

# **Water and health**

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## Water and health

Act No. 258/2000 Coll.  
on public health protection:



**„Drinking water** is all water in its original state or after treatment intended for drinking, cooking, preparation of food and drinks, water used in the food industry, water intended for body care, cleaning of objects , which by their intended purpose come into contact with food or human body and for other purposes of human consumption, irrespective of its origin, state and mode of delivery. „

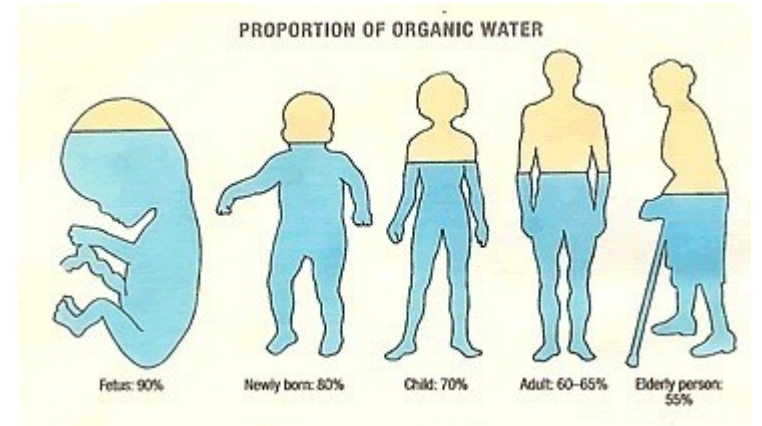
# Water and health

## Function of water in body:

- transport (transmission of nutrients, waste products, heat, electrolytes, hormones)
- assistance in thermoregulation
- acts as a solvent and a suitable environment for chemical reactions taking place in the body
- protects the surroundings of joints, spinal cord and brain
- surrounds the fetus like amniotic fluid
- involved in maintaining homeostasis, ensuring a physically and chemically stable internal environment of the body



# Water and health



Water requirement:

Very individual, can not be standardized.

It depends on many factors - age, sex, weight, ambient temperature and air humidity, health, diet, physical activity

After birth, water is 75% of body weight, in adults 60% and in old age 50% of body weight

The need for water is partly covered by its natural content in foods ranging from 20-30% (very fatty products) and very often between 80-90% (fruits, vegetables, soups, sauces).

# Water and health

By the oxidative metabolism of organic macronutrients, 300 ml of water per day is produced in the human body.

Necessary water intake is average 2.5 l per day for an average adult (1.5 liters in the form of beverages and 1 l from regular food).

Literature - 22 ml - 50 ml per kg of body weight, regardless of climatic conditions

Children are dehydrated faster, so they should drink more - schoolchildren by half more than adult of the same weight.

Water delivery and intake should always be in equilibrium

# Water and health

Lack of water in the body (dehydration) - headaches, fatigue, malaise, decrease in physical and mental performance, including decreased concentration

- children - decreased ability to concentrate

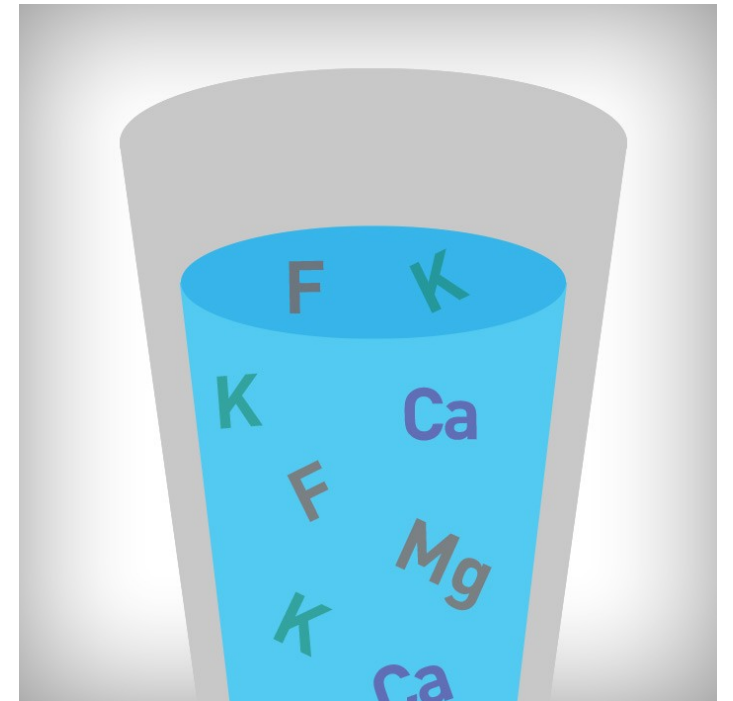
Long-term fluid deficiency - renal impairment, kidney and urinary stones, risk of urinary tract infection,...

# Biological (biogenic) value of drinking water

Drinking water must be health-conscious with a satisfactory biological value.

Mineral substances contained in drinking water are usually in ion form, perfectly dissolved, and are therefore easily resorbable and more usable for the organism.

Water is an important source of all required minerals (fluorine in the form of fluoride anions, iodine, sodium, potassium, the calcium / magnesium ratio, selenium, zinc and other macro and micro elements).



# Drinking water sources - their protection

Czech Republic - surface sources: underground source = 1: 1

2016 - 2.305 water treatment plants - 600 million m<sup>3</sup> (Prague 100 million)

Brno dam - 7.6 - 10.8 million m<sup>3</sup>

When determining the range of hygiene protection, account shall be taken of:

- geological composition of soil, its permeability (sand x clay)
- slope of the land around the source
- yield of water source
- industrial activity
- agricultural activity
- transportation around the source



Campaign For Water Protection



# Drinking water sources - a multi-barrier approach to their protection

To ensure that water is microbiologically safe, it is necessary to apply:

1. barrier - consistent protection of water source (functional protection zone)
2. barrier - the use of such water treatment technology, which corresponds to the quality of raw water
3. barrier - water protection against secondary contamination during distribution to the consumer
4. barrier - internal water supply (domestic water supply) - design of hygienically safe materials

# Drinking water sources - water treatment

Category according to Decree of the Ministry of Health No. 428/2001 Coll., As amended by Decree No. 146/2004 Coll.

	Resources % surface	Resources % underground
A 1 - <b>Simple physical treatment</b> and disinfection, for example fast filtration and disinfection, or simple sand filtration, chemical deacidification or mechanical deacidification or removal gaseous components by aeration.	7.1	76.5
A 2 - common <b>physical treatment, chemical treatment and disinfection</b> , coagulation filtration, infiltration, slow biological filtration, flocculation, sedimentation, filtration, disinfection (final behavior), single- or two-stage jamming and demagnetization.	54	9
A 3 - <b>intensive physical and chemical treatment</b> , extended treatment and disinfection, for example chlorination to break point, coagulation, flocculation, sedimentation, filtration, adsorption (activated carbon), disinfection (ozone, final chlorination). Combination physically chemical and microbiological and biological treatment	38,9	14,5

# Drinking water sources and their protection

Suspicion or finding that the water in the source is contaminated:

The source of the pollution is removed, building modifications are carried out, the hygienic protection zone is restored

Wells - the inner walls of the well are mechanically cleaned, the water is drained, the bottom is cleaned from sludge

One-off disinfection is carried out



# Disinfection of drinking water

Chloramine - 2-3 g / m<sup>3</sup> of water, Sagen (Ag), Savo, Chlorine, Ozone, UV, filtration

Boiling : bubbles on the whole surface of water (100 ° C), leave for 10 minutes stand and naturally cool down - do not put ice in it. **Water is not sterile !!!** (sterility only ensures sterilization in the **autoclave**).



# Non-potable/running water

It is hygienically safe water which is not used as drinking water and for cooking but only for washing, bathing and for production purposes.

Domestic hot water is produced from drinking water under the Public Health Act but is not considered drinking water.

Industrial water

Technological water

Water for irrigation





# Microbes transmitted by water

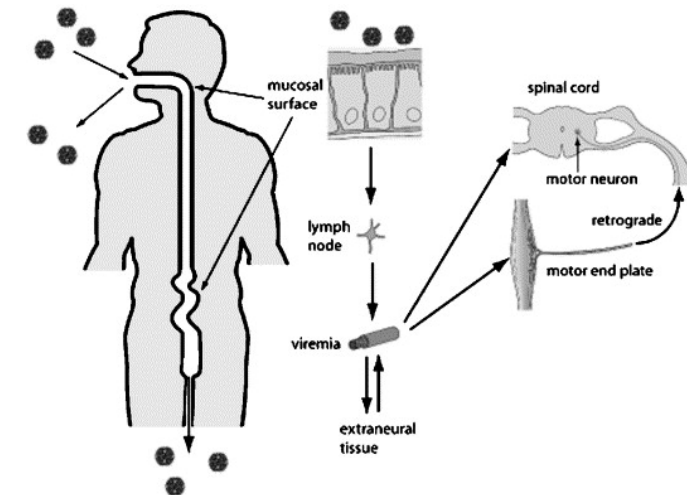
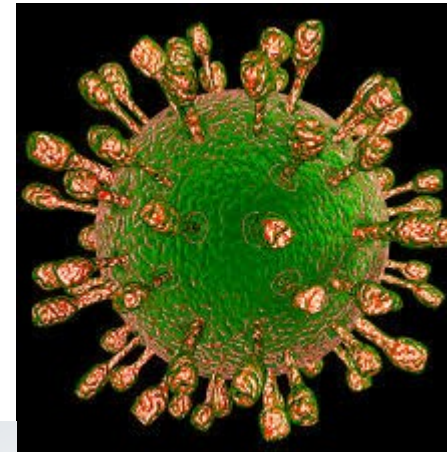
Condition: excretion of agent by excrement (humans and animals) and possibility of new food infections

