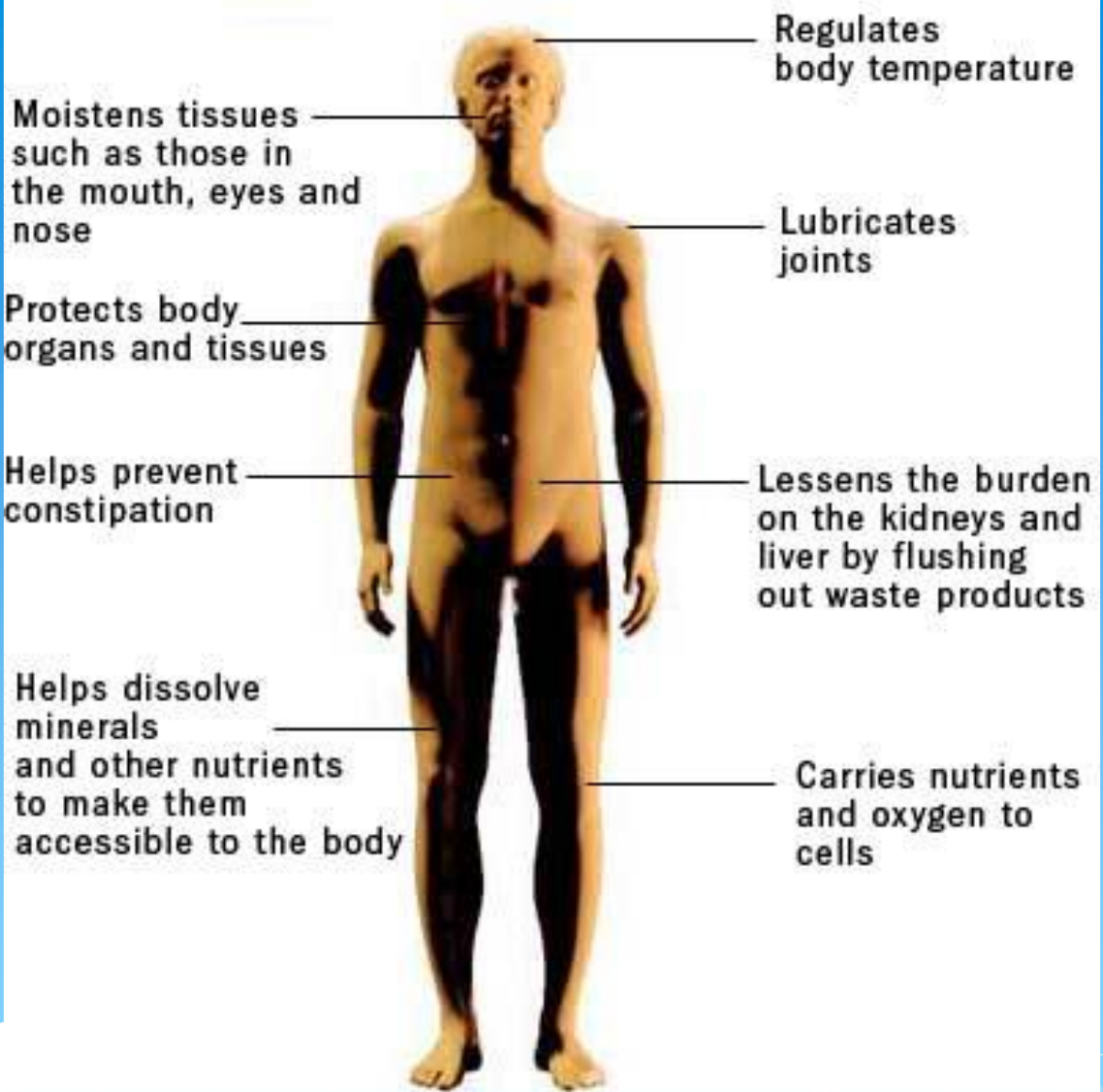
Water has a large heat capacity which helps limit changes in body temperature in a warm or a cold environment.

Water allows the body to release heat when ambient temperature is higher than body temperature. The body begins to sweat, and the evaporation of water from the skin surface very efficiently cools the body.

## 5. Elimination of waste

Water is an effective lubricant around joints. It also acts as a „shock absorber“ for eyes (removes impurities), brain, spinal cord and even for the foetus through amniotic fluid.

**Water is at the center of life. This is why nobody can live more than 3 to 5 days without any water intake.**



© Mayo Foundation for Medical Education and Research. All rights reserved.

<http://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/multimedia/functions-of-water-in-the-body/img-20005799>

# In the body

- \* **Intracellular fluid (ICF)** - account for **40% of body weight** of an adult male, or **66% of total body water**
  
- \* **Extracellular fluid (ECF)** – **20% of the total body weight** of an adult male (15 liters of water).  
Extracellular fluid is divided into intravascular fluid - **blood plasma** and interstitial fluid - **tissue fluid**

# Organs – in comparison



- most water content is in the **blood** (83%)
- in **muscle** tissue (75%)
- in the **skin** (72%)
  
- less water containing
- **bones** (22%) and **adipose tissue** (10%)
  
- little water content has **tooth enamel** (2%)

# Water content in the body



## Percent of Water in the Human Body

100%



Fetus

80%



Baby  
at Birth

70%



Normal  
Adult

50%



Elderly  
Person



## Average total body water (TBW) as body weight percentage

Age	Males	Both	Females
0 - 1 month		76	
1 - 12 months		65	
1 - 10 y		62	
10 - 16 y	59		57
17 - 39 y	61		50
40 - 59 y	55		47
60 y and older	52		46

The water content of the body changes:

with age - about 75 % in the newborn, usually less than 50 % in the elders,  
with the total fat (10 % H<sub>2</sub>O) and muscle (75 % H<sub>2</sub>O) content,

**a lean person has high TBW, an obese person has low TBW**



# Fluid daily intake



## Human adult:

- drinking water, fluids - about **1000 – 1500 ml/day**
- from food : about **1000 ml/day** (against composition of food)
- metabolic water: **300 ml/day** (is formed in oxidativ reactions)

# Loss of body water

Adult daily:

- 1000 – 1500 ml of urine (diuresis)
- 50 ml by skin (against physical activity, climatic conditions)
- 400 ml - by respiration (lung)
- 100 ml gastrointestinal tract (faeces), in diarrhea more



# How much should you drink?



## How much should you drink water every day?

Water is essential to good health, yet needs vary by individual

How much water do you need?

5 -8 cups (1.5 liters) or more a day

Recommendations against Mayo Clinic:

Water is still your best because it's calorie-free, inexpensive and easily available

Beer, wine and caffeinated beverages — such as coffee, tea or soda — can contribute, but these should not be a major portion of your daily total fluid intake.

