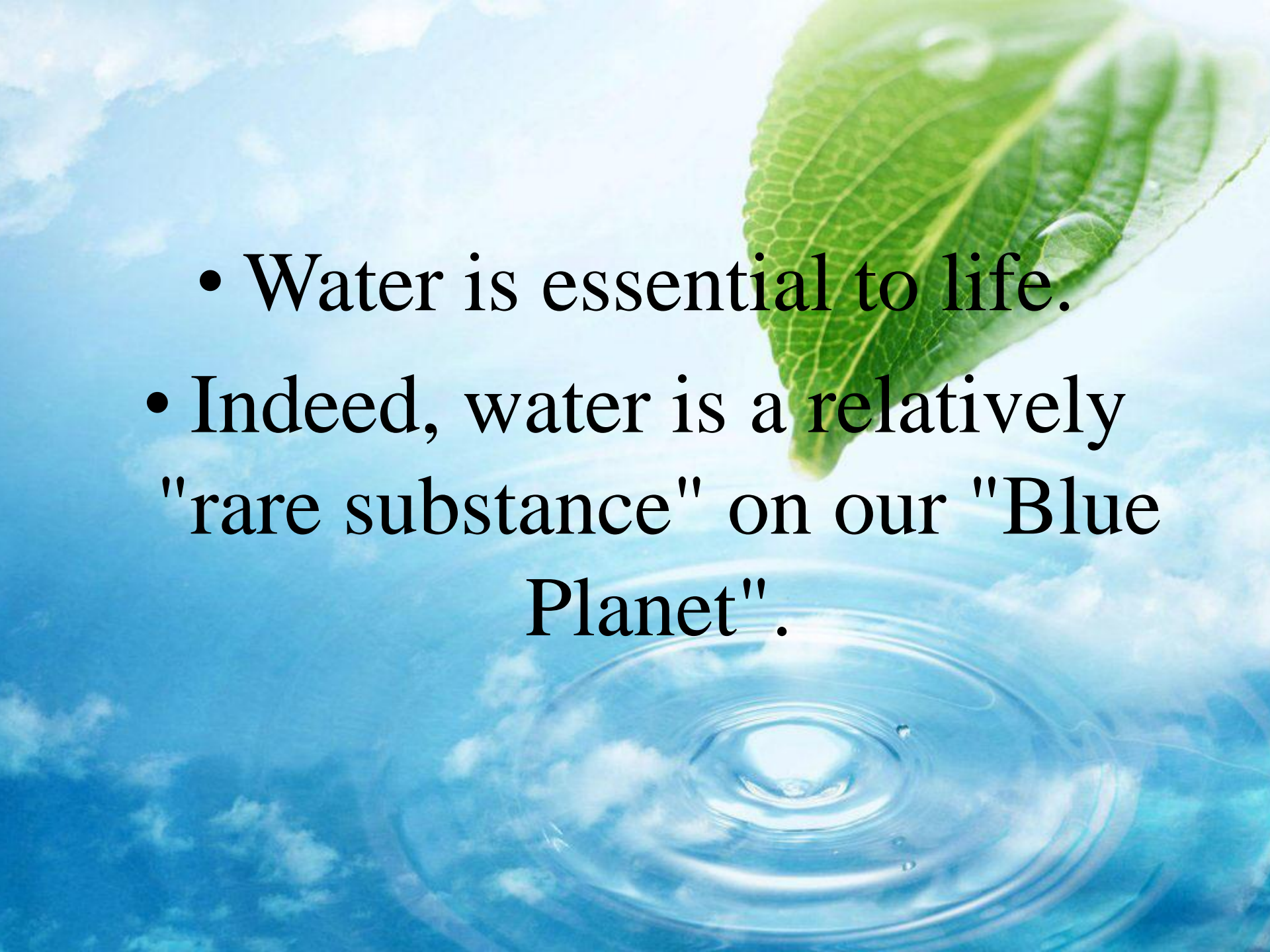


The Ministry of Health Care and Social Development  
The Volgograd State Medical University  
The Chair of hygiene and ecology

LECTURE

# The hygiene of water and water supply the residential area



- 
- Water is essential to life.
  - Indeed, water is a relatively "rare substance" on our "Blue Planet".

# **Physiological importance of water for a human being**

- 1. Water is a universal dissolver. The majority of chemical reactions in the human body take place in aqueous (water) solutions.**
- 2. The human tissues and organs are composed of water. 90% of blood and lymph of a human being is water and relatively little water is found in the bone stock. Nearly 70% of the body of an adult is water. The younger the body, the more fluid is in the living tissues.**
- 3. Water takes part in the thermal regulation of body temperature, i.e. release of heat into the atmosphere as a result of perspiration.**



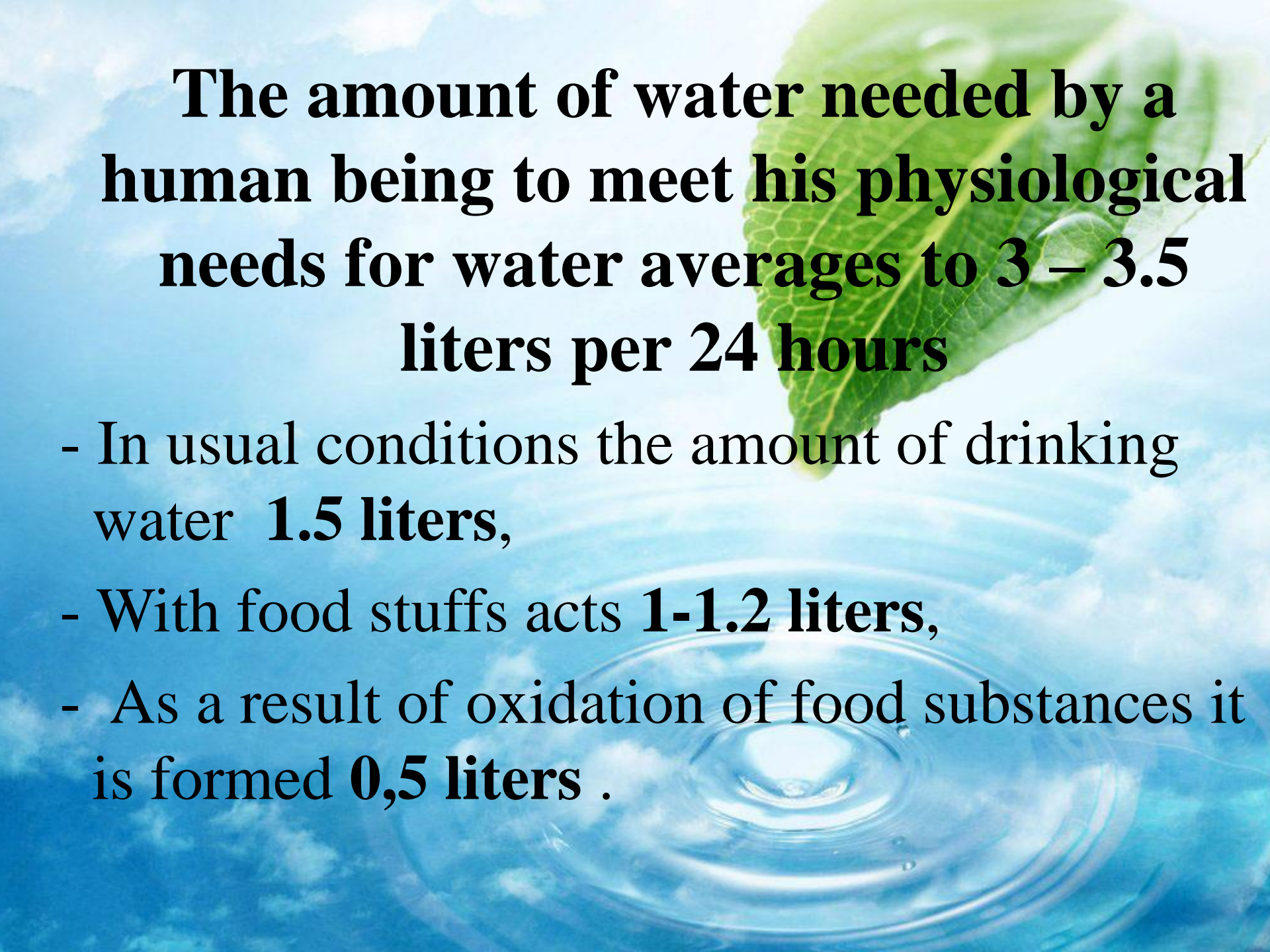
**Более 80%**

**От 52% до 60%**



[Aqua-Life.com.ua](http://Aqua-Life.com.ua)





**The amount of water needed by a human being to meet his physiological needs for water averages to 3 – 3.5 liters per 24 hours**

- In usual conditions the amount of drinking water **1.5 liters,**
- With food stuffs acts **1-1.2 liters,**
- As a result of oxidation of food substances it is formed **0,5 liters .**

# **Hygienic importance of water for a human being**



**Water is necessary for a human being to meet his hygienic needs, for example, the needs of a human being for a clean body, clothes, dwelling. Water is needed for cooking foods and so on.**

# Hygienic importance of water for a human being

- The amounts of water needed by the residents of a city with a central system of water supply to meet their hygienic requirements in water average to 350 – 450 liters per 24 hours. In the country with a decentralized system of water supply, for example, in the rural area, where people take water from wells the amounts of water needed by people daily average to 50 – 70 liters per a resident.

# In comparison...

- On average, people in Europe use more than **200 liters**—in the United States more than **400 liters**.
- The 1.1 billion people who don't have access to drinking water only use up to **5 liters**.



# **Mental & physiological importance of water**

**Water is the factor which has a favorable effect on the mental and emotional state of a person. Watching a smooth water surface, listening to the tide or rain, a gentle murmur**



# Epidemiologic importance of water

Water may be dangerous for a person due to the factors which can cause the development of diseases. First of all, it is a microbiological factor.