Viruses:

Rotaviruses - diarrhoeal diseases

Polioviruses - agents of poliomyelitis

RNA viruses – hepatitis A, E, (F)

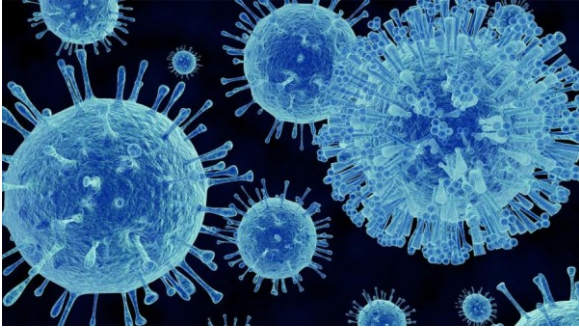


**What is hepatitis?**

The A, B, C, D and E of hepatitis	What vaccines are available for which types of hepatitis?	Estimated cases worldwide (per year)	How does the virus spread?
<p>There are five main hepatitis viruses</p>	<ul style="list-style-type: none"> <li>✓ Hepatitis A</li> <li>✓ Hepatitis B</li> <li>✗ Hepatitis C</li> <li>✓ Hepatitis D</li> <li>✓ Hepatitis E</li> </ul> <p>Inflammation of the liver</p>	<p><b>Hepatitis B and C:</b> <b>400 million cases</b></p> <hr/> <p><b>Gradual death:</b> An estimated <b>1.4 million</b> people die worldwide from hepatitis every year</p> <hr/> <p><b>Treatment:</b> <b>90%</b> of hepatitis C patients can be healed within three to six months</p>	<p><b>Hepatitis A and E:</b> Lack of food hygiene, contaminated water and sub-standard sanitary facilities</p> <p><b>Hepatitis B, C and D:</b> Blood, sperm and other bodily fluids</p>

Source: WHO © DW



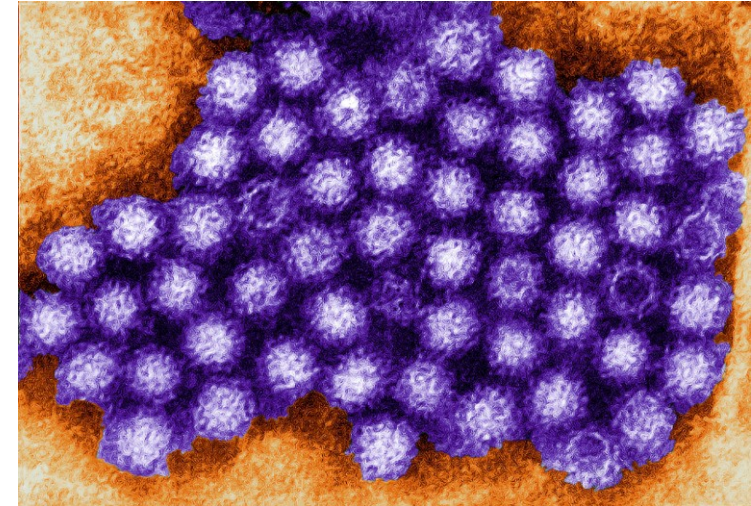


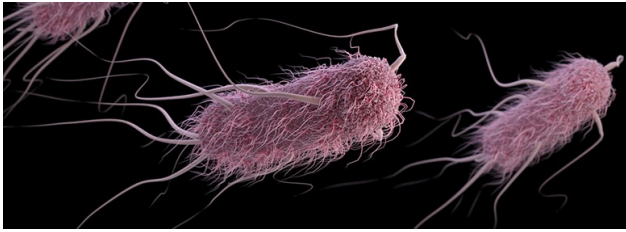
## Microbes transmitted by water

Viruses – cont.:

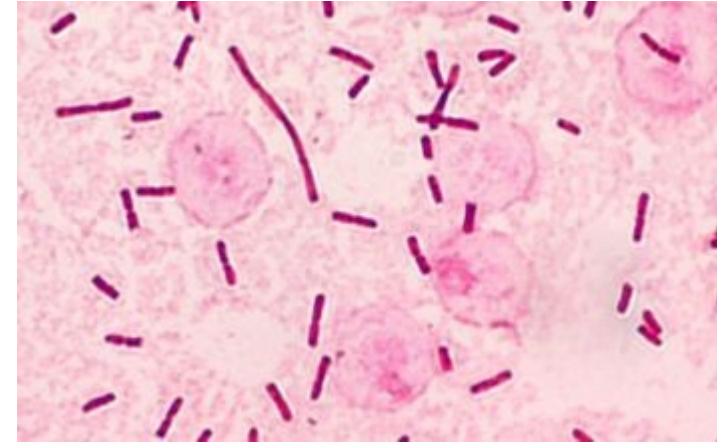
**Norovirus** - originally called the Norwalk virus

- RNA virus
- it causes an epidemic acute gastroenteritis
- diseases from **water** (Prague), food, but also through direct contact
- **symptoms** of the disease - nausea, vomiting, diarrhea and abdominal cramps, mild fever, fever, pain of muscles and headache, fatigue
- it is also transmitted via a faecal oral route





## Microbes transmitted by water



### Gram negative facultative anaerobic rods:

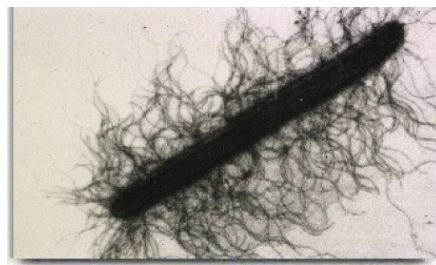
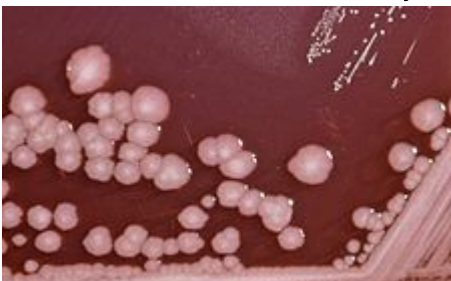
*Escherichia coli*, *Klebsiella* spp., *Citrobacter* spp., *Salmonella typhi*, *Salmonella paratyphi* - frequent water transfer

*Shigella sonnei*, *Shigella flexneri* - bacillary dysentery

*Yersinia enterocolitica* - diarrheal diseases in children

*Serratia marcescens* - infection of the urogenital and respiratory tract

*Proteus mirabilis*, *Proteus vulgaris* – urogenital tract, gastroenteritis in infants





# Microbes transmitted by water

## Gram negative aerobic rods and cocci:

*Klebsiella pneumoniae*, *Pseudomonas aeruginosa*

- via aerosols
- inflammation of the upper respiratory tract, lung, urogenital tract

*Neisseria gonorrhoea*, *Treponema pallidum*

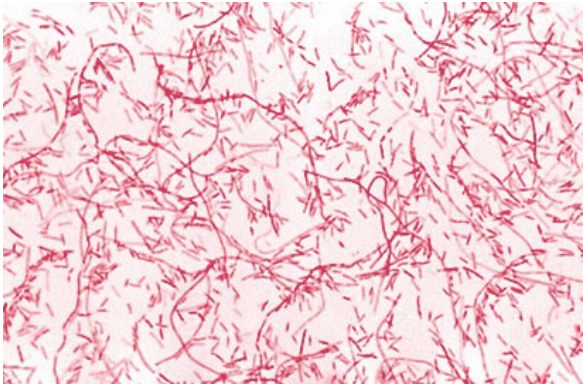
- they do not survive in the waters, transmission is unlikely

*Campylobacter spp.* - diarrheal diseases



CAMPYLOBACTER





## Microbes transmitted by water



*Legionella pneumophila* (Legionella) – G- aerobic rod

### Occurrence:

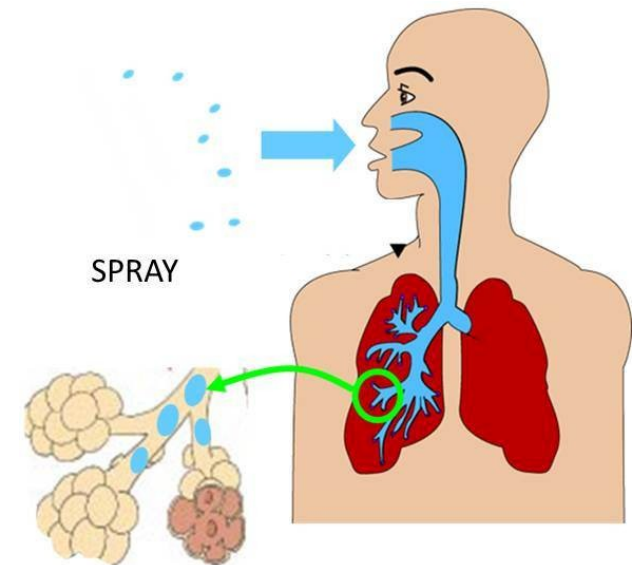
hot and cold water, surface water, water courses as part of biofilms, filters, refrigeration circuits of air conditioners.