**Water is still best because it's calorie-free, inexpensive and readily available**

# Next recommendation

To ward off dehydration and make sure your body has the fluids enough - good idea:



cz.123rf.com

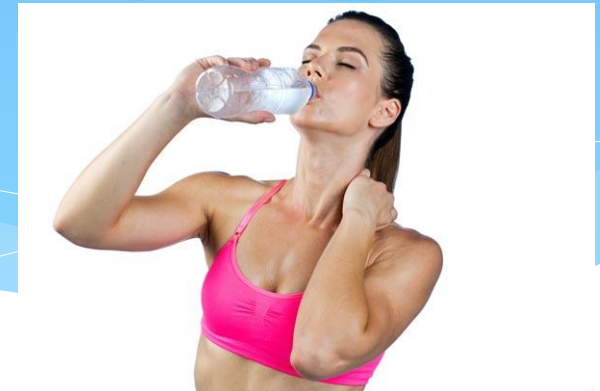
➤ Drink a glass of water or other calorie-free or low-calorie beverage with each meal and between each meal

Drink water before, during and after exercise



cz.123rf.com

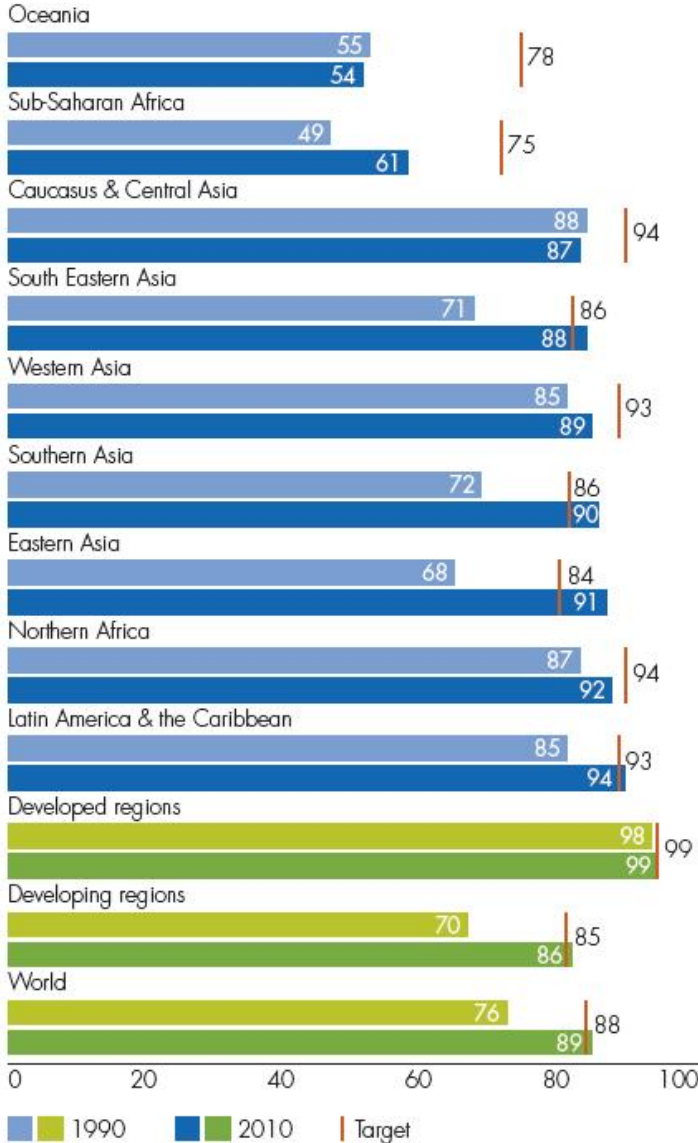
[kaloricketabulky.cz/2014/01/jak-spravne-jist-a-pit-pred-a-po-cviceni/](http://kaloricketabulky.cz/2014/01/jak-spravne-jist-a-pit-pred-a-po-cviceni/)



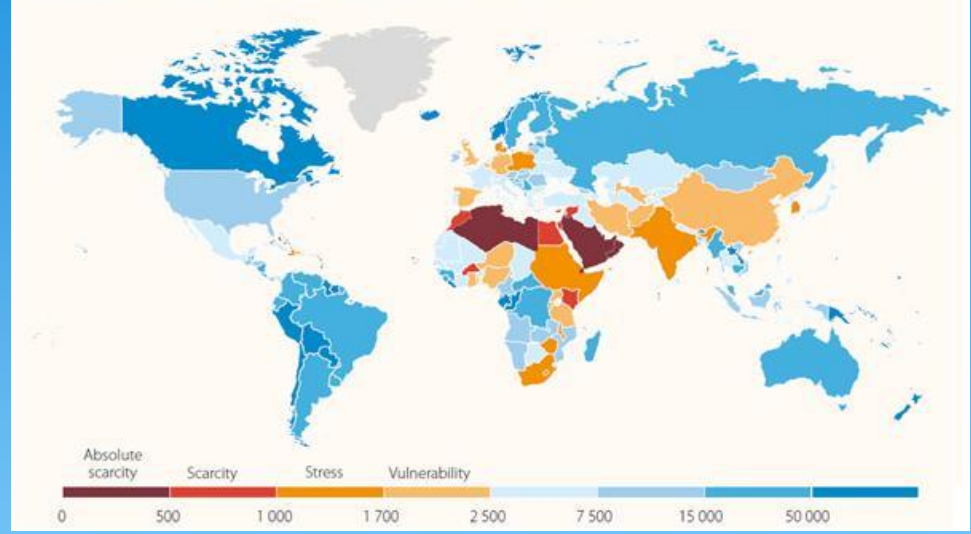
# Is water readily available ?



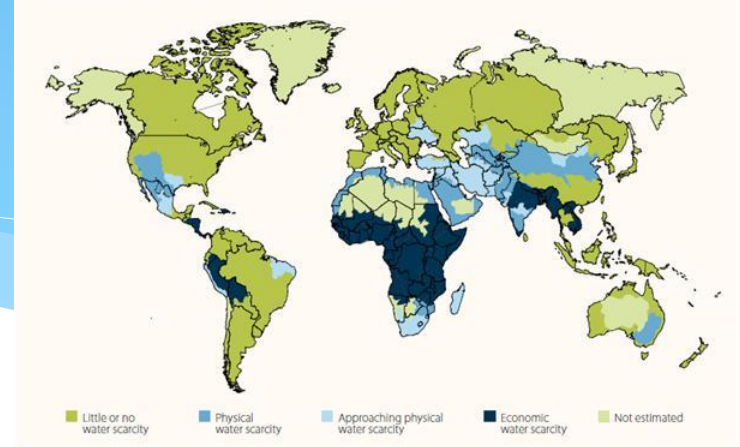
Proportion of population using an improved water source, 1990 and 2010 (Percentage)



Total renewable water resources, 2011 (m³ per capita per year)