- The water is the medium in which microorganisms, including pathogenic ones, can live and multiply for a long time.
- For example, in river water
  - bacillus of typhoid fever can live for 6 months
  - cholera vibrio – for 3 months
  - dysentery stick – for 3 months

# Consequences

- At the start of the 21st century un-clean water is the world's **second biggest killer of children**.
- **1.6 million** people die every year from diarrheal diseases, the leading cause of disease worldwide
  - 90% of these are children under 5
- **133 million** suffer from high intensity intestinal helminthes (parasitic worms) infections
  - 1.5 million cases of clinical **hepatitis A** every year



# Epidemiologic importance of water

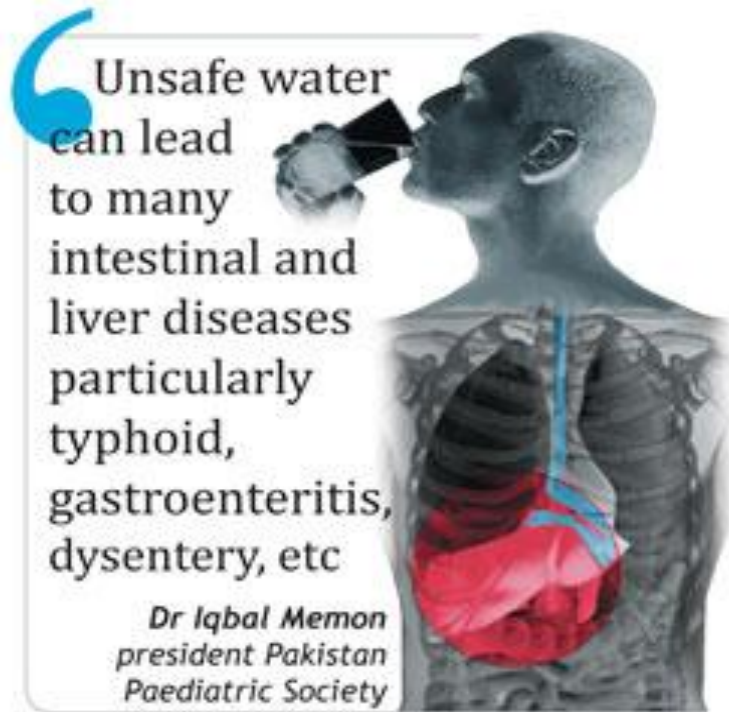
A green leaf is shown falling from the top right towards the center of the frame. Below the leaf, a pool of water is visible, with a single drop having just hit, creating concentric ripples. The background is a soft, blue sky with light clouds.

**There are 5 groups of infectious diseases which are transmitted via water:**

- 1. Enteric infections: typhoid fever, dysentery, cholera, paratyphoid, salmonellosis**
- 2. Viral diseases: ( hepatitis and poliomyelitis viruses.**
- 3. Leptospiroses: Vassiliev disease (ictero-haemorrhagic leptospirosis) and water fever**
- 4. The diseases which are caused by protozoa**
- 5. Anthroponosis infections: tuberculosis, brucellosis, anthrax and others**

# 1. Enteric infections

Enteric infections such as **typhoid fever, dysentery, cholera, paratyphoid, salmonellosis**. These diseases usually occur in summer and spring when the temperature of water is high and the water is **badly contaminated**. typhoid fever, dysentery, cholera, paratyphoid, salmonellosis



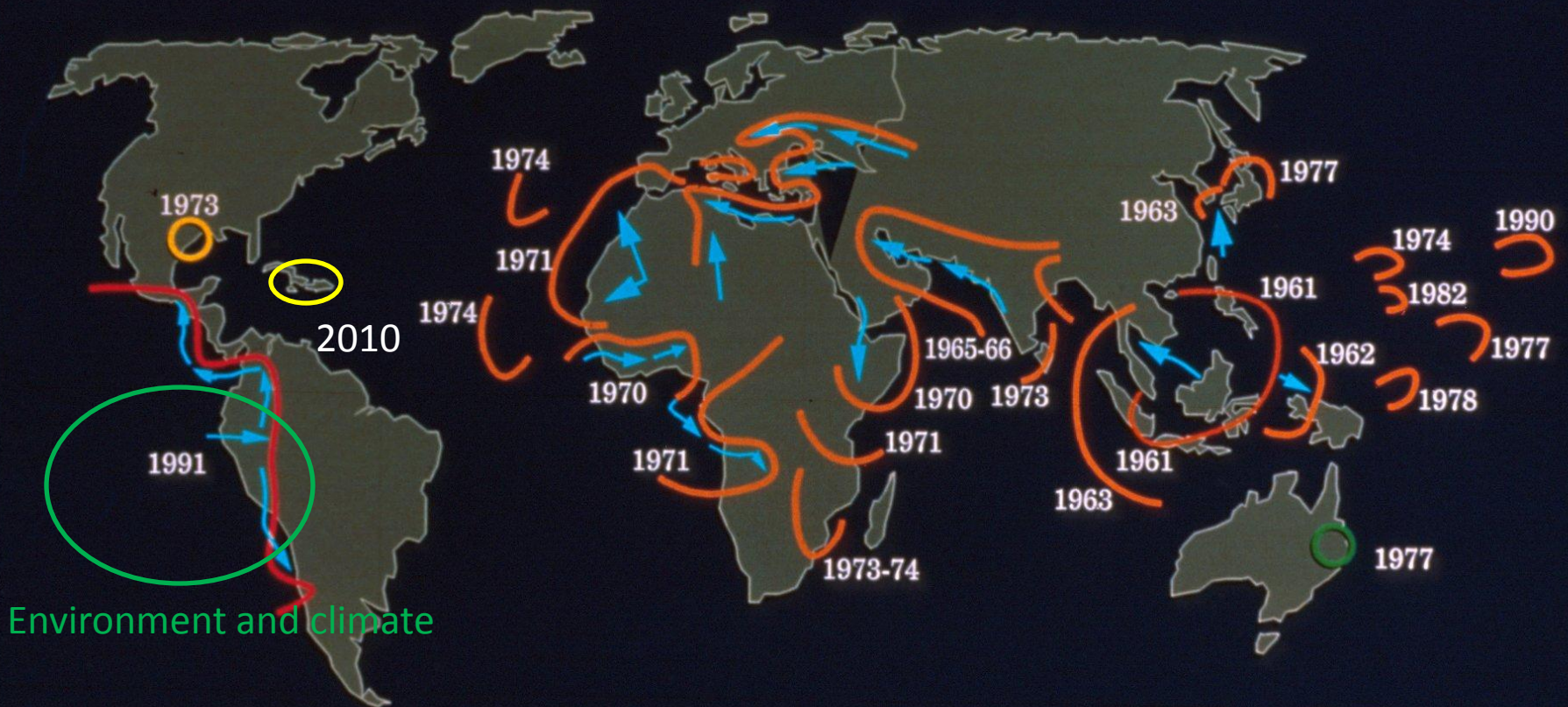
# Cholera

- Derived from Greek word referring to rain rushing from a gutter
  - Causes profuse watery diarrhea
- Known since Hippocrates
- First epidemic described in 1563 in India
- 7 seven known pandemics
  - 7th began in 1961

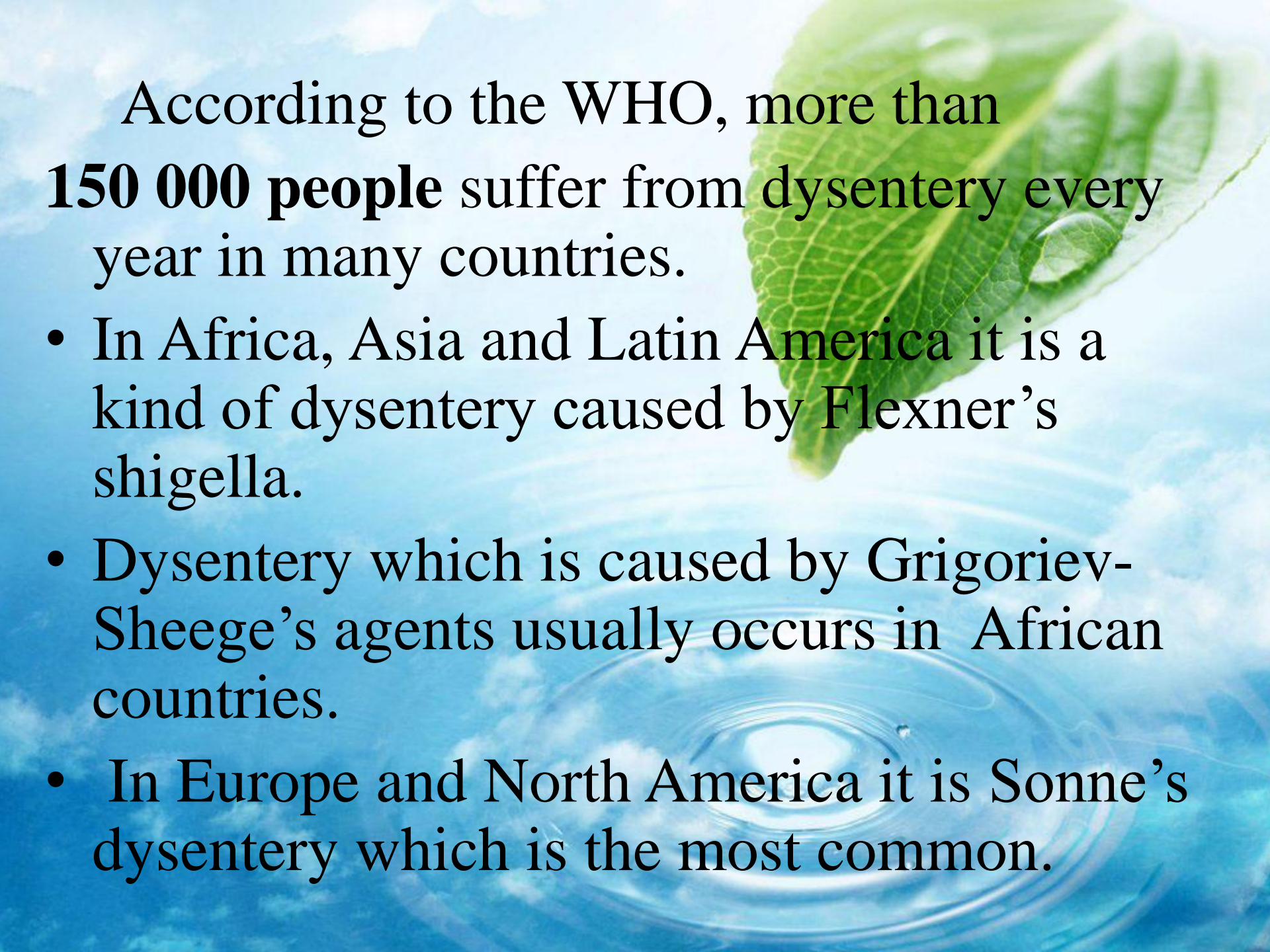


# Seventh Cholera Pandemic

## Global Spread of Cholera, 1961-1991



As of August 26, 1991



According to the WHO, more than **150 000 people** suffer from dysentery every year in many countries.