**Survives** in humid environments

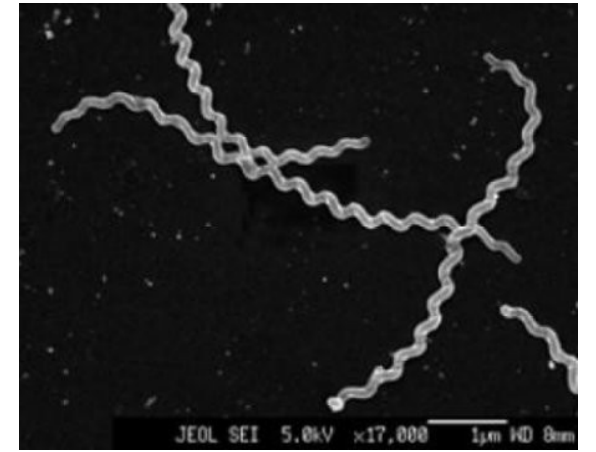
It **lives** and multiplies at 25-50 °C.

**Spread** with air - inhalation of aerosol contaminated water

**Respiratory** tract infections, pneumonia (Legionnaires' disease)



# Microbes transmitted by water



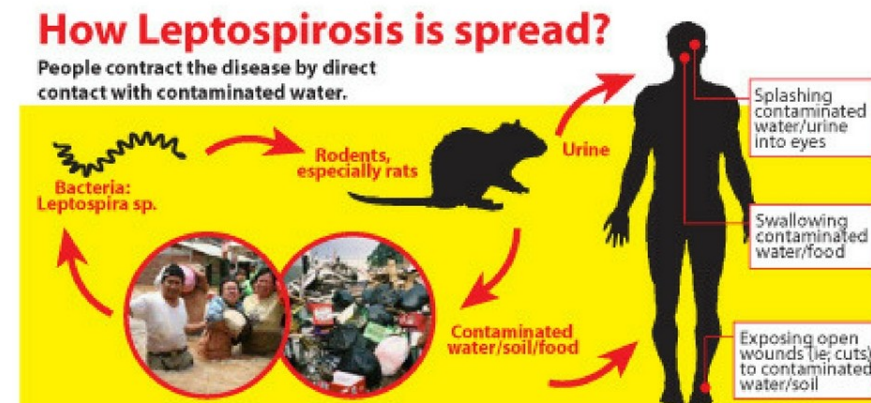
**Leptospirosis** – G- spirochete

Febrile bacterial disease, a **zoonotic** disease caused by genera *Leptospira*

The **way of infecting** people is contacting damaged skin, eyes or mucous membranes with water contaminated by the urine of the infected animal

This is an **antropozoonosis** – transfer from animal (rats, mice, cattle) to humans

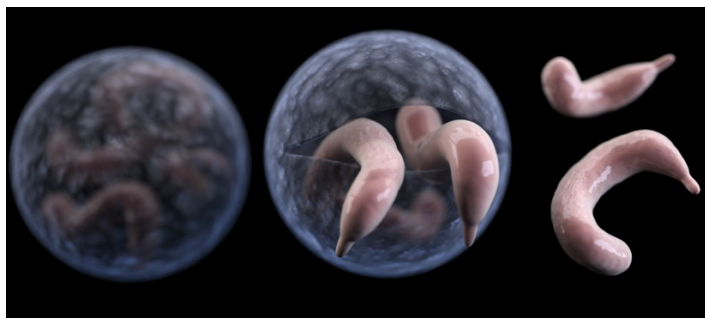
**Symptoms** - high fever, chills, tremor, severe headache and muscle aches, abdominal pain, nausea, vomiting



# Microbes transmitted by water

**Fungi and yeasts** – water mains, air washers, air conditioning



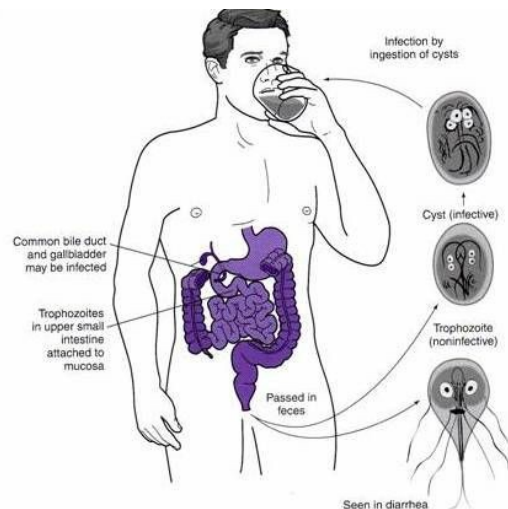


## Protozoa

*Cryptosporidium* - protozoa - occurrence in surface waters.

- it can also penetrate into drinking water - chemical disinfection against oocysts is ineffective.
- causes diarrheal disease - cryptosporidiosis.
- **1993 Milwaukee Cryptosporidiosis outbreak** - 400,000 patients  
104 death

*Giardia intestinalis* - human lamblia - it causes diarrheal disease – giardiasis



Infective germ can enter the body and cause the disease not only by the digestive tract, but also by the airways, skin abrasions and injuries.

\* DID YOU KNOW?

**Cryptosporidium,**  
a diarrheal disease  
caused by parasites,  
is easily spread  
in water and is  
resistant to chlorine.

Here's how to avoid contacting  
and spreading crypto at  
swimming pools:

- Don't swim if you have had diarrhea in the previous two weeks.
- Avoid swallowing pool water.
- Use swim diapers on babies, and check them often.
- Make kids take bathroom breaks every 60 minutes.

UNIVERSITY OF STAN  
HEALTH CARE  
healthfeed.uofuhealth.org



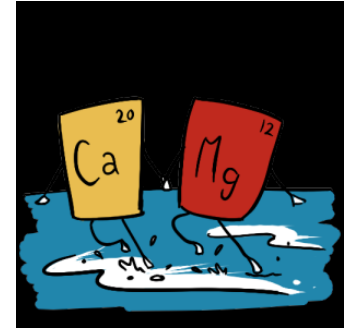
# Health aspect

The **route of inhalation and dermal** - may be more risky than the oral route

- substances after entry into the body can affect the target organs before liver biotransformation.
- **doses** received by inhalation and dermal route are, in their sum, at least equal to the dose obtained by ingestion of 2 liters of water.

Extra-intestinal and intestinal disease - extra-intestinal and intestinal infections

# Water hardness and cardiovascular diseases



Water hardness - mainly composed of calcium and magnesium carbonate

History: The 50s of the last century - Japanese chemist Kobayashi pointed out that mortality on the cerebral vascular disease of the population is higher in the vicinity of the Japanese rivers, where the water is more acidic (softer) than the rivers with water harder (more basic) - from where the water was used for drinking purposes.

The relationship between drinking water hardness and mortality in cardiovascular disease - demonstrated in many further studies.



Hardness minerals precipitate out of the water and form energy robbing scale.

**Hardness ?**



# Water hardness and cardiovascular disease

**Calcium:** necessary for the proper functioning of the heart's transfer system, for blood clotting and neuromuscular irritation

**Magnesium:** an important role as a cofactor and activator of over 300 enzymatic reactions including glycolysis, ATP metabolism, transport of elements such as Na, K, Ca through membranes.

It is also important for protein and nucleic acid synthesis.

Magnesium deficiency increases the risk of vascular spasms and promotes cardiac arrhythmias.

Protective effect of calcium and magnesium against the development of tooth decay



# Water hardness and cardiovascular disease

## **Calcium and magnesium - beneficial antitoxic function**

Ca and Mg also prevent the absorption of some toxic metals such as lead and cadmium.

Utilization of magnesium from the water is also higher than that from food.

Cooking in soft water causes considerable loss of elements from food, while cooking in hard water minimizes losses.

# Drinking water and cancer

**Water disinfection** with chlorination – chlorine can react with higher level of organic substances in water – production of low-molecular substances (chloroform, chlorobenzene, heptachlor and other chlorinated compounds) - genotoxic activity.

Studies show a **connection** between drinking chlorinated drinking water and the occurrence of bladder, rectum, kidney **tumors**. Negative effects on **reproduction** have also been demonstrated.

**Arsenic** in drinking water - exposure is associated with the occurrence of various skin lesions (pigmentation, keratoses, skin tumors and malignant tumors).

**Arsenites** show high embryotoxicity.

# Drinking water and cancer

**Nitrates** - no clear epidemiological evidence that people who consume drinking water with increased nitrate content are at increased risk of cancer (reaction with amino acids to produce nitrosamines).

Only one of three UK studies has revealed a relationship between stomach cancer mortality and nitrate content in water. So far, the results are inconsistent.

**Methemoglobinemia** may be more significant – especially in infants

**Radionuclides** – mainly natural radionuclides are important for drinking water.

It is generally assumed that the ingestion of radon in drinking water is not associated with any significant risk of cancer.

# Drinking water and cancer

**Fluorides** - fluorization of drinking water to prevent tooth decay has been reversed in the Czech Republic.

Environmental studies have not confirmed the effect of fluorides on cancer.

Industrially produced **organic substances** (chlorophenols, trichlorethylene, volatile organic compounds) - besides impairment of the immune system, there was an increased incidence of bladder cancer.

# Drinking water and cancer

## Cyanobacterial toxins (cyanotoxins)

Cyanobacteria - in warmer waters with higher nutrient content (especially phosphorus - agriculture, detergents)

They can cause digestive tract disorders, allergic reactions, liver disease, immune system weakness, respiratory and contact dermatitis...

They have embryotoxic and genotoxic effects



# Drinking water and cancer

Drinking water can theoretically contribute to the annual increase in the probability of developing cancers in the Czech Republic by only 1-2 cases to the total number of over 60,000 new cases of newly reported cancer.