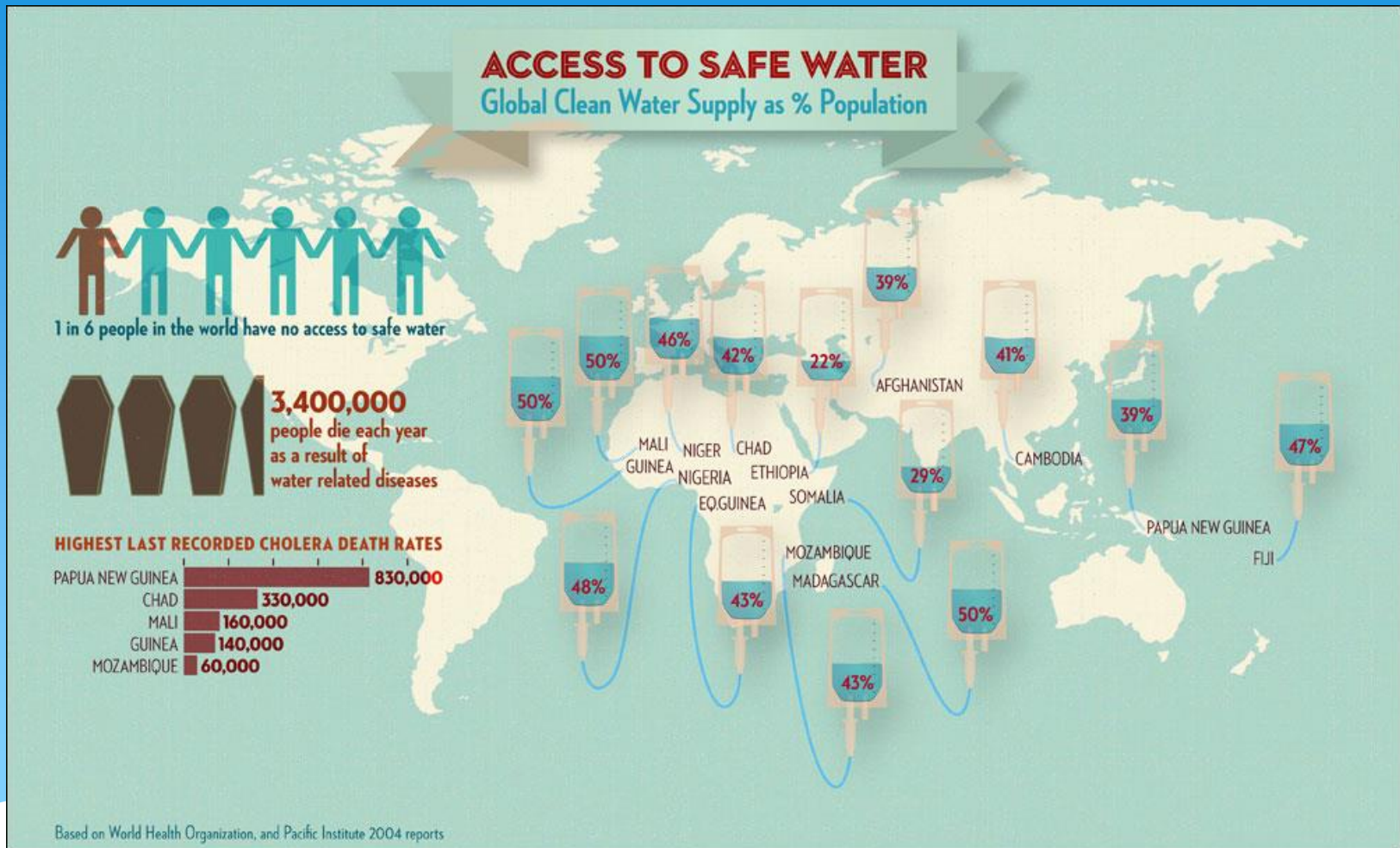


Global physical and economic surface water scarcity



google.com

# Access to safe - water



WHO: Pacific Institute, report 2004

Note: inhabitants without access to harmless drinking water

# WHO



[unicefconnect.wordpress.com](http://unicefconnect.wordpress.com)

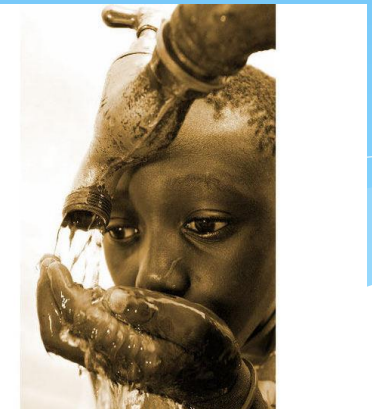


Safe-water isn't available in all countries !

The average distance to source of safe drinking water in Africa and Asia is six kilometers! **Need – daily!!**



[www.faceafrica.com](http://www.faceafrica.com)



# Without water isn't life

- In CR – summer – lack water !!!
- Resources are limited
- ! **Conserve , to save water !!!**



magazin.ceskenoviny.cz

In CR - popularity - swimming pools near at home !

eliteliving.cz

- Flushing toilets x **by drinking water!?!**
- Rain water - reservoirs, ↓ amount: new - max.6 litres !



cz.depositphotos.com/51610860ústock-photo-pflushing-toilet.cz



fyzmatik.pise.cz





# Water resources on Earth

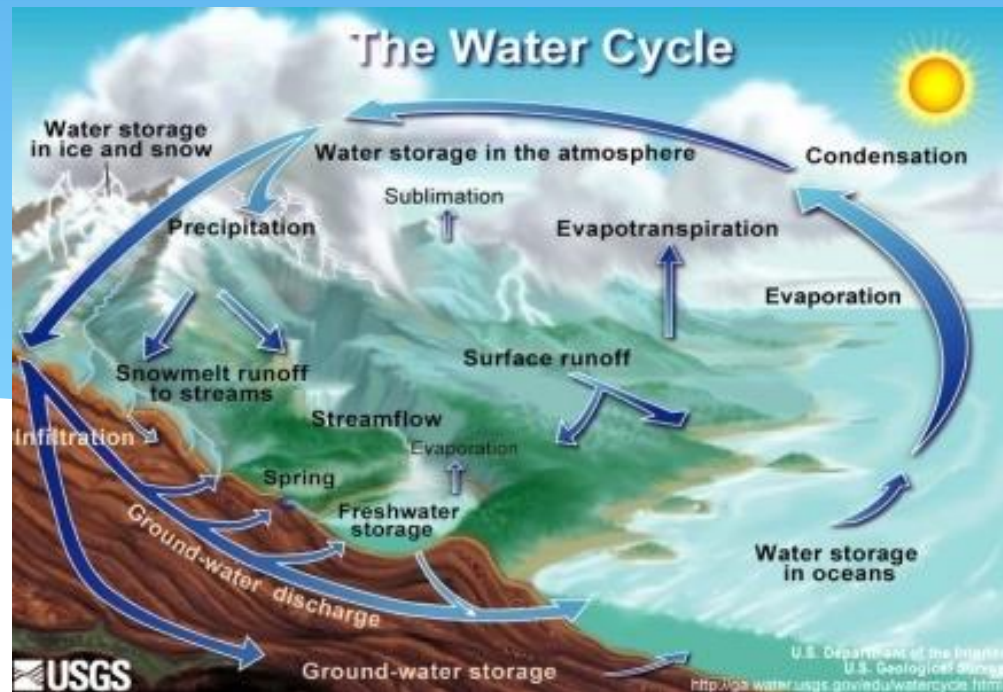
Water resources aren't inexhaustible!