- In Africa, Asia and Latin America it is a kind of dysentery caused by Flexner's shigella.
- Dysentery which is caused by Grigoriev-Sheege's agents usually occurs in African countries.
- In Europe and North America it is Sonne's dysentery which is the most common.





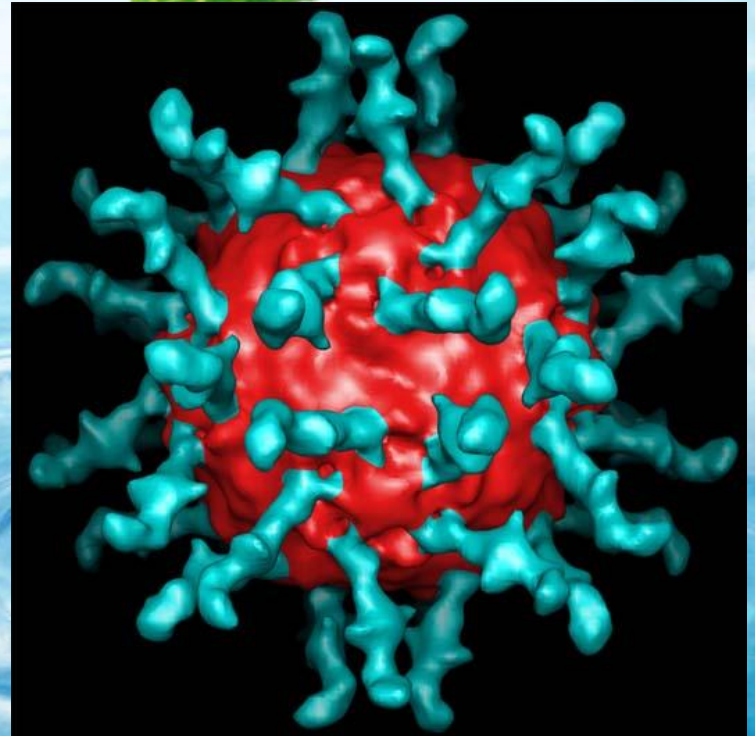
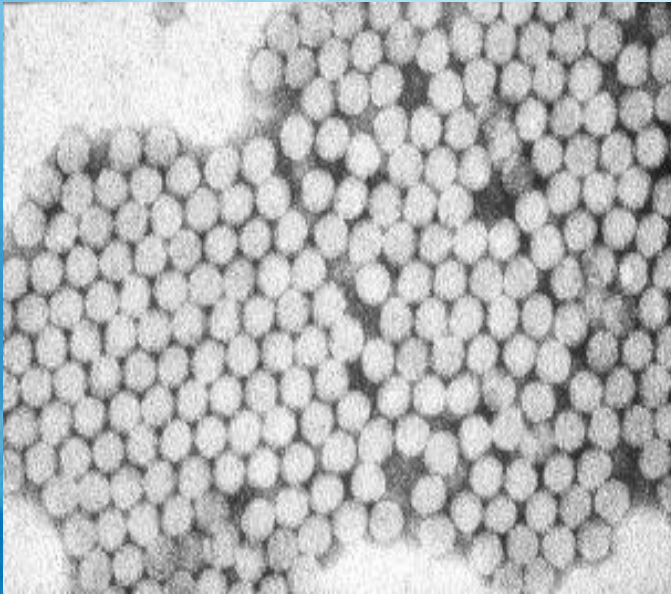
High morbidity and mortality are characteristic of **typhoid fever and paratyphoid A and B.**

The causative agents of these diseases are the microbes of the genus *Salmonella* family of *Escherichia coli*, which are very stable in the external environment:

- in cold water the causative agent of typhoid fever survive for up to **1.5 years**,
- can withstand freezing for **several months**,
- in tap water, these microorganisms survive for up to **3 months**,
- in open water survive for up to **12 days**.

## 2. Viral diseases

A lot of viruses live and multiply in water. The most dangerous for people are two of them: Hepatitis A virus and poliomyelitis viruses



# 3. Leptospiroses is an acute anthropo-zoonotic infection

Leptospirosis is caused by the *Leptospira* bacteria.

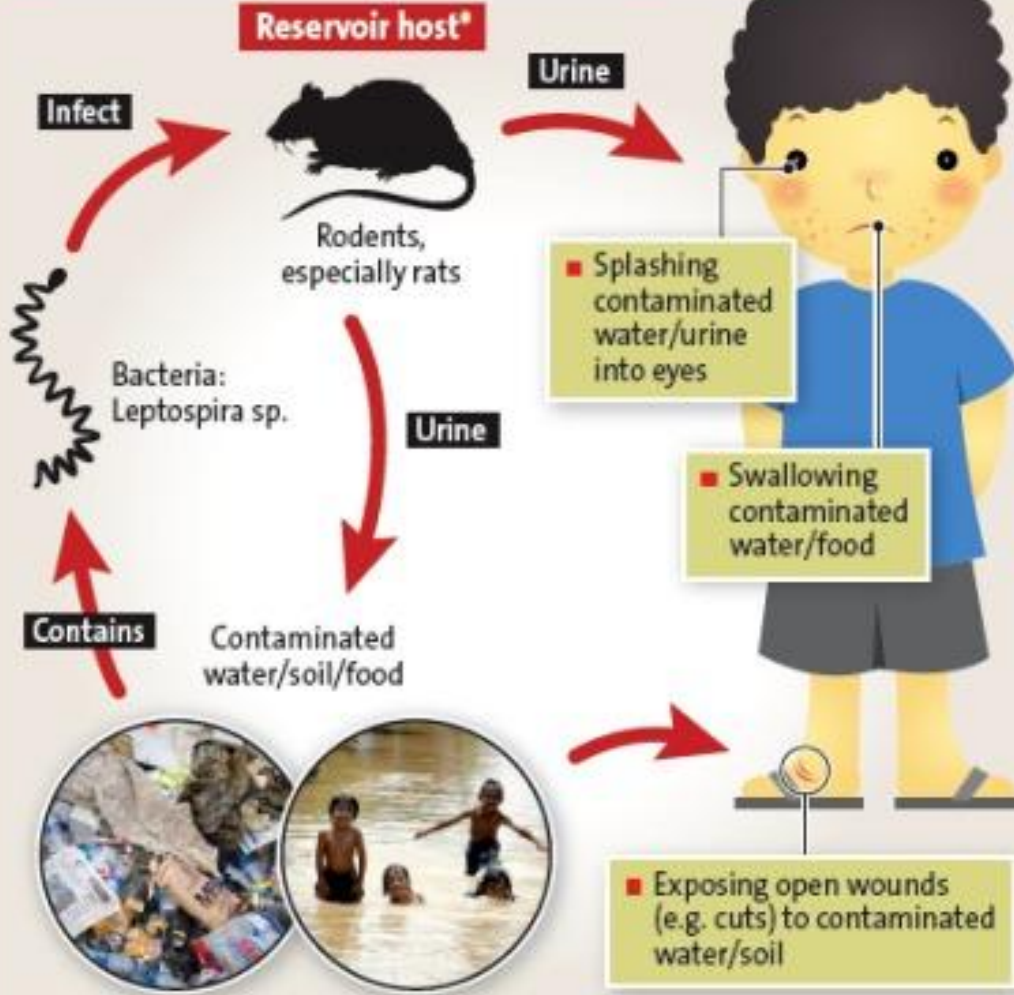
It occurs in tropical, subtropical and temperate zones.