# Bottled water

- Natural mineral water
- Spring water
- Infant water
- Drinking water



**Natural mineral water:** extracted from an underground resource that must be approved and regularly inspected by the Ministry of Health

Mattoni, Magnesia, Podebrady



# Bottled water

**Spring water** (table): from a protected underground resource that does not need to be approved by the Department of Health.

It must not be modified in any way that would alter the characteristic composition

Toma natura, Bonaqua

**Infant water:** from a protected underground resource, and more stringent requirements apply to it

Mountain spring (Horský pramen)

**Drinking water:** It does not have to come from an underground resource, it can be tapped from the public water supply, the quality is comparable to drinking water quality from the water supply



# Mineral bottled water

If you would drink only **mineral water**, you would get too much salt into your body, especially sodium.

**The mineral waters** - benefit mainly in heat, during heavy work and intense sports

**Pregnant and lactating women** should choose those with higher potassium and calcium levels

**The sodium content** should be mainly watched by the cardiac

Dyspnoeic **people**, people who suffer from swelling, who tend to develop kidney stones – no mineral water at all

**Artificially supplied carbon dioxide** does not bring anything to the body to benefit. It contributes to bloating and burying. Carbon dioxide is the waste product that our body must actually constantly get rid of.

# Health risks - demineralized water

Demineralized water - it does not have the character of drinking water and its regular consumption or one-off consumption in large quantities must be considered as a health risk

Devices based on distillation or deionization must be rejected as the final stage of drinking water treatment:

- virtually zero intake of calcium and magnesium with water
- reduced intake of some essential elements and microelements
- high losses of calcium, magnesium and other essential elements from foods cooked in demineralized water

# Water enriched with oxygen

Water artificially enriched with pure oxygen - a food supplement

Manufacturers claim: increased oxygen concentration in blood, increased vitality and performance, blood pressure regulation, improved metabolism, increased immunity, increased resistance to stress, improved concentration and memory

A safe concentration of oxygen in drinking water can be considered to be up to 25 mg per liter.

Increased oxygen saturation - the risk of oxidative stress and its cytotoxic effects

An increase in chromosome aberrations was observed in rats

# Water enriched with oxygen

Oxygen-enriched water manufacturers have not yet submitted any scientific study that would confirm the safety of higher oxygen values in water (when consumed)

Further work is needed to confirm or eliminate the potential physiological and toxic effect of oxygen enriched water

No international recommendations (WHO, FAO, etc.) on the safe maximum concentration of oxygen in drinking water

Natural pure water has a maximum of about 10 mg of oxygen per liter

# Water and health - Microbiological analysis of water

DECREE No. 83 of 30 April 2014 amending Decree No. 252/2004 Coll., laying down the sanitary requirements for drinking and warm water and the frequency and scope of drinking water control, as amended

**Limit value (MH):** Exceeding does not usually present an acute health risk. Unless otherwise indicated, this is the upper limit of the allowable range.

**Highest limit value (NMH):** The value of a health-related indicator of the quality of drinking water as a result of which the **use of water as a drinking water is excluded**, unless the public health authority decides otherwise under the law.

# Microbiological analysis of water

## Indicator (groups of) bacteria

**Psychrophilic bacteria** (22°C) - indicators of general contamination

**Mesophilic bacteria** (36°C) - indicators of general contamination

## Faecal contamination

**Coliform bacteria** - indicators of faecal contamination

(*Escherichia* spp., *Salmonella* spp., *Shigella* spp., *Yersinia* spp.)

**Enterococci** - indicators of faecal contamination

*Clostridium perfringens*

*Escherichia coli*

# Sampling procedure for microbiological analysis

**If the well has not been used for a long period of time** (eg in the winter season), it is necessary to drain the well prior to sampling (at least rinse well pipes from the well to the sampling point). If the well is drained, the water is allowed to rise and then sample of water is taken.

- **A sample of water is taken from the point** where water is normally used (from the distribution line, from the tap, from the pump, etc.). The sample can not be taken over the hoses used for watering and sprinkling.
- Prior to sampling, the water is drained for **1 to 5 minutes evenly** (according to the length of the pipeline) and then sampling bottle is filled with the sample as described below. The sample bottle is held in such a way that any impurity from the hands does not get into the sampler.
- **Samples should be stored in a refrigerator** and taken to the laboratory within 48 hours after sampling, sample for bacteriological analysis within 24 hours!

## **Sampling for chemical analysis:**

☒ The sample is taken up in polyethylene sample bottles (bottles). When sampling, the sample bottle, including the closure, is rinsed three times with tap water.

☒ The sample bottle is filled to the edge.

## **Sample collection for bacteriological analysis:**

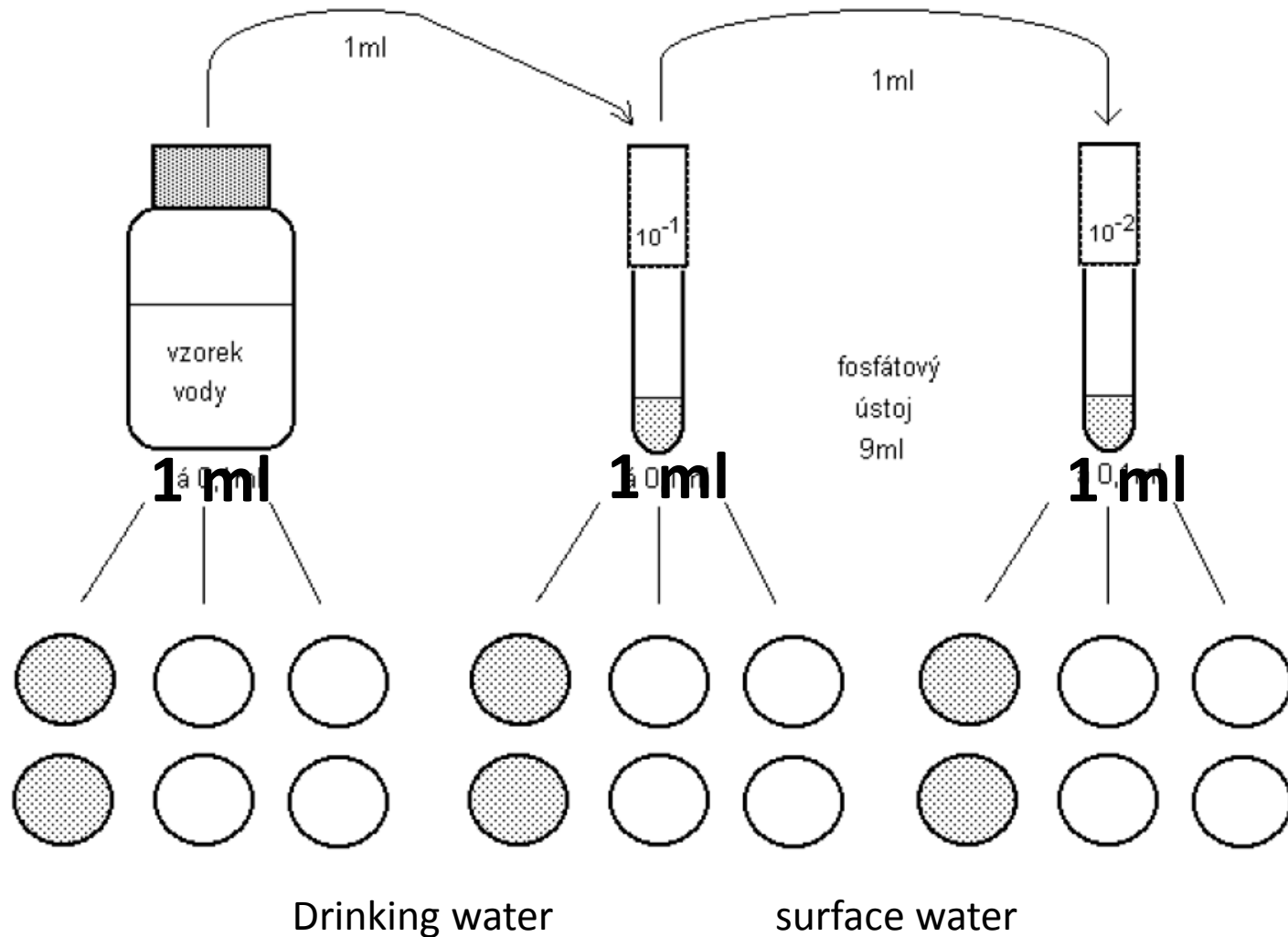
☒ The sample is to be taken only into glass bottles with aluminum foil.

☒ The sample bottle is opened just before sampling. The sample bottle is not flushed and it is filled so that between the surface and the plug there is about 2 cm of air.

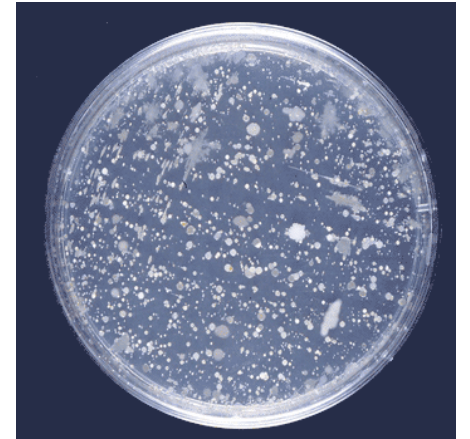
☒ After closure of the bottle, the socket plug is again covered with aluminum foil.