Many uses of water include: agricultural, industrial, household, recreational and environmental activities.

Only 2.5% of water on the Earth is fresh water, and over two thirds of this is frozen in glaciers and polar ice caps.

**!! 70% of world-wide water** use is for irrigation in agriculture.



# Water in hydrosphere

Ocean .....	97,7 %
Glacier .....	1,7 %
Atmospheric water .....	0,0009 %
Freshwater lakes .....	0,0093 %
Damps .....	0,0004 %
Rivers, streams .....	0,0001 %

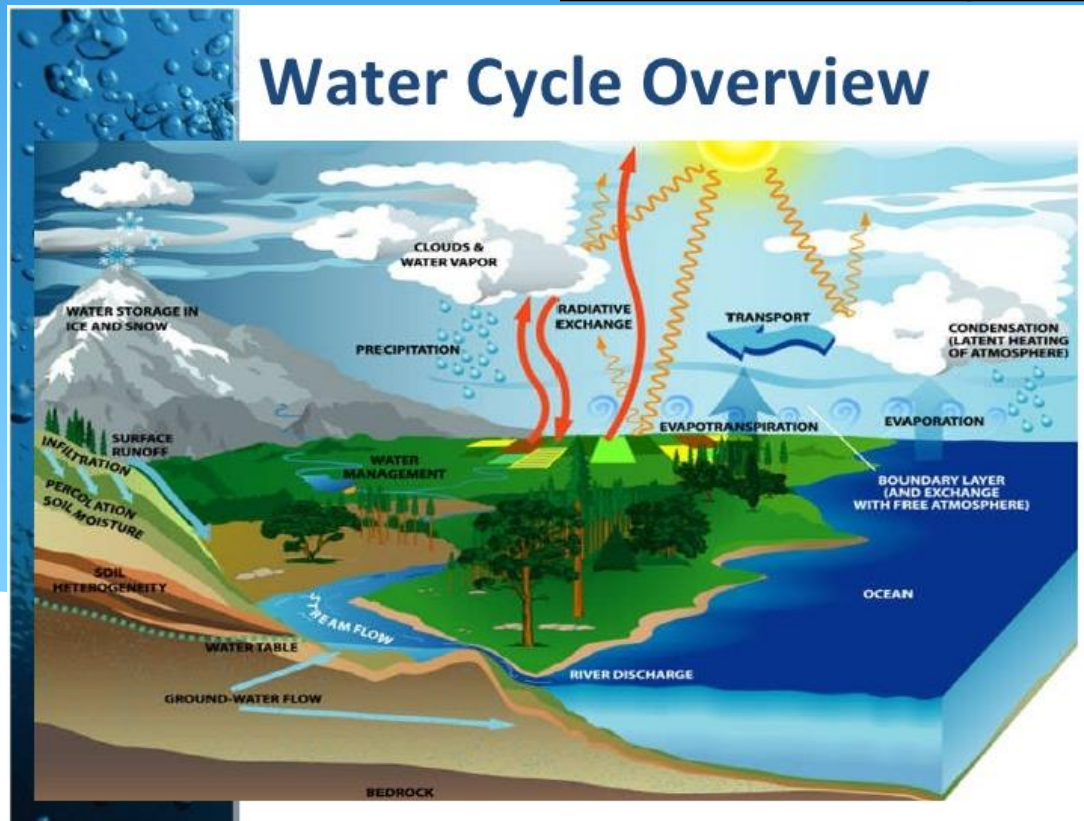


tapety.walpapers.cz

# Water cycle



Climate changes will have significant impacts on water resources around the world –  
close connections between the climate and hydrologic cycle



# Water pollution

## What are the sources of water pollution?

- Two general categories: direct and indirect contaminant sources
- Main: Agriculture and Industry
- Urbanic areas
- Direct sources include wastewaters from factories, refineries, waste treatment plants, animals etc



tyden.cz



enviregion.pf.ujep.cz



karvinsky.denik.cz



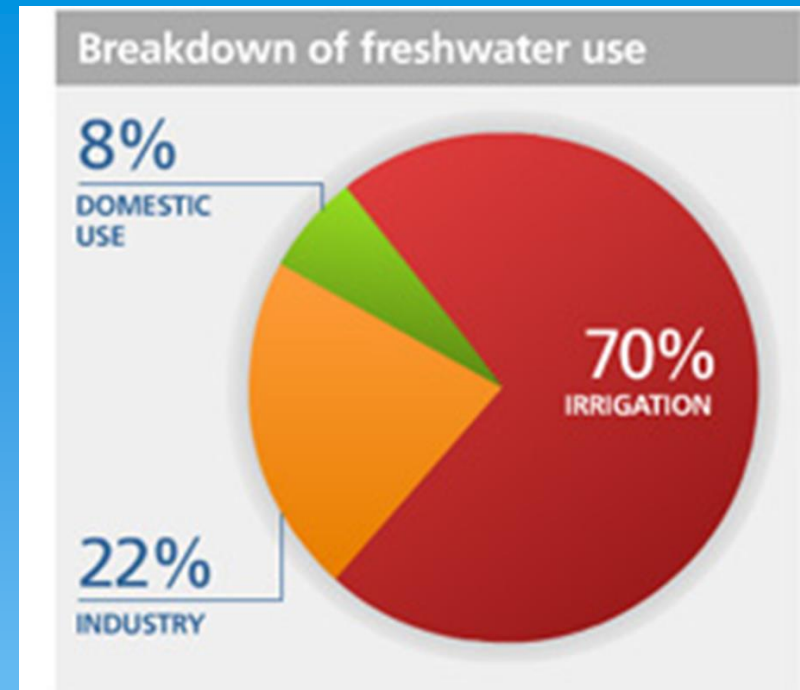
zenergo.cz



<http://vtm.e15.cz/ekozemedelstvi-vybrat-soulad-s-prirodou-ci-pesticidy>

# Agriculture

**Big consumption of water !**



Google: fewresources.org

**The consumption of water for irrigation from 1960 to 2005 increased by 60% - more than 2-times !**

**Why??**

**Reasons: growing population – growing consumption of food and feed (animals)...**

# Urban areas



Large agglomerations and cities (but not only big) produce a large amounts of waste water

- Contaminants from industry, traffic – heavy metals, organic compounds , ....
- Contaminants from household – detergents, phosphates, drugs – antiflogistics, antihypertensives, antidepressives, estrogenic hormones - contraceptives, aj. → they can cause change of sex the water organisms - fish – bad effect on reproduction, deformations of fish body, low weight, growth...