Weil Disease,  
Hemorrhagic  
Jaundice, Mud  
Fever, Swineherd  
Disease



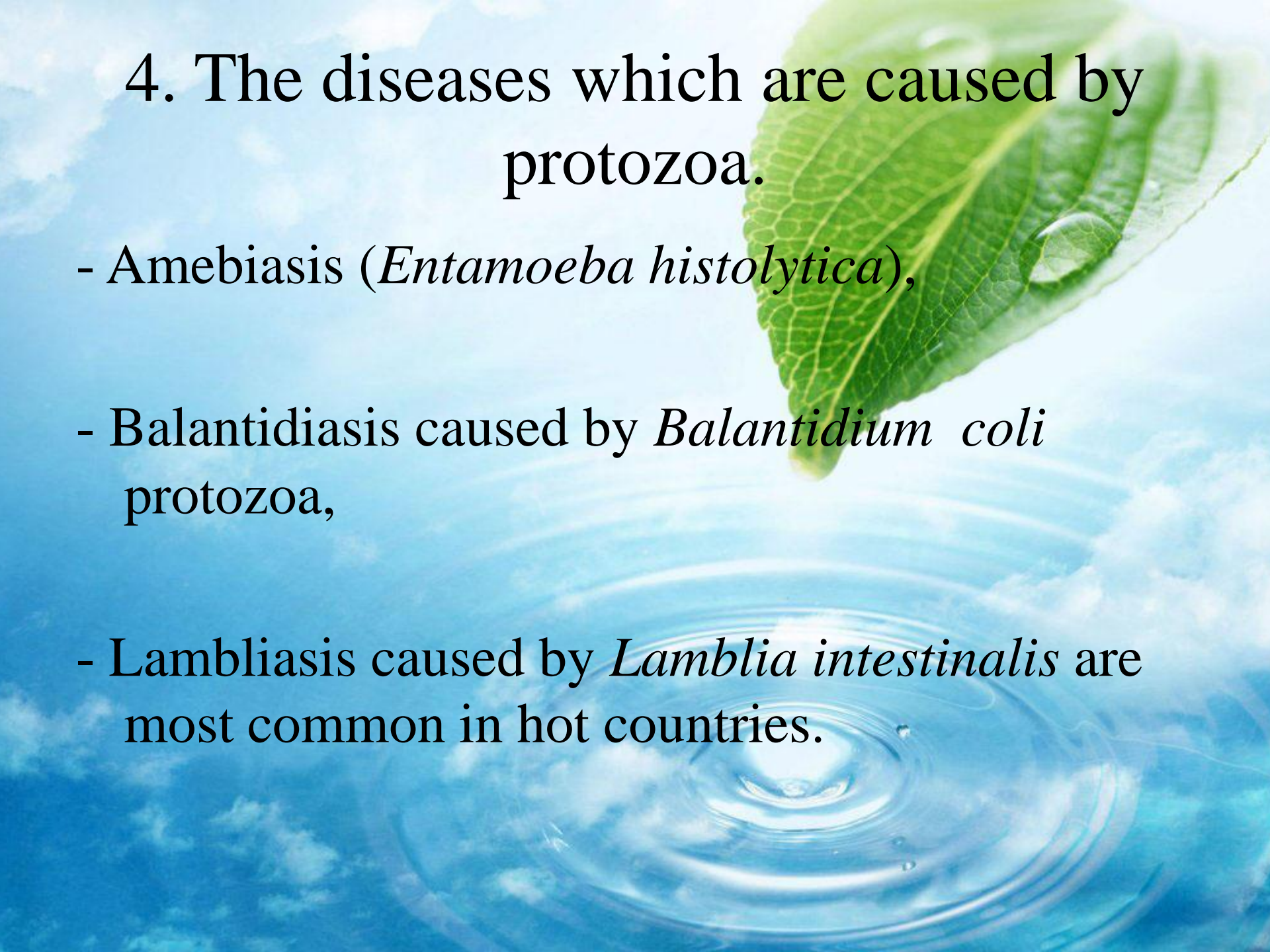
# How you can get infected

## Leptospirosis



\*Reservoir hosts are animals that harbors or nourishes a pathogen (a harmful organism) and serves as a source of infection.

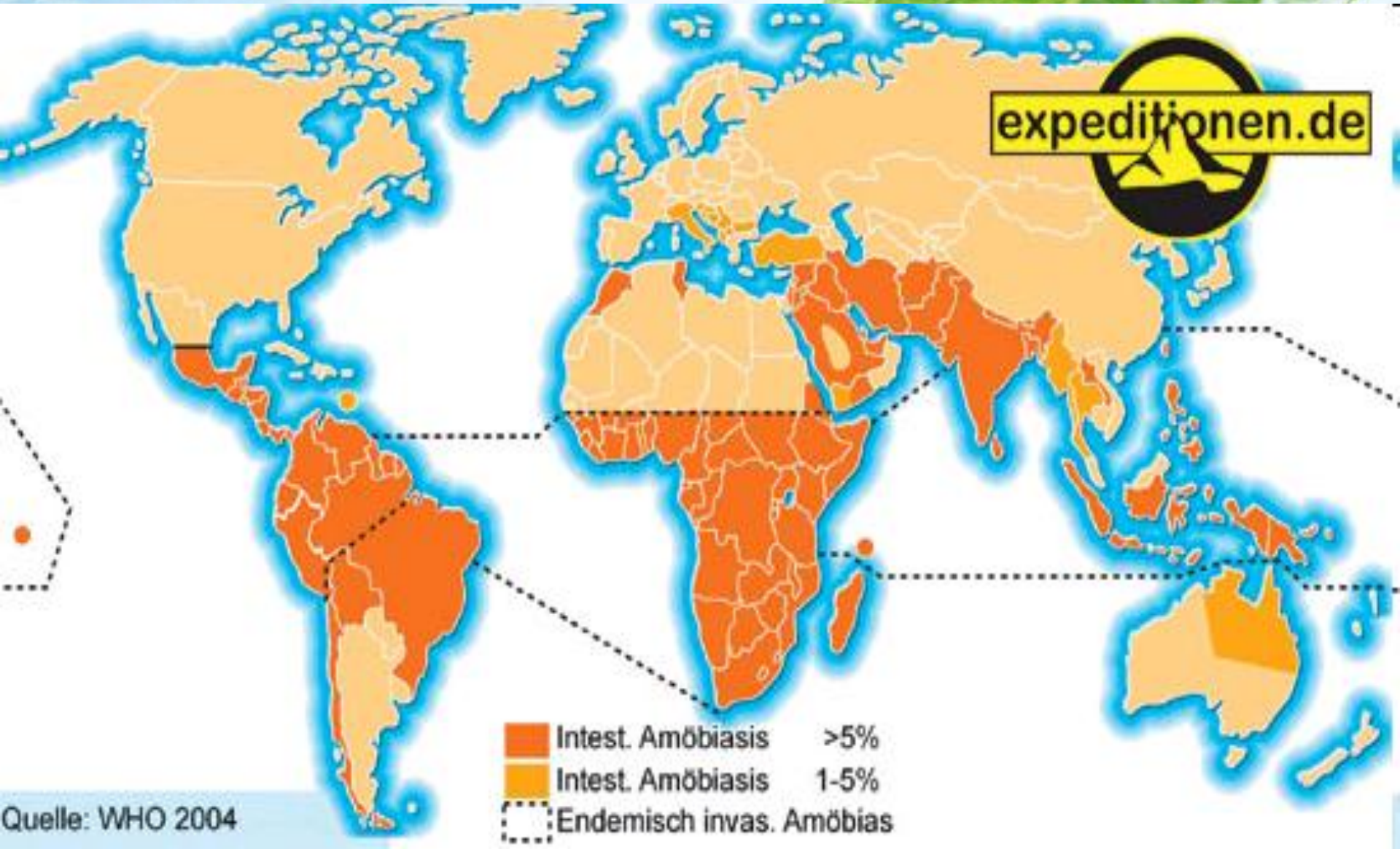
The main carriers of leptospires are animals such as rats, mice, dogs, cats and livestock.



## 4. The diseases which are caused by protozoa.

- Amebiasis (*Entamoeba histolytica*),
- Balantidiasis caused by *Balantidium coli* protozoa,
- Lambliasis caused by *Lambliia intestinalis* are most common in hot countries.

# Trends of Amoebiasis



## 5. Anthroponosis infections

- *Anthroponosis* derives its name from the word “*antropos*” which means “*human*” and “*zoo*” which means “*animal*”. These are the diseases which are transmitted from animals to man via water. These diseases include **tuberculosis, brucellosis, anthrax** and others.

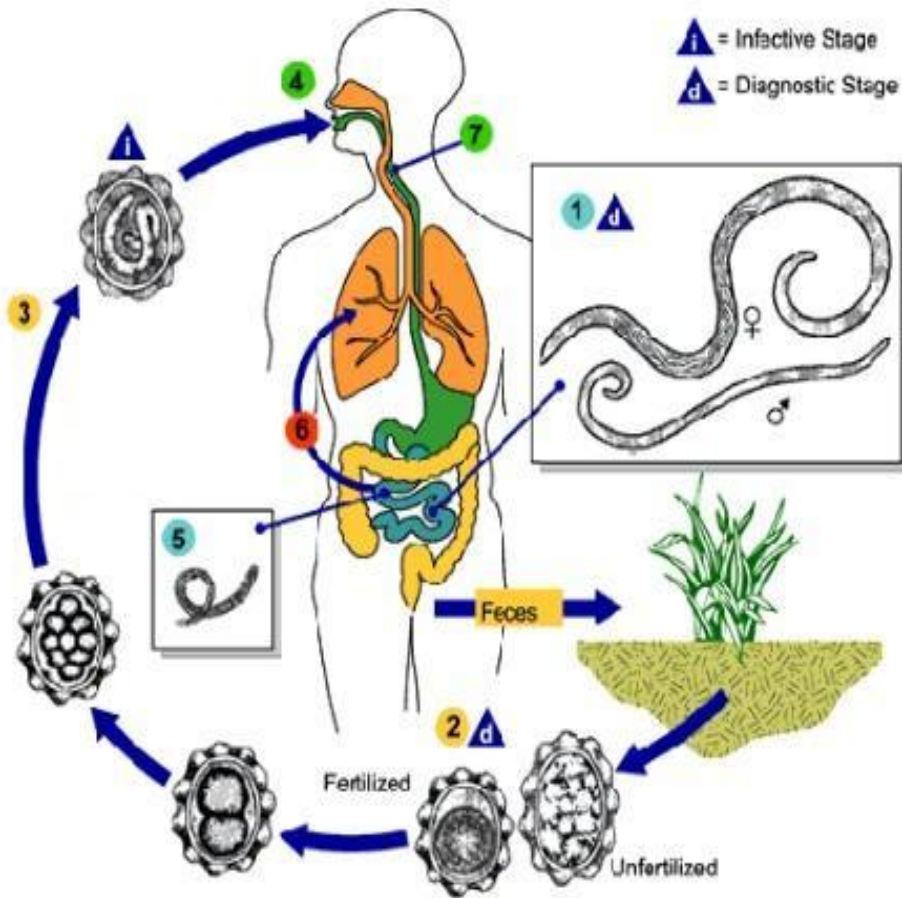
# 6. Helminthiasis or helminthes invasions