# Microbiological analysis of water

## Determination of general contamination indicators



1 ml of water plus 15 ml of TYEA agar



### Cultivation

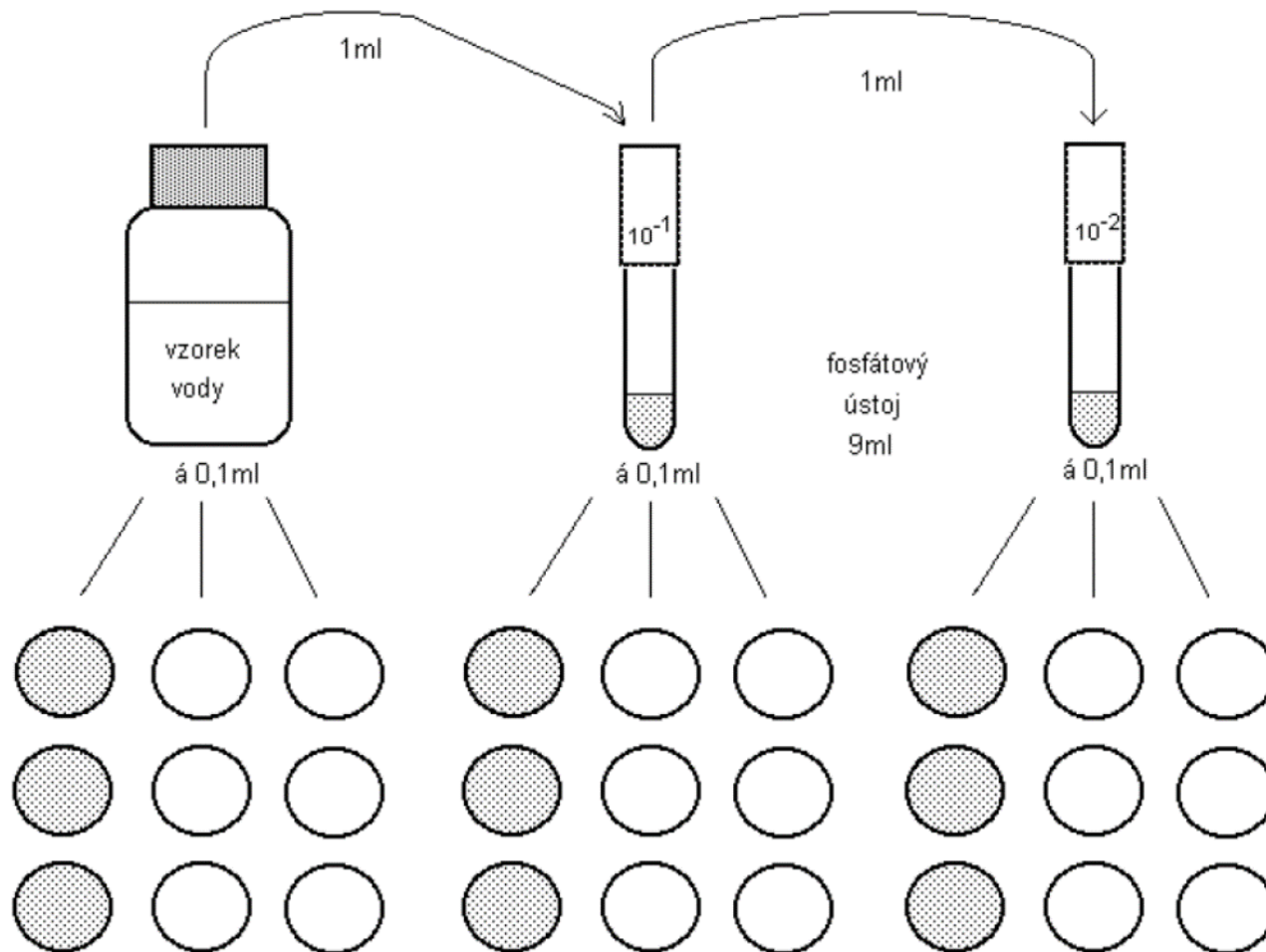
at 22°C – psychrophilic bacteria

at 36°C – mesophilic bacteria



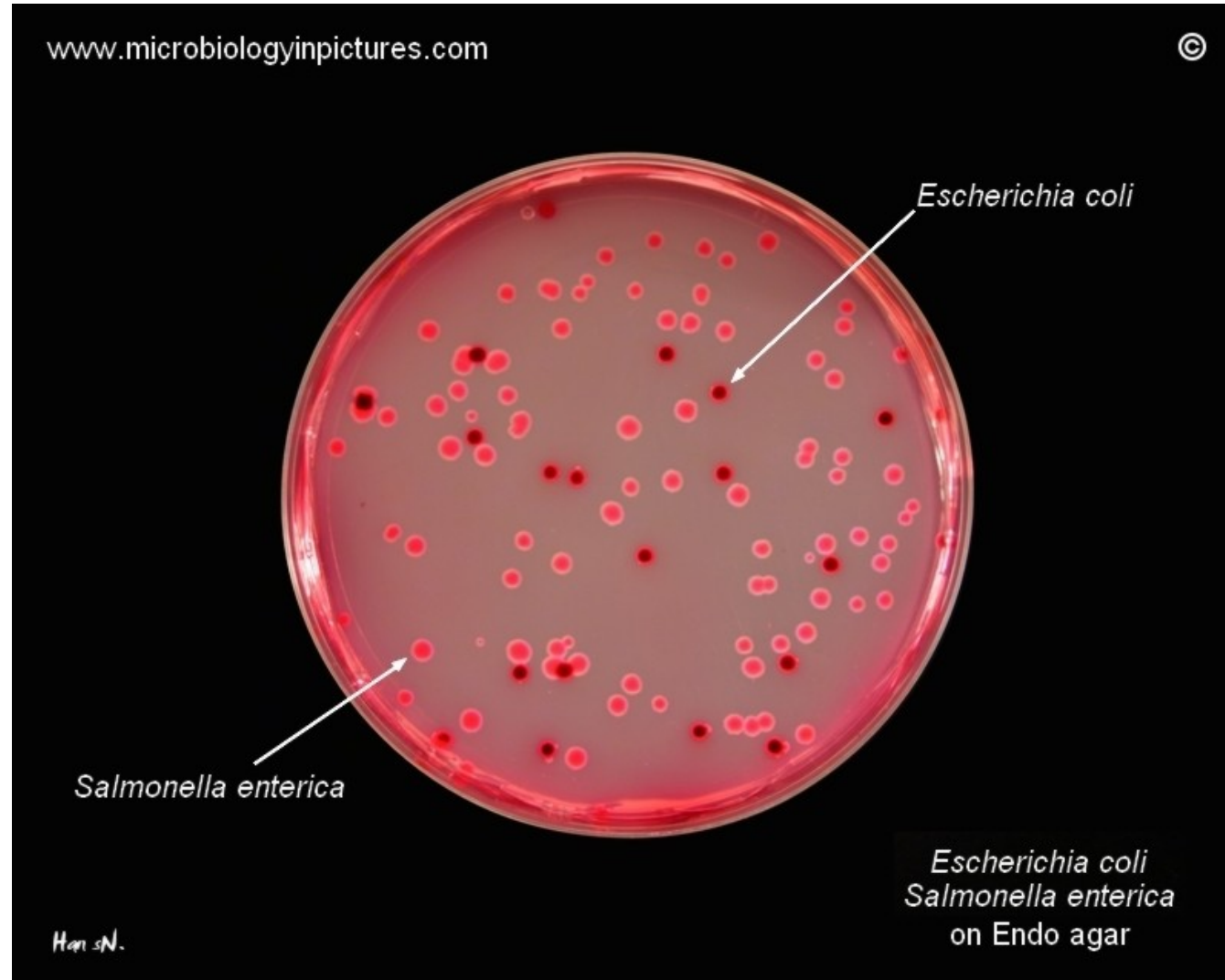
# Microbiological analysis of water

## Determination of general contamination indicators



**Endo 37°C**  
coliform bacteria  
**mFC 44°C**  
termotolerant coliform  
**SB 37°C**  
enterococci

# Coliform bacteria



# Escherichia coli



**E. coli on EMB agar. Has a nice green metallic sheen. How...**

# HiCrome Chromogenic Coliform Agar (CCA)

HiChromogenic Coliform Agar is a selective medium recommended for the simultaneous detection of *Escherichia coli* and total coliforms in water samples (1).

The medium contains three chromogenic substrates.

The enzyme  $\beta$ -D-galactosidase produced by coliforms cleaves 6-chloro-3-indoxyl- $\beta$ -D-galactopyranoside to form pink to red coloured colonies (3).