**!** Endocrine disruptors – hormonally active substances

**□ Question: Do you know – what's the consumption of safe-water for 1 person/day? In CR ...**

# Endocrine disruptors

## **hormonally active substances**

- affect the hormonal system at all levels
- similar structure to hormones
- may occupy receptors
- may modify receptors
- impaired hormone pathways
- connected with metabolic diseases, DM, impaired reproduction, reduction number of sperm
- changed sex of fish, other water organisms (crayfish) – the impossibility of reproduction, growth retardation

# Water pollution2



## What are the effects of water pollution?

The main effects of water pollution:

- Cannot be use as drinking water for human consumption (toxic compounds, xenobiotics), for animals (due to these organisms having bioaccumulated toxins from the environment)
- unbalanced water ecosystems
- effects are specific to the various contaminants



# Water pollution3



What are the ways we can take to decrease those problems?

1. to minimizing the present levels of pollutants, contaminants
2. remediating (cleaning up)
  - Approximately 90% of wastewater in developing countries is discharged without purification straight into rivers and other waterways !!!
  - !!! Wastewater treatment plant !!!
  - In our everyday lives – all activities to minimize pollution and save water !!!

# Wastewater



**Why is wastewater treatment so important ?**

**! Sources of diseases associated with pollution by various agents:**

**Do you know who they are ???**

**WHO:**

**In 2011 reported 600,000 cases of cholera !**

# Human impact on water – disease causing agents - pathogens



## Common diseases transmitted to humans through contaminated drinking water

Bacteria	Disease	Effects
Bacteria	Typhoid fever	Diarrhoea, severe vomiting, swelling of the spleen, inflammation of the intestine; often fatal if untreated
	Cholera	Diarrhoea, severe vomiting, dehydration; often fatal if untreated
	Bacterial dysentery	Diarrhoea; rarely fatal except in infants without proper treatment
	Enteritis	Severe stomach pain, nausea, vomiting; rarely fatal
Viruses	Infectious hepatitis	Fever, severe headache, loss of appetite, abdominal pain, jaundice, inflammation of the liver, rarely fatal but may cause permanent liver damage
Parasitic protozoa	Amoebic dysentery	Severe diarrhoea, headache, abdominal pain, chills, fever; if not treated can cause liver abscess, bowel perforation and death
	Giardiasis	Diarrhoea, abdominal cramps, flatulence, belching, fatigue
Parasitic worms	Schistosomiasis	Abdominal pain, skin rash, anaemia, chronic fatigue, and chronic general ill health

# Typhoid Fever Epidemiology



*Salmonella typhi* - has been a major human pathogen for thousands of years, cause: bad sanitation, waste

In history: Great Plague of Athens at the end of the Peloponnesian War

Presently occurs worldwide and is **endemic in Asia, Africa, Latin America, the Caribbean, and Oceania** (80% of cases come from **Bangladesh, China, India, Indonesia, Laos, Nepal, Pakistan, or Vietnam**) – wastewater contaminating rivers → contaminating sources of drinking water (poor sanitation)

**Danger:** school-aged children and young adults

High incidence among very young children and infants !

**WHO: kills about 4.000 children/day worldwide**

# Typhoid fever



Enteric fever, potentially fatal multisystemic illness

Caused by *Salmonella typhi*

The classic presentation includes fever, malaise, diffuse abdominal pain, and constipation

**DDx:** abdominal pain

Typhoid – treatment:

**Fluoroquinolone** for both complicated and uncomplicated cases of typhoid fever (must **test sensitivity**)

Multidrug-resistant *S typhi* is, by definition, **resistant** to the original first-line agents, ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole

**How can we protect before? Vaccination**

**Education**

# Waterborn disease 1

Example: Israel – before and after new regulations(1989)

Table 4. **Average number of communities with contaminated water in >25% of samples by district, Israel 1985–97<sup>a</sup>**

District	Years						
	1985–87	1988 <sup>b</sup>	1989 <sup>c</sup>	1990–91	1992–93	1994–95	1996–97
Jerusalem	2	0	10	4.5	0	0.5	0
North	47	29	125	77	24.5	13	8
Haifa	7	7	15	7	0	0.5	0
Central	10	6	31	17	5.5	3	1
Tel Aviv	0	0	0	0	0	0	0
Ashkelon	2	4	16	5.5	5	3	1
South	1	0	5	1.5	0	0	0
<b>Total</b>	<b>70</b>	<b>46</b>	<b>202</b>	<b>112.5</b>	<b>35</b>	<b>20</b>	<b>10</b>

<sup>a</sup> Source: Department of Environmental Health, Ministry of Health, 1999.

<sup>b</sup> Includes all of 1988 and the first 3 months of 1989 when the standards changed.

<sup>c</sup> Includes the 9 months from 1 April to 31 December — that is, the first period governed by the new regulations.

\* Reported by WHO: **Bull World Health Organ vol.78 n.12 Geneva Jan. 2000**

\* <http://dx.doi.org/10.1590/S0042-96862000001200015>

# Waterborn disease 2

Table 3. **Reported cases of waterborne enteric disease, total number of cases of enteric disease, and proportion of total disease identified as waterborne in community and non-community water sources, Israel 1976–97<sup>a</sup>**

Disease	Year				
	1976–80	1981–85	1986–90	1991–95	1996–97
<b>Shigellosis</b>					
Waterborne	6557	10 180	1524	260 <sup>b</sup>	0
Total (%)	32 839 (20)	44 152 (23.1)	29 070 (5.2)	25 874 (1.0)	7274 (0)
<b>Salmonellosis</b>					
Waterborne	979	157	244	260 <sup>b</sup>	0
Total (%)	10 101 (9.7)	12 386 (1.3)	17 127 (1.4)	28 986 (0.9)	11 481 (0)
<b>Typhoid</b>					
Waterborne	112	76	0	0	0
Total (%)	596 (18.8)	629 (12.1)	216 (0)	0	0
<b>Total all causes</b>					
Waterborne	7648	10 413	1768	520	0
Total (%)	43 536 (17.6)	57 167 (18.2)	46 413 (3.8)	54 984 (0.9)	18 788 (0)

<sup>a</sup> Source: Epidemiology Department, Ministry of Health, 1999.

<sup>b</sup> See footnote b Table 2.

- \* Reported by WHO: before and after new regulations (1989)
- \* Bull World Health Organ vol.78 n.12 Genebra Jan. 2000
- \* <http://dx.doi.org/10.1590/S0042-96862000001200015>

# Wastewater treatment -1



## Technology of wastewater treatment

1. Flocculation
2. Sedimentation
3. Filtration
4. Sanitation (desinfection)

### 1) Flocculation

Chemical reactions - a positive effect on water pollution – forming flakes with dissolved particles in the water, the particles bind with the chemicals and form larger particles called flocs (alum – aluminium sulfate used)



# Wastewater treatment-2



## 2) Sedimentation

Flocs sedimentates to the bottom of sedimentation tank

## 3) Filtration

Filtration through **filters** – **3 layers**, compositions: sand, gravel, charcoal - remove dissolved particles, such as dust, parasites, bacteria, viruses and other chemicals, espec. organic substanties, but hormanly active compounds (**endocrine disruptors**) – big problem !