- Geohelminthoses
- Biohelminthoses (Schistosomiasis)





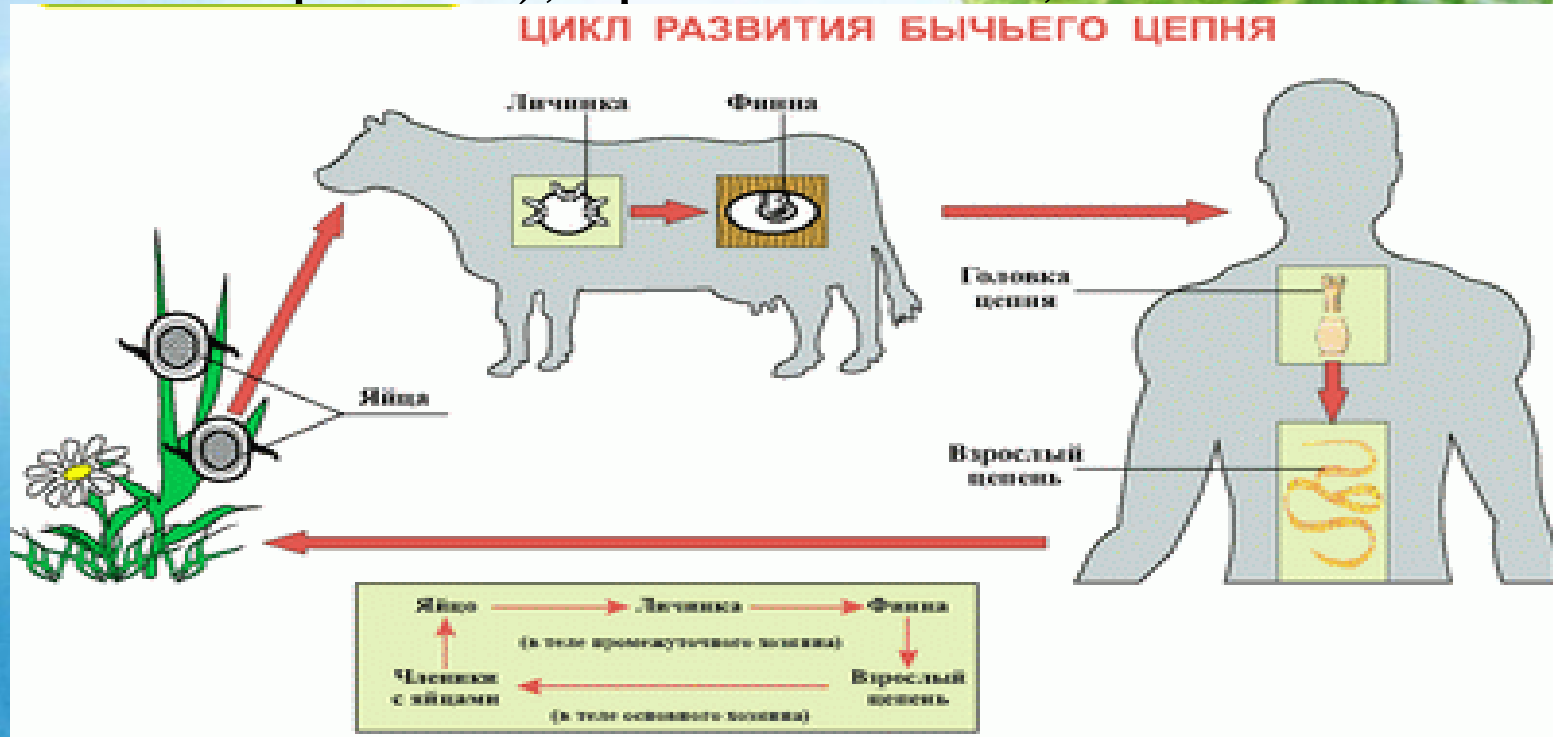
# Geohelminthoses



- The causative agents of develop and spread without an alternate host. The infection can be transmitted via water, soil, different things. The most common agent of this group is *Ascaris*. Hot wet climate is required for the development of such infections as ankylostomiasis and strongyloidiasis. It determines their natural location in Asia and Africa.

# Biohelminthoses

This group of helminthoses includes tapeworms (beef and porked), opisthorchiases, trematode.



- The causative agents of biohelminthoses develop in the body of the principal host until puberty, and then they parasitize their larvae in the body of alternate and optional hosts. Virtually, water is not a source of parasites. The alternate stages of the development of their larvae, however, take place in the shellfish, Crustacea and fish.

# Schistosomiases

Schistosomiasis is caused by helminthes parasites of the genus *Schistosoma*.

## TRANSMISSION

Waterborne transmission occurs when larval cercariae, found in contaminated bodies of freshwater, penetrate the skin.

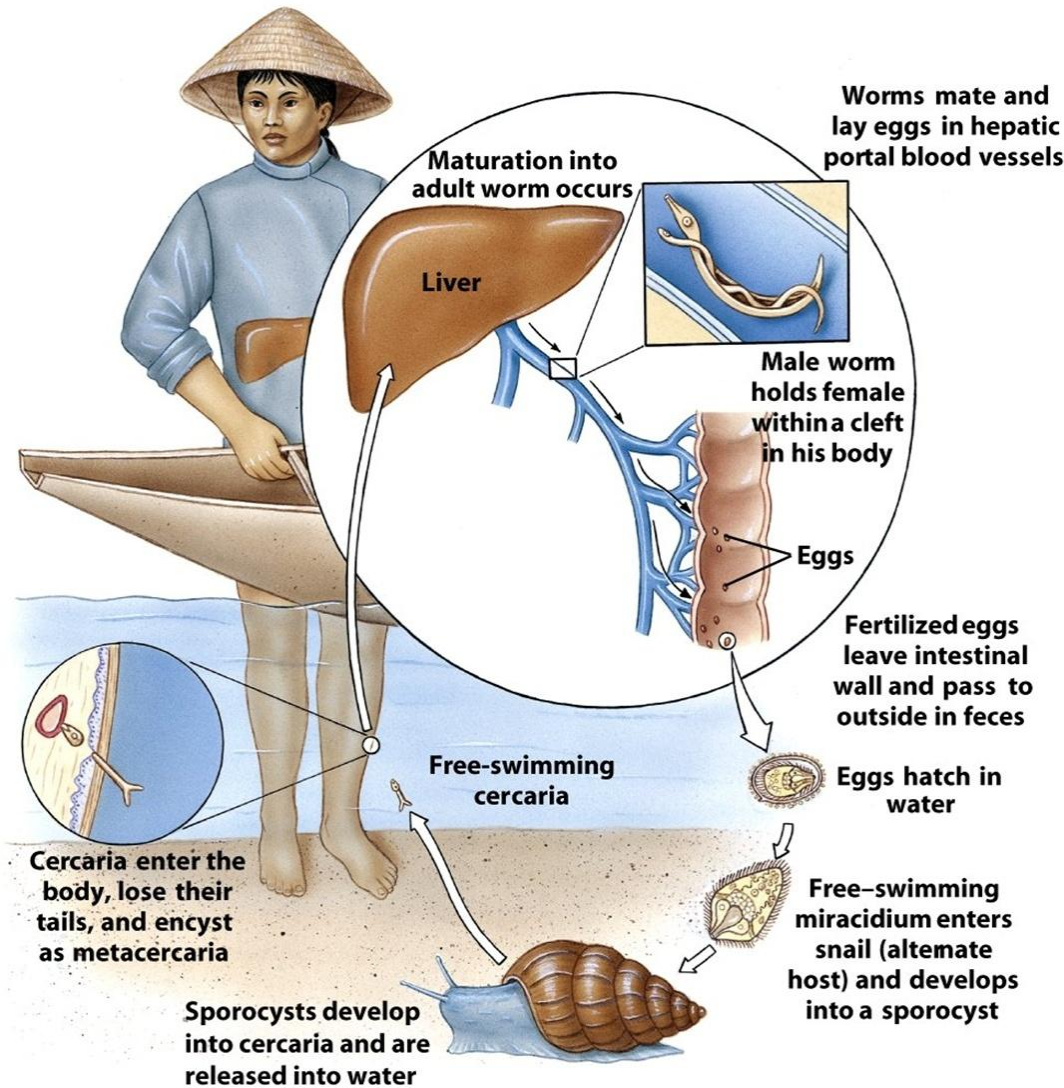
Cercariae penetrate the skin of people who drink, swim or bathe in infected water