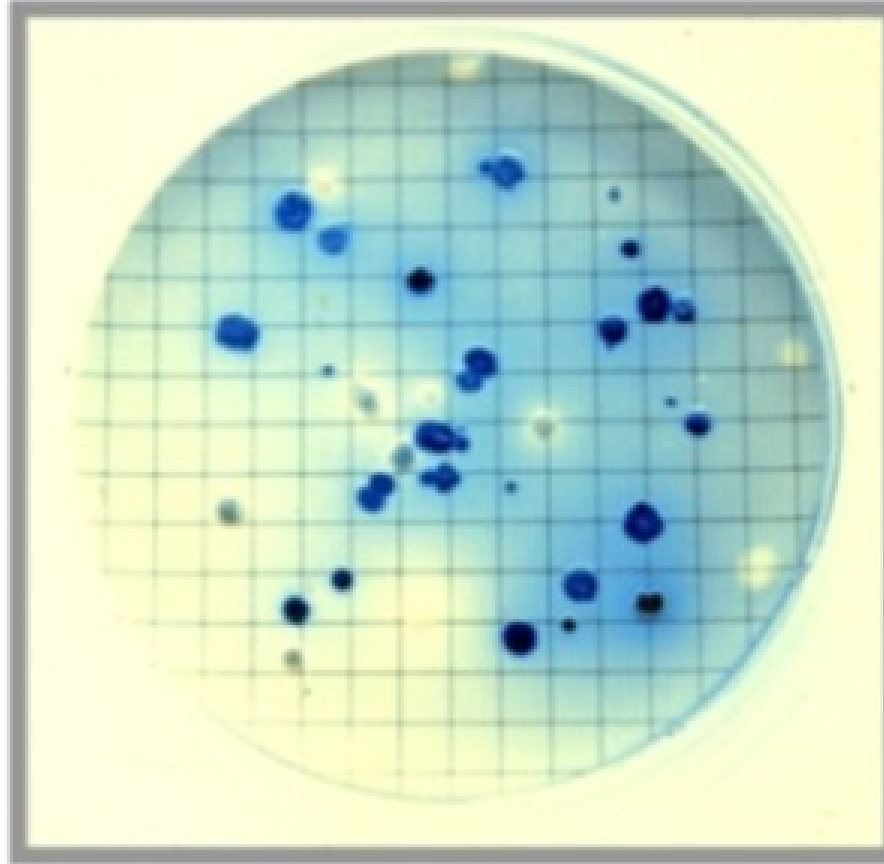
The enzyme  $\beta$ -D-glucuronidase produced by *E.coli*, cleaves 5-bromo-4chloro-3-indoxyl- $\beta$ -D-glucuronic acid (2).

Colonies of *E.coli* give dark blue to violet coloured colonies due to cleavage of both the chromogens.

The presence of the third chromogen IPTG enhances the colour reaction. Addition of L-Tryptophan improves the indole reaction thereby increasing the detection reliability.

# Thermotolerant coliform bacteria

mFC agar



Colonies that are light to dark blue,  
in whole or part, are counted as fecal coliforms

# Enterococci

## Slanetz & Bartley Medium

Originally intended as a medium for the enumeration of enterococci in water using Membrane Filtration, this medium has become more popular in many other areas such as food bacteriology.

The medium contains Tetrazolium Chloride, which is reduced by enterococci to the insoluble red dye Formazan resulting in **dark red colonies** of enterococci on the agar. It should be noted that this reaction is not exclusive to enterococci and colonies should be confirmed by additional testing e.g. aesculin hydrolysis.



# Physico-chemical properties

pH

Alkalite

Total hardness

Nitrates

Nitrites

Chlorides

Sulfates

Phosphates

Oxidability

Ammonia

Calcium

Magnesium

Iron

Cadmium

Trihalomethanes

PAH - polyaromatic hydrocarbons

**Organoleptic evaluation** - temperature, color, turbidity, taste, smell



# Accredited water analysis in Brno

## Water management services of the Czech Republic

Basic analysis of water with mikrobiology - 1290, - CZK

pH

overall hardness

COD-Mn (Chemical Oxygen Demand)

nitrates

nitrites

iron

manganese

sulphates

chlorides

ammonium ions

coliform bacteria - cfu

*Escherichia coli* - cfu



Zdravotní ústav se sídlem v Ostravě  
Centrum hygienických laboratoří  
Zkušební laboratoř č. 1393 akreditovaná ČIA podle ČSN EN ISO/IEC 17025:2005  
Partyzánské náměstí 7, 702 00 Ostrava

**PROTOKOL č. 32767/2017**

**Zákazník :** Krajská hygienická stanice Jihomoravského kraje se sídlem v Brně  
Jeřábkova 1847/4  
602 00 Brno

**Číslo zakázky :**  
**Příjem vzorku :** 31.5.2017 12:54  
**Vyšetření vzorku :** 31.5.2017 - 15.6.2017  
**Číslo jednací :** ZU/15317/2017  
**Číslo spisu :** S-ZU/15317/2017  
**Spisový znak :** 4.0.3

**Číslo objednávky :** ZBM0173

**Vzorek číslo :**  
**Datum odběru :** 31.5.2017 **Čas odběru :** 12:10  
**Název vzorku :** voda pitná - studna  
**Množství vzorku :** cca 5 l  
**Místo odběru :**  
**Matrice :** voda pitná  
**Vzorkoval :** Mrázová Zina, Bc.  
**Metoda vzork. :** SOP VZ OV 001 (ČSN EN ISO 5667-1, ČSN EN ISO 5667-3; ČSN ISO 5667-5, ČSN ISO 5667-14; ČSN EN ISO 19458, ČSN ISO 11731)  
**Způsob odběru :** prostý vzorek  
**Účel odběru :** státní zdravotní dozor

**Místní měření**

Ukazatel	Hodnota	Jednotka	TYP	Použitá metoda	Nejistota
teplota vzorku	12,3	°C	A	SOP OV 042	±1°C
chlor volný	<0,03	mg/l	A	SOP OV 008.01	-
pH	7,4		A	SOP OV 033	±0,3 pH

**Výsledky zkoušení - chemické vyšetření**

Ukazatel	Hodnota	Jednotka	TYP	Použitá metoda	Nejistota
1,2-dichlorethan	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
amonné ionty	<0,040	mg/l	A	SOP OV 064 <sup>7</sup>	-
Sb (antimon)	<0,50	µg/l	A	SOP OV 201 <sup>5</sup>	-
As (arzen)	<1,0	µg/l	A	SOP OV 201 <sup>5</sup>	-
barva	<5	mg/l Pt	A	SOP OV 064.02 <sup>7</sup>	-
benzen	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
benzo(a)pyren	<0,004	µg/l	A	SOP OV 331 <sup>5</sup>	-
B (bor)	<0,050	mg/l	A	SOP OV 201 <sup>5</sup>	-
bromičnany	<3	µg/l	A	SOP OV 003 <sup>2</sup>	-
TOC	1,3	mg/l	A	SOP OV 307 <sup>7</sup>	±20%
dusičnany	6,94	mg/l	A	SOP OV 003 <sup>7</sup>	±15%
dusitany	<0,020	mg/l	A	SOP OV 064.04 <sup>7</sup>	-
fluoridy	0,246	mg/l	A	SOP OV 003 <sup>7</sup>	±15%
Al (hliník)	<0,005	mg/l	A	SOP OV 201 <sup>5</sup>	-
Mg (hořčík)	51,6	mg/l	A	SOP OV 201 <sup>5</sup>	±20%
CHSK-Mn	1,5	mg/l	A	SOP OV 016 <sup>7</sup>	±25%
chloridy	288	mg/l	A	SOP OV 003 <sup>7</sup>	±15%
chlortany	<10,0	µg/l	A	SOP OV 003 <sup>2</sup>	-
Cr (chrom)	<1,0	µg/l	A	SOP OV 201 <sup>5</sup>	-
chut'	přijatelná	-	A	SOP OV 062 <sup>7</sup>	-
Cd (kadmium)	<0,20	µg/l	A	SOP OV 201 <sup>5</sup>	-
elektrická vodivost (25°C)	170	mS/m	A	SOP OV 064.13 <sup>7</sup>	±10%

**Výsledky zkoušení - chemické vyšetření**

Ukazatel	Hodnota	Jednotka	TYP	Použitá metoda	Nejistota
kyanidy celkové	<0,0050	mg/l	A	SOP OV 022.01 <sup>6</sup>	-
Mn	<0,030	mg/l	A	SOP OV 050 <sup>7</sup>	-
Cu (měď)	6,2	µg/l	A	SOP OV 201 <sup>5</sup>	±20%
Ni (nikl)	<2,0	µg/l	A	SOP OV 201 <sup>5</sup>	-
Pb (olovo)	<1,00	µg/l	A	SOP OV 201 <sup>5</sup>	-
pach	přijatelný	-	A	SOP OV 062 <sup>7</sup>	-
suma PAU	0	µg/l	A	SOP OV 331 <sup>5</sup>	-
Hg (rtuť)	<0,2	µg/l	A	SOP OV 200.03 <sup>5</sup>	-
Se (selen)	<1,00	µg/l	A	SOP OV 201 <sup>5</sup>	-
sírany	175	mg/l	A	SOP OV 003 <sup>7</sup>	±15%
Na (sodík)	23,9	mg/l	A	SOP OV 201 <sup>5</sup>	±20%
tetrachlorethan	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
trihalomethany	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
trichlorethan	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
trichlormethan (chloroform)	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
Ca (vápník)	240	mg/l	A	SOP OV 201 <sup>5</sup>	±20%
zákal	0,58	ZF(n)	A	SOP OV 044.01 <sup>7</sup>	±20%
Fe (železo)	<0,030	mg/l	A	SOP OV 051 <sup>7</sup>	-
dichlorbrommethan	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
dibromchlormethan	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
bromoform	<0,5	µg/l	A	SOP OV 344 <sup>5</sup>	-
chlorečnany	<10,0	µg/l	A	SOP OV 003 <sup>2</sup>	-
suma vápník a hořčík (tvrdost)	7,4	mmol/l	A	SOP OV 039 <sup>7</sup>	±8%