# Wastewater treatment-3



## 4) Disinfection

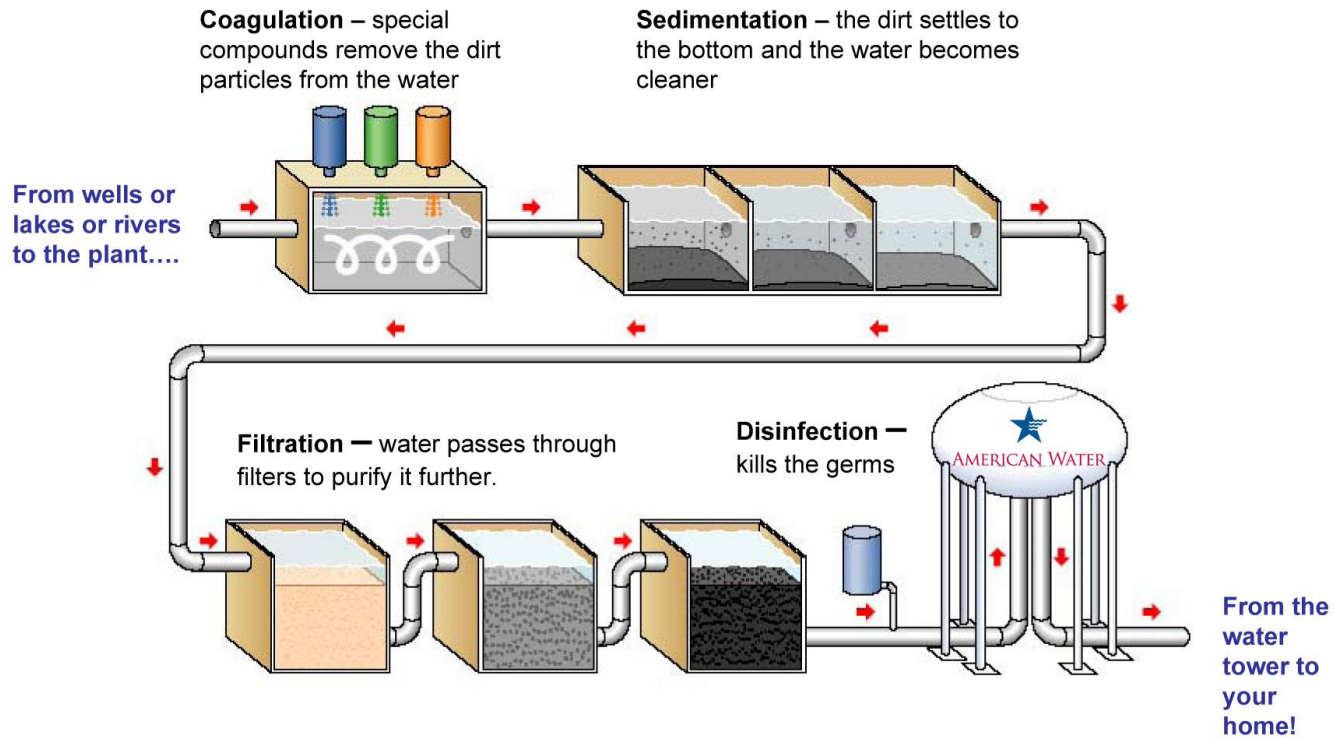
After the water has been filtered, a disinfectant (chlorine, chloramine) may be added in order **to kill** any remaining parasites, bacteria, and viruses, and to **protect the water from bacteria** when it is distributed to households, offices, schools ... for common use