Adult worm live in the veins that drain the urinary system

(*S. haematobium*) or mesentric blood vessels intestines (*S. mansoni*, *S. japonicum*) and release eggs

into water in urine or faeces

Eggs develop into miracidia which then infect snails



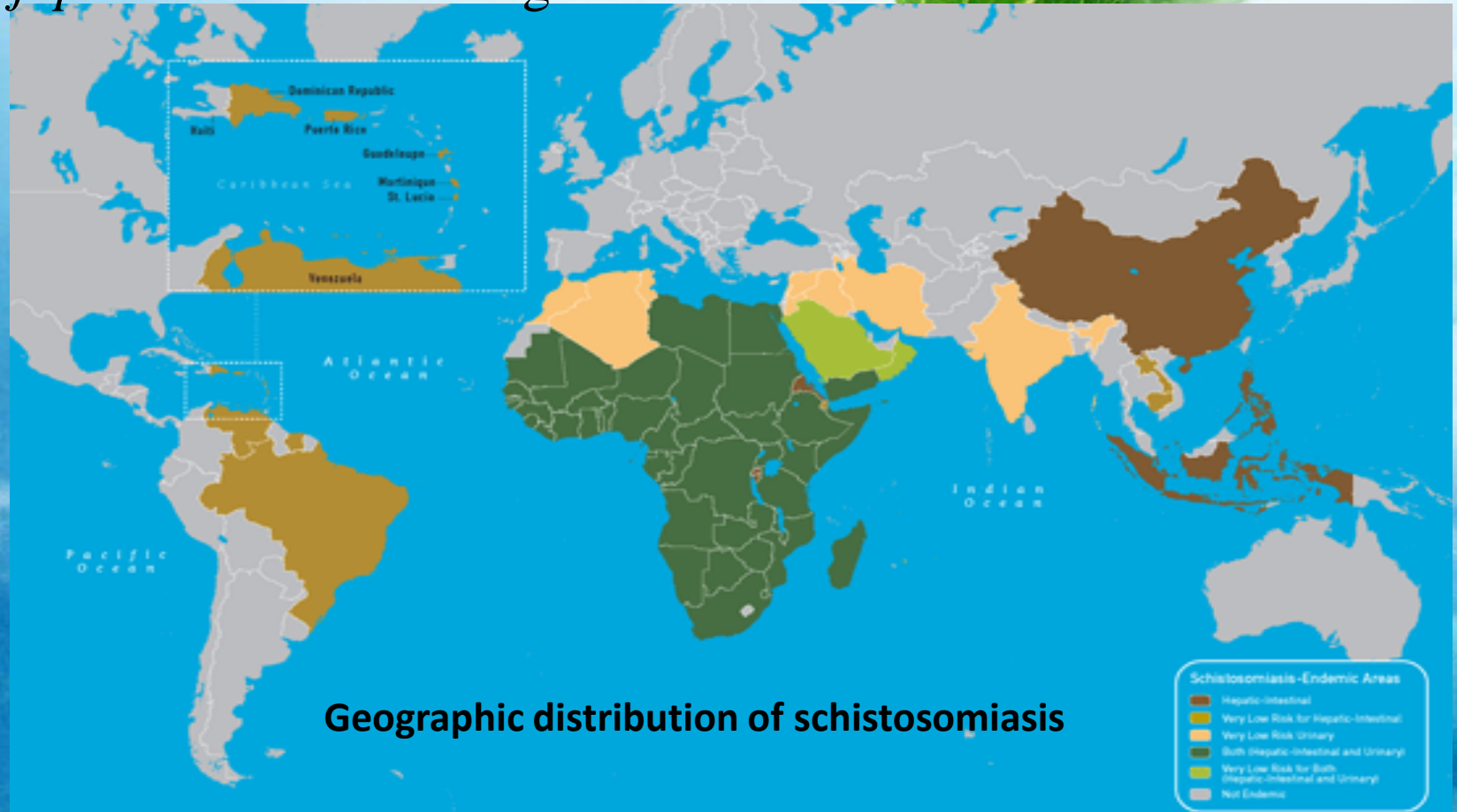
# Epidemiology

An estimated 85% of the world's cases of schistosomiasis are in Africa, where prevalence rates can exceed 50% in local populations.

*S. haematobium* - Africa and middle east (most prevalent)

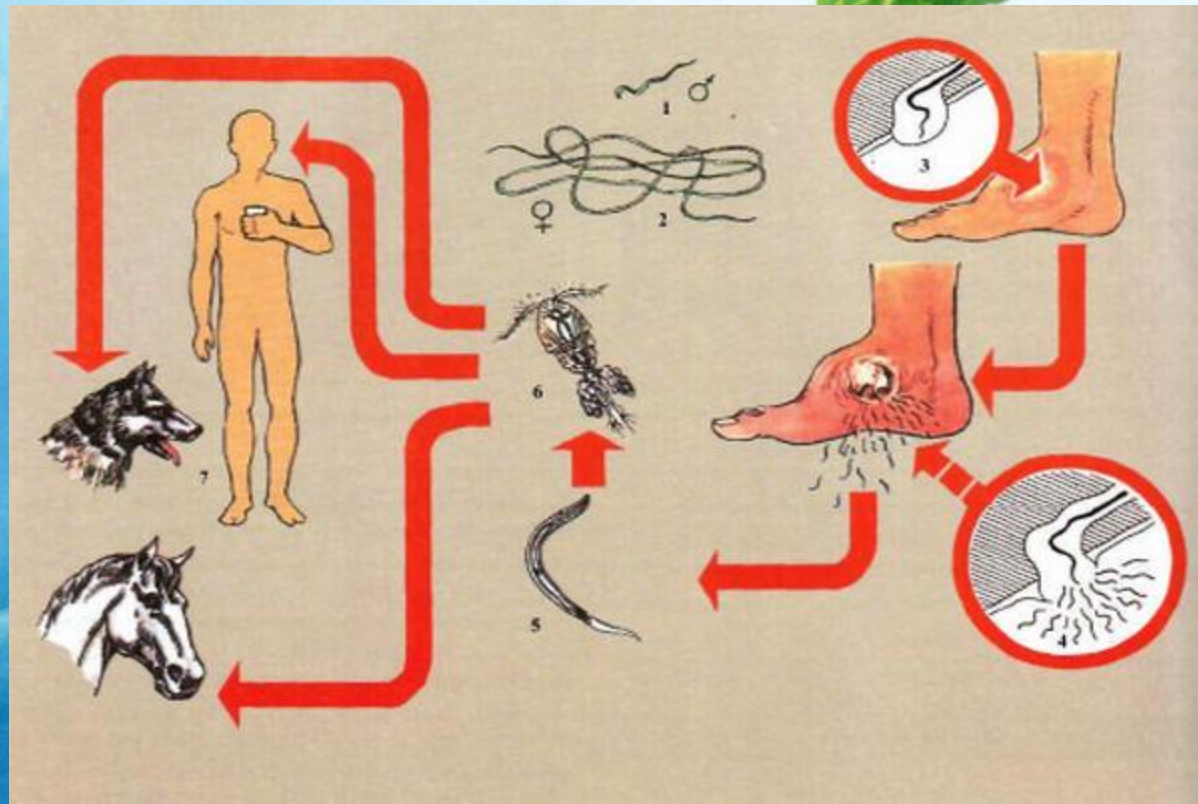
*S. Mansoni* - Africa and Latin America

*S. japonicum* – Pacific region



# Dracunculoses (guinea worm)

Guinea worms are widespread in the countries of Africa and Asia (especially in India). The source of infection is an infected person. An alternate host is a microscopic freshwater Cyclops-crab. The person becomes infected by using water which contains these crabs for drinking or bathing. The larvae penetrate through the intact skin and mucous membranes of a person and migrates through the lymphatic system to the subcutaneous fat. A grown-up species can be 120 cm long and live in the human body up to 14 months.



# The Life Cycle of Guinea Worm Disease

**1** The cycle starts...  
sufferer soaks exposed worm

**3** Another person drinks the water containing the water fleas

**7** The cycle continues...

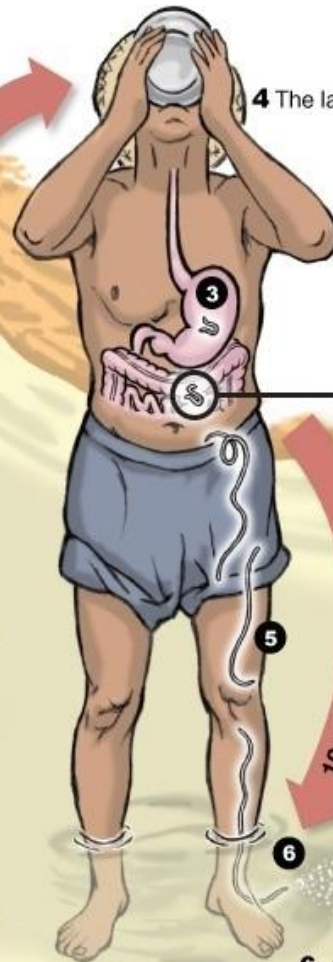
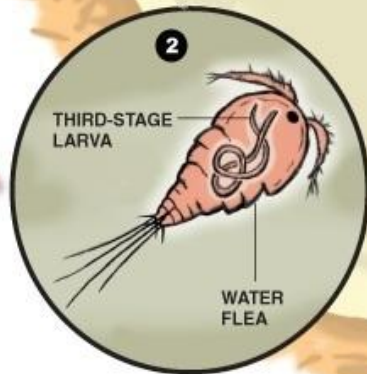
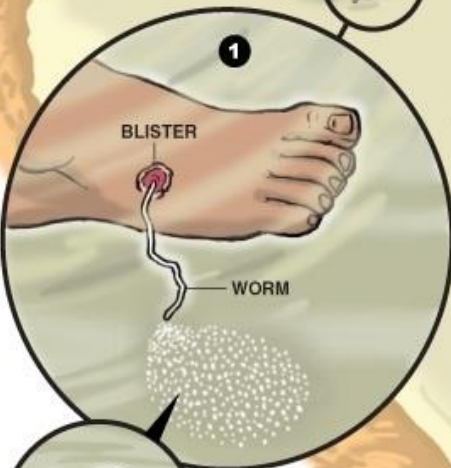
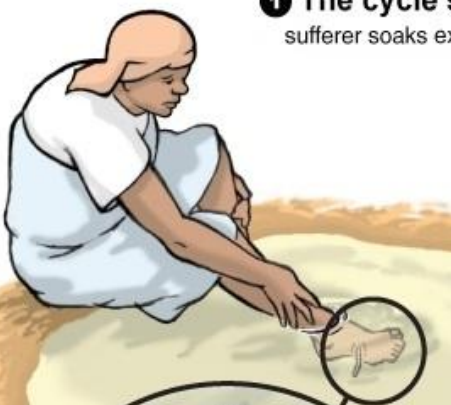
**4** The larvae migrate to the small intestine