**Výsledky zkoušení - pesticidní látky**

Ukazatel	Hodnota	Jednotka	TYP	Použitá metoda	Nejistota
2,4-D	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
acetochlor	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
acetochlor ESA	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
acetochlor OA	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
alachlor	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
alachlor ESA	0,064	µg/l	A	SOP OV 341.02 <sup>5</sup>	±30%
alachlor OA	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
atrazin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
desethylatrazin	0,077	µg/l	A	SOP OV 341.02 <sup>5</sup>	±30%
atrazine-desisopropyl	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
hydroxyatrazin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
azoxystrobin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
bentazon	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
carbendazim	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
carboxin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
clomazone	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
clopyralid	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
cyanazin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
cyproconazole	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
cyprodinil	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
desmedipham	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
dicamba	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
dichlormid	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
dichlorprop	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
dimethachlor	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
dimethenamid	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
epoxiconazole	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
ethofumesate	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
fenpropidin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
fenpropimorph	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
fluazifop-p-butyl	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-

Výsledky zkoušení - pesticidní látky					
Ukazatel	Hodnota	Jednotka	TYP	Použitá metoda	Nejistota
fluroxypyr	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
flusilazole	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
haloxyfop-metyl	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
hexazinon	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
chloridazon (pyrazon)	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
chlorotoluron	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
chlorpyrifos	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
isoproturon	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
kresoxim-methyl	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
lenacil	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
linuron	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
MCPA	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
MCPB	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
MCPB (mecoprop)	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
mefenpyr-dietyl	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metamitron	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metazachlor	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metazachlor ESA	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metazachlor OA	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metconazole	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metobromuron	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metolachlor	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metolachlor ESA	0,089	µg/l	A	SOP OV 341.02 <sup>5</sup>	±30%
metolachlor OA	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
metoxuron	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
pendimetalin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
pethoxamid	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
phenmedipham	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
prochloraz	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
propiconazole	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
quinmerac	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
quinoxifen	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
sebutylazin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
simazin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
spiroxamin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
tebuconazole	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
terbuthylazin	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
thiophanate-methyl	<0,025	µg/l	A	SOP OV 341.02 <sup>5</sup>	-
pesticidní látky celkem	0,077	µg/l	A	SOP OV 341.02 <sup>5</sup>	±30%

Výsledky zkoušení - mikrobiologické vyšetření					
Ukazatel	Hodnota	Jednotka	TYP	Použitá metoda	Nejistota
Clostridium perfringens	0	KTJ/100ml	N	SOP OV 914.01 <sup>7</sup>	-
intestinální enterokoky	0	KTJ/100ml	A	SOP OV 906 <sup>7</sup>	-
Escherichia coli	3	KTJ/100ml	A	SOP OV 900 <sup>7</sup>	1-9
kolidiformní bakterie	50	KTJ/100ml	A	SOP OV 900 <sup>7</sup>	36-64
počty kolonií při 22°C	1,44x10 <sup>7</sup>	KTJ/ml	A	SOP OV 908 <sup>7</sup>	1,2x10 <sup>7</sup> 1,68x10 <sup>7</sup>
počty kolonií při 36°C	29	KTJ/ml	A	SOP OV 908 <sup>7</sup>	18-40
abioseton	3	%	A	SOP OV 916 <sup>7</sup>	30%
počet organismů	0	jedinci/ml	A	SOP OV 916 <sup>7</sup>	-
živé organismy	0	jedinci/ml	A	SOP OV 916 <sup>7</sup>	-
mrtvé organismy	0	jedinci/ml	A	SOP OV 916 <sup>7</sup>	-

**Poznámka k odběru :** Odběr je předmětem akreditace, nedílnou součástí protokolu je Protokol o odběru č. 7404/2017

**Poznámky k analýze :**

Do sumy pesticidů jsou zahrnuti pouze relevantní metabolity. Ostatní nerelevantní metabolity jsou uvedeny pro informací zákazníkovi. Postup pro hodnocení viz. metodika SZU.

Suma PAU obsahuje: benzo(b)fluoranthen, benzo(k)fluoranthen, benzo(ghi)perylene, indeno(1,2,3-cd)pyren.

**Upřesnění SOP :**

SOP OV 003	(ČSN EN ISO 15061, ČSN EN ISO 10304-1, ČSN EN ISO 10304-4)
SOP OV 008.01	(návod firmy HACH)
SOP OV 016	(ČSN EN ISO 8467)
SOP OV 022.01	(ČSN ISO 6703-2, ČSN 75 7415)
SOP OV 033	(ČSN ISO 10523)
SOP OV 039	(ČSN ISO 6059)
SOP OV 042	(ČSN 75 7342)
SOP OV 044.01	(ČSN EN ISO 7027-1)
SOP OV 050	(ČSN ISO 6333)
SOP OV 051	(ČSN ISO 6332)
SOP OV 062	(TNV 75 7340)
SOP OV 064.02	(návod firmy Thermo Scientific)
SOP OV 064.04	(návod firmy Thermo Scientific)
SOP OV 064.13	(návod firmy Thermo Scientific)
SOP OV 064	(návod firmy Thermo Scientific)
SOP OV 200.03	(ČSN 75 7440)
SOP OV 201	(ČSN EN ISO 17294-1, ČSN EN ISO 17294-2)
SOP OV 307	(ČSN EN 1484)
SOP OV 331	(ČSN EN ISO 17993)
SOP OV 341.02	(EPA 535, EPA 536)
SOP OV 344	(ČSN EN ISO 15680, ČSN EN ISO 10301)
SOP OV 900	(ČSN EN ISO 9308-1:2015)
SOP OV 906	(ČSN EN ISO 7899-2)
SOP OV 908	(ČSN EN ISO 6222)
SOP OV 914.01	(Vyhláška č. 252/2004 Sb., příloha č. 6)
SOP OV 916	(ČSN 75 7712, ČSN 75 7713, ČSN 75 7717)

**Místo provedení zkoušky (pracoviště) :**

- <sup>(2)</sup> - analýzy provedeny pracovištěm Ostrava (Partyzánské nám. 7, 702 00 Ostrava)
- <sup>(5)</sup> - analýzy provedeny pracovištěm Olomouc (Wolkerova 6, 779 11 Olomouc)
- <sup>(6)</sup> - analýzy provedeny pracovištěm Jihlava (Vrchlického 57, 587 25 Jihlava)
- <sup>(7)</sup> - analýzy provedeny pracovištěm Brno (Gorkého 6, 602 00 Brno)

Metody v sloupci TYP: "A" akreditovaná zkouška, "N" neakreditovaná zkouška

< - výsledek pod mez detekce, > - výsledek je vyšší než uvedená hodnota

Výsledky se týkají pouze zkoušených vzorků.

Bez písemného souhlasu laboratoře se nesmí protokol reprodukovat jinak než celý.

Uvedené rozlišené nejistoty měření jsou součinem standardní nejistoty měření a koeficientu rozšíření k=2, což odpovídá hladině spolehlivosti přibližně 95 %, nezohledňují vlivy odběrů vzorků.

Pro mikrobiologické ukazatele je nejistota měření vyjádřena jako 95% konfidenční meze vyjadřující variabilitu Poissonova rozdělení, nezohledňují vlivy odběrů vzorků.

**Vedoucí CHL :** Doškářová Šárka, RNDr.

**Kontroloval :** Komínková Jana, Bc.

**Protokol vyhotovil:** Komínková Jana, Bc.

**Počet stran:** 4

**Dne:** 20.6.2017

Ing. Dagmar Pecáková  
zástupce vedoucího Oddělení anorganických analýz

# Waste water

- Ancient Greece, Rome - the first sewer system, sewage drawn into rivers, or soak up.
- The Middle Ages - a great decline.
- 18th century - construction of sewerage systems (drainage of army objects, later church and public buildings).
- The end of the 19th century - sewer systems in most European cities.
- 1865 - England - The creation of the "Royal Commission on River Pollution".
- 1860 - First sewage WWTP - sewage farms.
- 1880 - First sedimentary treatment plant.
- 1900 - First intermittent biofilters.
- 1910 - USA - experimental aeration of sewage
- 1912 - England - Invention of the activation system





# Waste water

- The protection of watercourses is primarily aimed at ensuring the **required quality of effluent** on runoff from WWTP.
- Typical symptoms of **waste water content in streams** (odor, sludge, oxygen deficiency) caused by organic substances - in European proportions are virtually eliminated.
- **New cleaning issues**: nitrogen, phosphorus, microfibers, pharmaceuticals.
- Act No. 254/2001 Coll. on water - defines the concept of wastewater.
- Act No. 274/2001 Coll. about public water supply systems and sewers as amended by Act No. 76/2006 Coll.
- Government Decree No. 61/2003 Coll. in the act 229/2007 Coll. A 23/2011 Coll. about indicators and values of permissible surface water pollution, discharging requirements of sewage into surface water and sewage waters and about sensitive areas.
- Act No. 185/2001 Coll. on waste - determines the treatment of waste from WWTPs (sludge, shrubs, sand, soil from root fields, etc.)