# Wastewater treatment-4



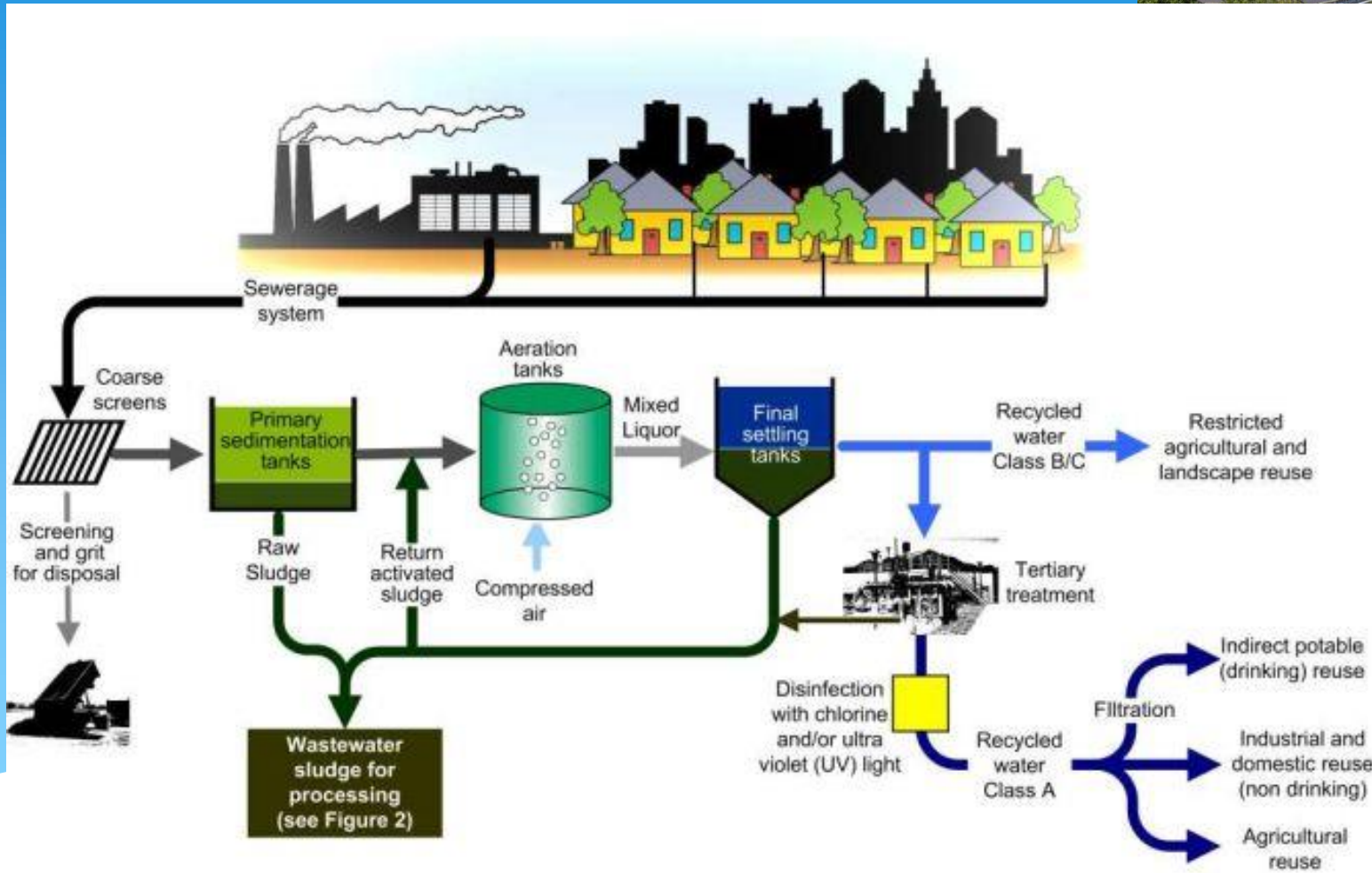
## Technology of wastewater treatment

### How a Water Treatment Plant Works



# Wastewater treatment

## Principle w-w. treatment from city



# Principles for water purification



**youtube:**

**Short video - 3 minutes**

- <https://www.youtube.com/watch?v=aMcamQJxFHs>

**Important video-lecture: 1:26 hour**

- <https://www.youtube.com/watch?v=JL3y1CWhirQ>

**Principle of flocculation: 5 minutes**

- [https://www.youtube.com/watch?v=5uuQ77vAV\\_U](https://www.youtube.com/watch?v=5uuQ77vAV_U)

# What is drinking water ?



- water to be consumed for a long period and will not cause harm !

- **WHO: Safe drinking-water** is defined:

- does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages.

**Drinking water** is suitable for all usual domestic purposes, including personal hygiene.

# Water Quality and Health



## WHO Water Quality and Health Strategy 2013-2020

1. protect existing sources of drinking water and the possibility of finding and building additional sources
  - Strategies for developed and developing countries:
2. fighting with infectious diseases transmitted by water
  - **In 2011 reported 600,000 cases of cholera !**
  - Every year bad quality of water cause death 1,8 milion of children under 15 y. = (4.000/day)!!!**
  - **88% of all diarrheal diseases are caused by contaminated water and bad or lack sanitation**

# W H O



The quality of drinking-water is a powerful environmental determinant of health

Safety drinking-water is a prevention against of waterborne diseases

Sanitation: the provision of clean drinking water and adequate wastewater disposal(treatment plant)



# Sources of water?

What sources for drinking water we can use?

- Ground water
- Surface water
- Sea water? High salinity !

**CR: Švihov - dam (or Želivka dam) –**  
lies on the Želivka river), 90 km from Prague

- reservoir of drinking water
- surface water reservoir
- supply capitol Prague
- from 1972 y.
- supplementation : 76% of consumption

**Performance: 6,93 m<sup>3</sup>/s of water**



# Surface water



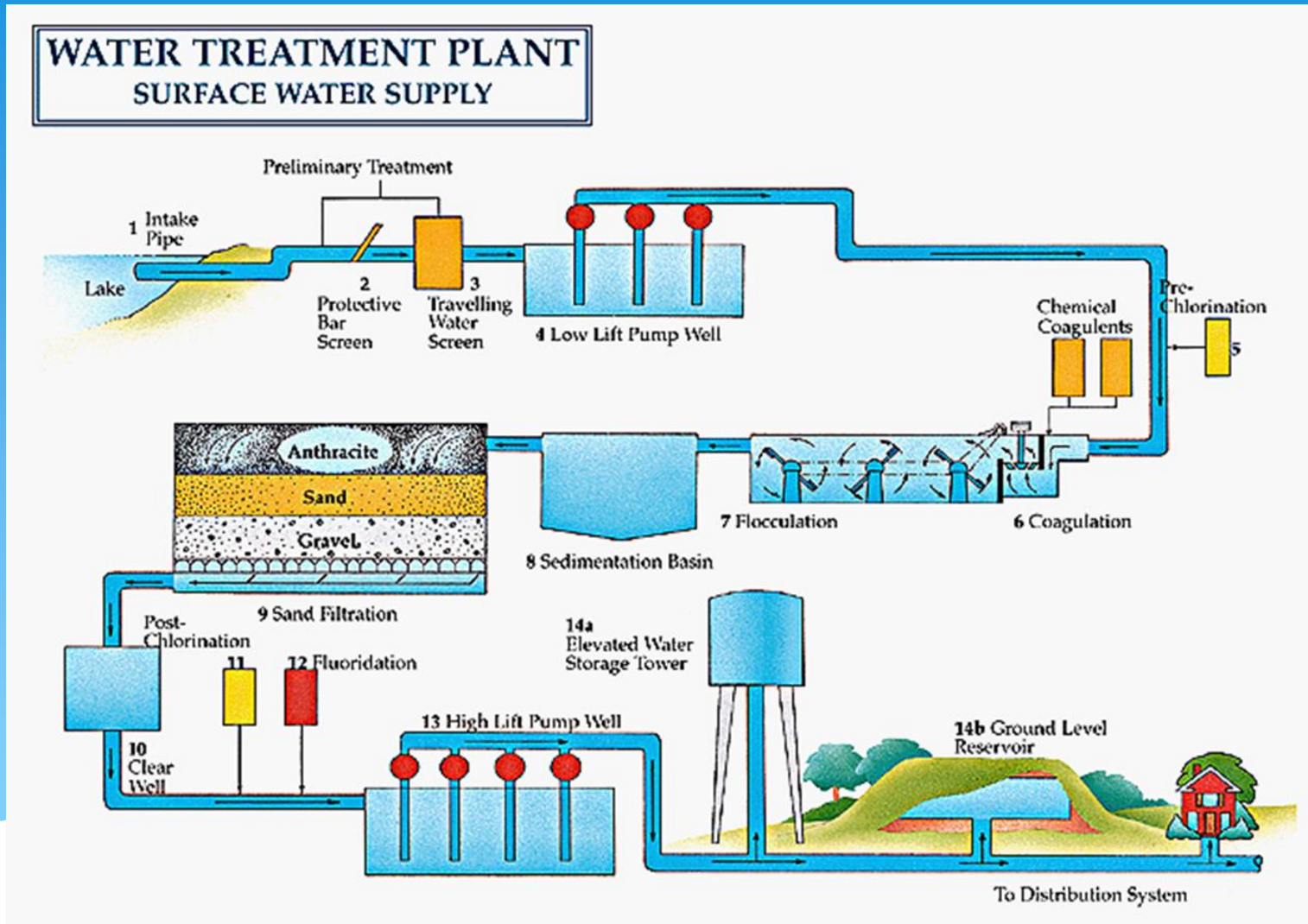
## Definition:

**Surface water** collects on the ground, in streams, rivers, lakes, dams and in oceans

Differs from groundwater (composition)

Surface water is naturally recycled by rain, but naturally lost through evaporation and underground infiltration

# Principle of surface w.-treatment for drinking



# Threshold Limit Value

## What is it?

The level that can be exposed day after day for a lifetime without adverse health effects

## Main attention is focused on:

Concentration of active Cl<sup>-</sup> -

Concentration of nitrates and nitrites

Presence of bacteria (pathogenic microflora-Enterobacteriaceae)!