**2** Tiny water fleas ingest the larvae

**5** worms move through connective tissue

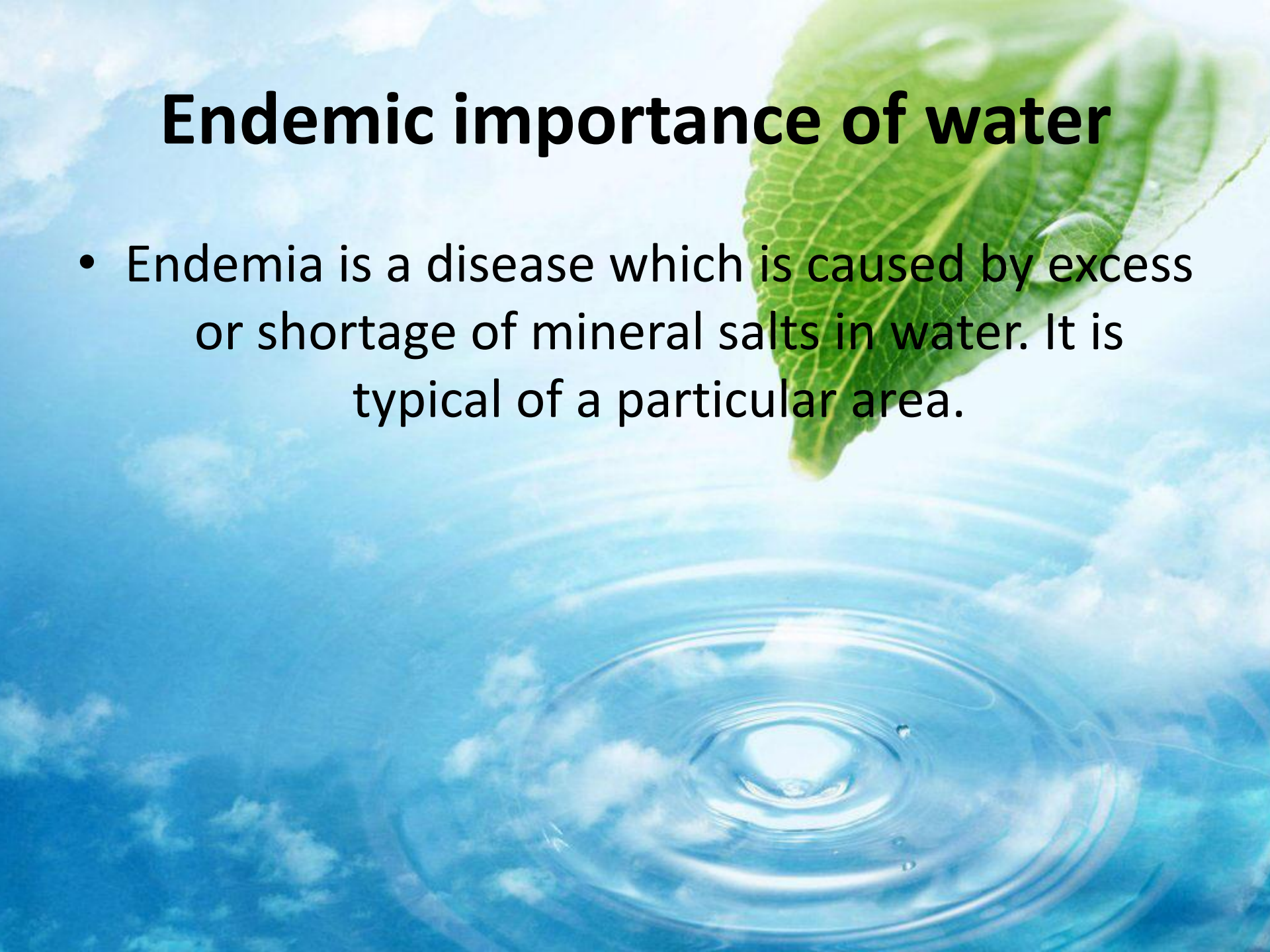
**6** worm forms a painful blister

10-14 MONTHS



# Endemic importance of water

- Endemia is a disease which is caused by excess or shortage of mineral salts in water. It is typical of a particular area.



# 1. Water nitrate methemoglobinemia or blue-baby syndrome

- name due to bluish or lavender skin color.
- It is the disease which is caused by excess nitrate (more than 45 mg/l) in drinking water.
- This disease doesn't occur in a city with a central system of water supply because the nitrate content in water is controlled.





- **Nitrate ( $\text{NO}_3^-$ ) & Nitrite ( $\text{NO}_2^-$ ):** are produced by bacteria feeding off of human and animal waste. Nitrate can also come from fertilizers such as ammonium nitrate. The nitrite ion enters the blood and converts the hemoglobin in red blood cells to methemoglobin. The "met" is from "meta" meaning "changed." This "changed" hemoglobin has less ability to carry oxygen, causing a condition known as methemoglobinemia, also called "blue baby syndrome."



**NITRITES  
NITRATES**



# Why Are Babies Most Affected?

1. They have high levels of fetal hemoglobin which is more easily oxidized to methemoglobin
2. In the organism of the infant there is a ferment nitrate reductase which reduces nitrates into nitrites.  
**Nitrites - Methemoglobinemia or Methemoglobin reductase enzyme is not completely developed in infants.**
3. Higher intestinal pH enhances conversion of nitrate to nitrite
4. Their intestinal flora is more likely to change nitrates to nitrites

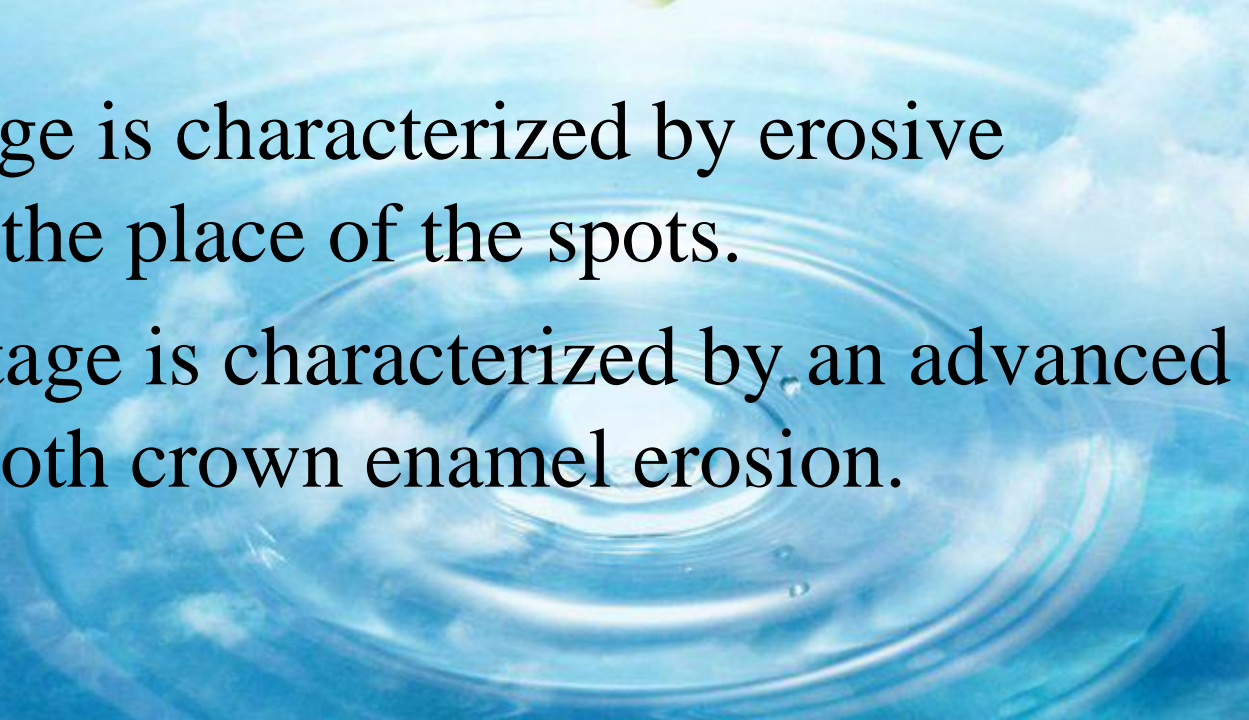
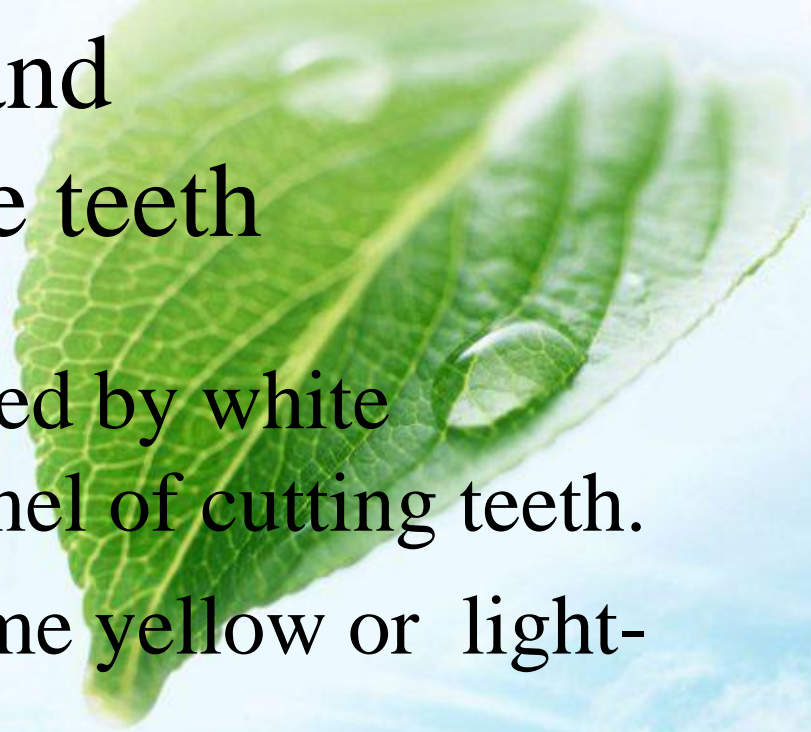


## 2. Endemic fluorosis

- This disease is caused by drinking the water with high fluorine content. When F in water is more than 1.5 mg per liter, it is toxic to health
- Fluorosis is a public health problem in many parts of the world.
- Endemic in 22 countries
- Asia, India and China are worst affected
- Mexico in North and Argentina in Latin America
- East and North Africa are also endemic
- Fluorosis is a disease caused by deposition of fluorides in the hard and soft tissues of the body

# Pitted enamel and discoloration of the teeth

- The first stage is characterized by white symmetric spots on the enamel of cutting teeth.
- The second stage they become yellow or light-brown.
- The third stage is characterized by erosive processes in the place of the spots.
- The fourth stage is characterized by an advanced process of tooth crown enamel erosion.





mild



moderate



pitting



severe

- The fifth stage is characterized by generalization of the process – the dentition as well as the spine, joints, central nervous system, digestive tract are affected.