# Waste water

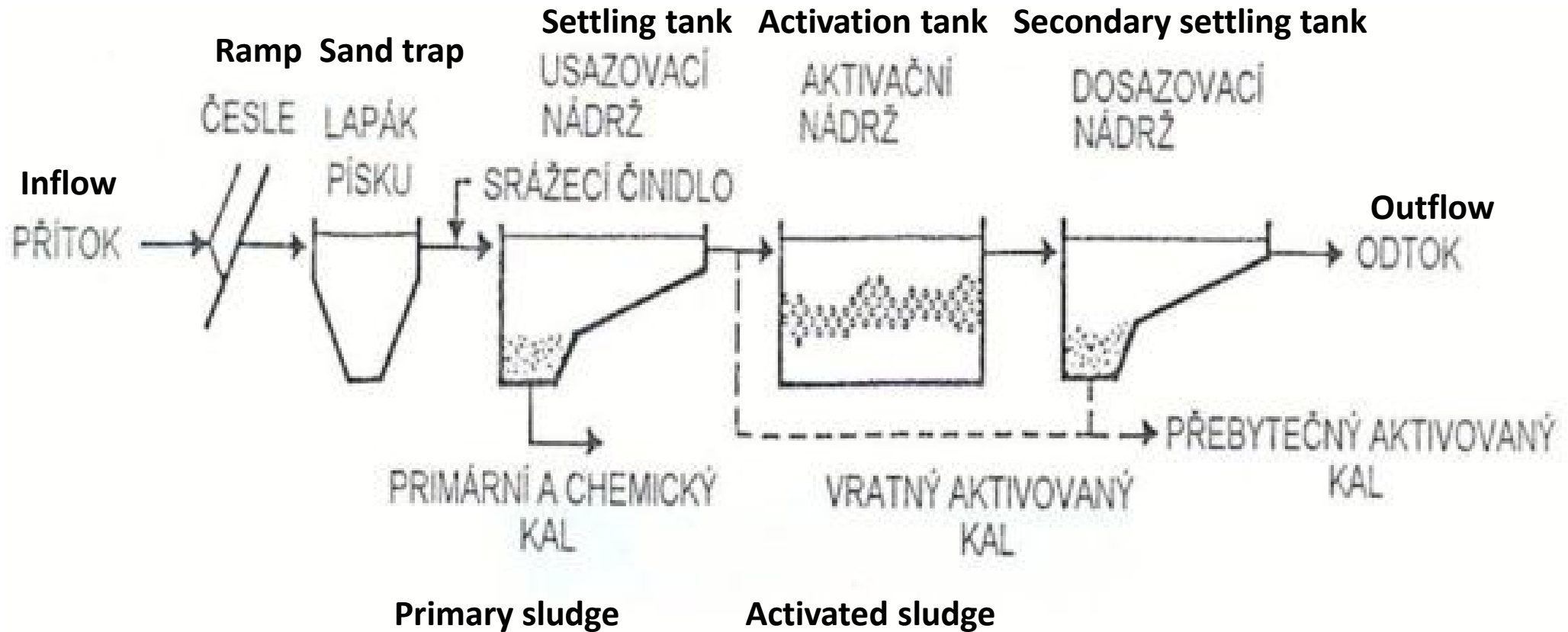
## Basic methods of wastewater treatment

- Mechanical
- Physical-chemical
- Biological
- In practice, combination of the three procedures are used

## Sewage sorting

- Wastewater sewage
- Waste water industrial
- Wastewater rainfall (rainfall)

# Waste water – WWTP scheme





# Waste water – WWTP

The waste water first goes to the **gravel trap**.

The next level is **ramp**

- removal of rough floating dirt  
(protection of other parts of the  
treatment plant)
- landfill, composting, combustion.

**A sand trap** is next

The last device for mechanical cleaning

- **the settling tank** is a gravitational separation  
of suspended substances

**Primary sludge** is formed

- processed in the sludge management.



# Waste water – WWTP

## BIOLOGICAL CLEANING (SECONDARY)

- activation line
- secondary settling tank

**Activation tank** - microorganisms in aerobic conditions decompose organics

- biological oxidation of organic substrate, ammoniacal nitrogen, nitrification, denitrification, biological decomposition of phosphorus, or its chemical precipitation.

### **Secondary settling tank**

separation of activated sludge from purified water

# Waste water – WWTP

## Sludge processing technology

1. Concentration
2. Stabilization
3. Drainage
4. Hygiene

- **Stabilization of sludge** - reduction of degradable organic matter (microbes in aerobic or anaerobic conditions) and the destruction of pathogenic microorganisms
- **Total decomposition and other sludge stabilization methods:**
  - drying at low temperatures,
  - drying at high temperatures (105 ° C),
  - total decomposition with oxygen at 160 ° C,
  - combustion of sludge with other fuels in power stations or cement plants

# Waste water – WWTP

## Sludge hygiene

- heat treatment of sludge at high temperatures
- pasteurization of sludge
- chemical treatment of sludge - liming
- anaerobic thermophilic processing methods
- composting
- special methods: ionizing radiation, ozone, decomposition

# Waste water – WWTP

**Category I** - sludges can generally be applied to land used in agriculture

**Category II** - sludge can be applied to agricultural land intended for the cultivation of technical crops, and land that will not grow for at least 3 years after the use of sewage sludge field vegetables and intensely fruit-bearing fruit planting

Kategorie kalů	Přípustné množství mikroorganismů (KTJ*) v 1 gramu sušiny aplikovaných kalů		
	termotolerantní koliformní bakterie	enterokoky	<i>Salmonella sp.</i>
I.	$< 10^3$	$< 10^3$	negativní nález
II.	$10^3 - 10^6$	$10^3 - 10^6$	nestanovuje se

# Waste water – WWTP

Limit values of concentrations of selected hazardous substances and elements in slurries for their use on agricultural land

Riziková látka	Mezní (maximální) hodnoty koncentrací v kalech (mg.kg <sup>-1</sup> sušiny)
As – arzén	30
Cd - kadmium	5
Cr - chrom	200
Cu - měď	500
Hg - rtuť	4
Ni - nikl	100
Pb - olovo	200
Zn - zinek	2500
AOX	500
PCB (suma 6 kongenerů - 28+52+101+138+153+180)	0,6

# Waste and health

Waste is every movable thing the person discards, or has the intention or duty to discard it, and it belongs into one of the categories of waste listed in the catalog waste (Act No. 185/2001 Coll.)

## Types by production:

**Communal-mixed** - occurring in the activity of natural persons, dangerous drugs, cans from paints and thinners, etc. - it is **the largest amount** of all wastes

**Agricultural** - wastes from plant and livestock production (urine, manure),  
agrochemicals (fertilizers)

**Industrial** - from industrial activities



# Waste and health

## According to the composition:

**Inert** - not subject to biodegradation - does not decompose/rot

Construction waste, glass, has no dangerous properties

**Biological** - is capable of aerobic and anaerobic digestion.

Food, paper, green mater

**Toxic, radioactive** - nuclear waste, old batteries, drugs, oils

**Hospital** - parts of human bodies, infectious waste, needles, plasma, cytostatics

# Waste and health

## Categories of waste from medical facilities

### **Specific waste**

Sharp objects

Pathological and biologically contaminated waste

Discarded chemicals, drugs

### **Non-specific waste**

Other wastes not requiring protection against the spread of infections

# Waste and health

## Exposure:

Dust

Contact

Mediated (contamination of water, soil, food chains, insects, rodents)

# Waste and health

## Effects:

Irritation, toxic smoke

Parasitic infections - helminthoses, amoebae, cercariae (maggot stage, the evolutionary stage of the motile, leaving the guts and looking for the host - the human)

Zoonoses

Hepatitis, AIDS

Poisoning

# Waste and health

## **Action:**

Minimizing quantity (recycling, use of one – off packaging)

Selection of suitable sites and landfill security

Separation of toxic, infectious, radioactive waste

Education of the population

# Waste and health

## Waste disposal:

Landfills

Composting

Combustion

Chemical destruction

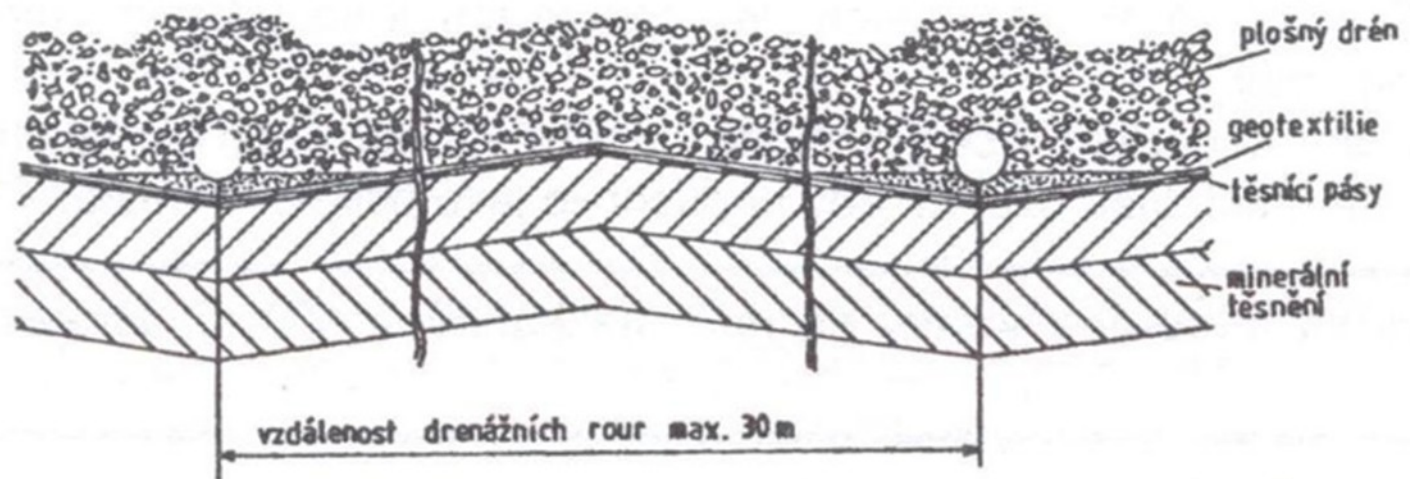
Storage

Feeding to animals

Recycling of sorted waste (glass, paper, plastics, metals)









## Schéma systému odplyňení