Presence of polychlorinated hydrocarbons (PCB) - a synthetic organic chemical compound

Presence of alfa activity



# Composition - limits



nitrate 50 mg/l – NMH

nitrite 0,5 mg/l – NMH

Fluoride ions 1,5 mg/l – NMH

ammonia ions 0,5 mg/l – MH

chlorides 100 mg/l – MH, při chloridech v podloží 250 mg/l

iron 0,2mg/l – MH , při železe v podloží 0,5 mg/l

Free chlorine in chlorinated water 0,3 mg/l - MH

# Microbiological and biol.parameters of drinking water

## In Czech Republic : Degree 252/2004



parameter	unit	limit	
22°C psychrophilic microorganisms	*KTJ/ml	500	- **well for individual supply
	-----		
	KTJ/ml	200	- ***for public supply
	-----		
36°C mesophilic microorganisms	KTJ/ml	100	- well for individual supply
	-----		
	KTJ/ml	20	for public supply
	-----		
Pseudomonas aeruginosa	KTJ/250 ml	0	
	-----		

➤ Next parameters ..... next slide ...

**Notes:** \*KTJ – colony forms units of bacteria  
\*\* individual supply – for less than 100 person  
\*\*\*public supply – more than 100 person

# Microbiological and biol.parameters



indicator	number of colonia / limit	
1. Clostridium perfringens	KTJ/100 ml	0 public
	KTJ 10 ml	0 individ
2. Enterococcus	KTJ/100 ml	0 public
	KTJ 10 ml	0 individ
3. Escherichia coli	KTJ/100 ml	0 public
	KTJ 10 ml	0 individ
4. coliforms bacteria	KTJ/100 ml	0 public
	KTJ 10 ml	0 individ

Note: **KTJ\*** – colony forms units of bacteria (CFU)

# Composition of drinking water



<b>Ca<sup>++</sup></b>	<b>40 - 70 (min 30) mg/l</b>
<b>Mg<sup>++</sup></b>	<b>20 - 30 (min 10) mg/l</b>
<b>Na<sup>+</sup></b>	<b>5 - 25 mg/l</b>
<b>K<sup>+</sup></b>	<b>1 - 5 mg/l</b>
<b>Cl<sup>-</sup></b>	<b>less than 50 mg/l</b>
<b>SO<sub>4</sub><sup>-</sup></b>	<b>less than 50 mg/l</b>
<b>HCO<sub>3</sub><sup>-</sup> hydrocarbons</b>	<b>100 až 300 mg/l</b>
<b>F<sup>-</sup> - fluorides</b>	<b>0,1 - 0,3 mg/l</b>
<b>NO<sub>3</sub><sup>-</sup></b>	<b>less than 10 mg/l</b>

**RL - dissolved compounds, mineralization) 150 až 400 mg/l**



## Parameters of drinking water for infants x adults



**For newborns (especially under 4-5 weeks) water supplements can be risky**

Babies under two months should not be given supplemental water.

**Parameters are stricter for infants**

**Infants:**  $\text{NO}_3^-$  less than 10 mg/l

$\text{NO}_2^-$  less than 0,02 mg/l ... **methemoglobinemia !!!**

$\text{Na} \leq 20$  mg/l

Parameters

Infants

Adults

Parametry kojenecké a kohoutkové vody (mg/litr) a KTJ/ml		
Sledovaný parametr	KOJENECKÁ VODA	PITNÁ VODA
Organotrofní bakterie 22 °C	max. 100	max. 100
Organotrofní bakterie 36 °C	max. 20	max. 20
Vápník	dop. 40 – 80	dop. 40-80
Sodík	max. 20	max. 200
Dusičnany	max. 10	max. 50
Dusitany	max. 0,02	max. 0,50
Benzo(a)pyren	méně než zjizitelné	max. 10
Železo (nanogramy/litr)	max. 300	max. 200

*(KTJ – kolonie tvořící jednotky), dop. – doporučené množství, max. – maximální množství*

# Main parameters – example what is monitored

Left column  
-parameters

<i>Compliance levels in water supply zones exceeding 1000 m<sup>3</sup> per day as an average or serving more than 5000 persons</i>			
	2005	2006	2007
<i>Microbiological parameters</i>			
E.coli	99.5	99.7	99.8
Enterococci	97.4	99.7	99.7
<i>Chemical parameters</i>			
Arsenic	100	100	92.9
BaP	99.3	100	100
Bromate	96.4	100	100
Copper	100	100	99.7
Lead	100	100	99.3
Nickel	100	100	98.5
Nitrate	99.5	99.4	99.3
Nitrite	100	99.8	100
Total pesticides	100	100	99.3
<i>Indicator parameters</i>			
Aluminium	100	99.4	100
Ammonium	100	99.8	99.9
Chloride	99.9	100	99.8
Cl.perfringens	98.5	100	100
Colour	99.7	99.7	99.8
Conductivity	100	100	99.9
pH	99.9	99.7	99.5
Iron	99.4	98.5	98.0
Manganese	98.9	98.5	97.9
Odour	100	100	99.9
Oxidisability	99.9	100	99.8
Sodium	99.9	99.9	99.9
Sulphate	100	99.6	99.8
Coliform bacteria	97.5	100	100
TID and tritium	100	100	100
All other DWD parameters had full compliance in the three reporting years.			

# WATER: historical public health

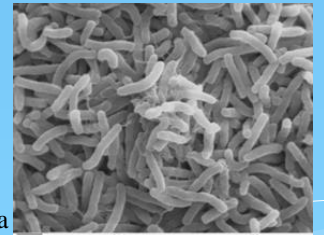


- Water is one of the basic physiologic and hygienic human needs
- Daily access to drinking water was a precursor to human development
- Contaminated water has been identified with disease spread throughout history and was not properly described until the 19<sup>th</sup> century (germ theory)

Proteobacteria *Vibrio cholerae*

**Robert Heinrich Herman Koch** 1843 – 1910

wikipedia



German physician, microbiologist, identifying the specific causative agents of tuberculosis, **cholera** and anthrax (infection disease).

# Important links



1. Water , 2 – 3 minutes

[http://www.youtube.com/watch?v=\\_R\\_vpNQofJc](http://www.youtube.com/watch?v=_R_vpNQofJc)

2. flocculation , 5 - 6 minutes

[https://www.youtube.com/watch?v=5uuQ77vAV\\_U](https://www.youtube.com/watch?v=5uuQ77vAV_U)

( 5 minutes, flocculation)

3. Lecture: youtube WATER : 1,5 hour in English

Water and wastewater treatment

<https://www.youtube.com/watch?v=JL3y1CWhirQ>

# Important links:

www pages of Department of Hygiene and Epidemiology 1.Faculty of  
Medicine, Charles University, Prague

**Link:** <http://hyg.lf1.cuni.cz/>

- **Question for Test/ State Exam**
- **Materials for downloading**
- **Materials for Hygiene: Water – J.Quinn, V.Bencko**
- **In Czech: Pitná voda – A. Slámová**

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