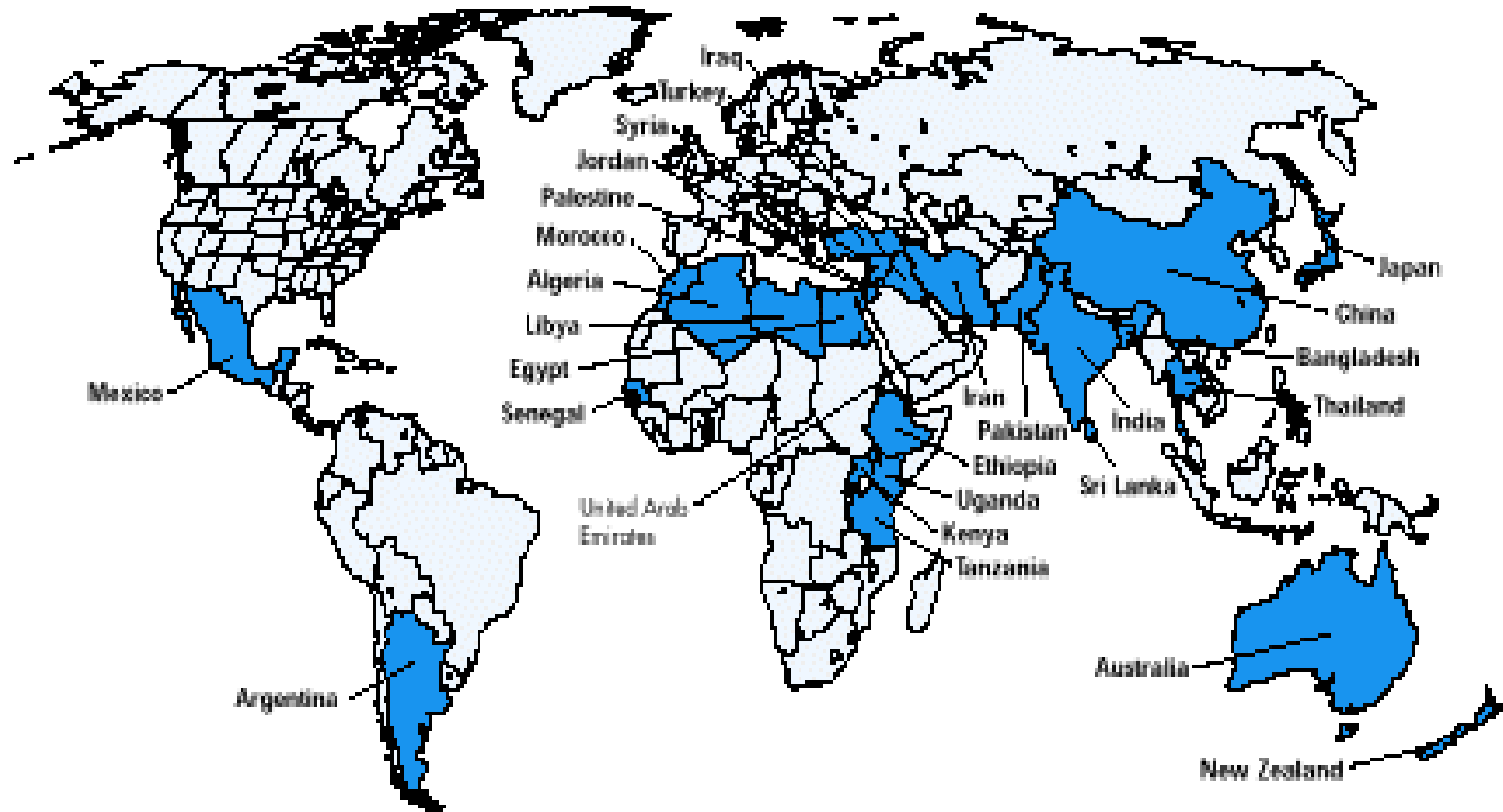
- **Skeletal Fluorosis** – pain and stiffness of joints, going into chronic joint pain, arthritis and calcification of ligaments etc.

- X-ray examinations of the bones reveals thickening and high density of bones. In some patients with calcium deficiency osteomalacia type changes are seen



Endemic genu valgum

# UNICEF Map of Fluorosis



*Countries with endemic fluorosis due to excess fluoride in drinking water*

### 3. Endemic caries

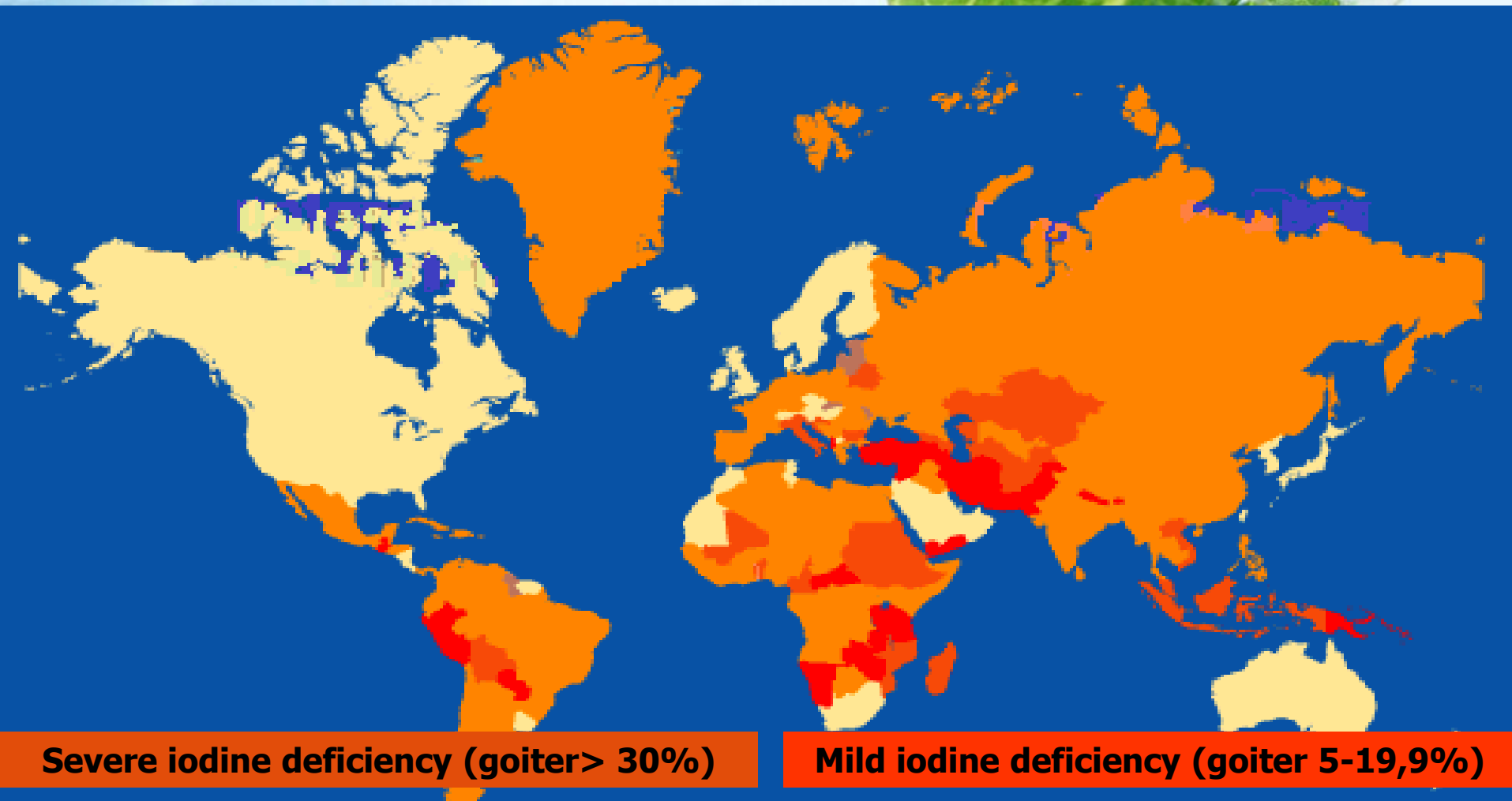
- is caused by drinking water with low fluorine content.
- in Volgograd the residents need 1.2 mg of fluorine in 1 litre of drinking water for the normal functioning of the organism. In fact there is 0.3 milligram per litre of fluorine in the Volga River from which people take water. It is 4 times less than the required amounts.



## 4. Endemic goiter

- is a disease which is caused by the insufficient iodine intake. One of the reasons for insufficient iodine intake is its low content or absence in drinking water. It usually results in the absence of iodine in foods of animal and plant origin. Thus, one can observe a total deficiency of iodine which leads to the proliferation of thyroid gland (compensatory hyperplasia) and formation of goiter.

# Map prevalence of iodine deficiency disorders in the world



**Severe iodine deficiency (goiter > 30%)**

**Mild iodine deficiency (goiter 5-19,9%)**

**Moderate iodine deficiency (goiter 20-29,9%)**

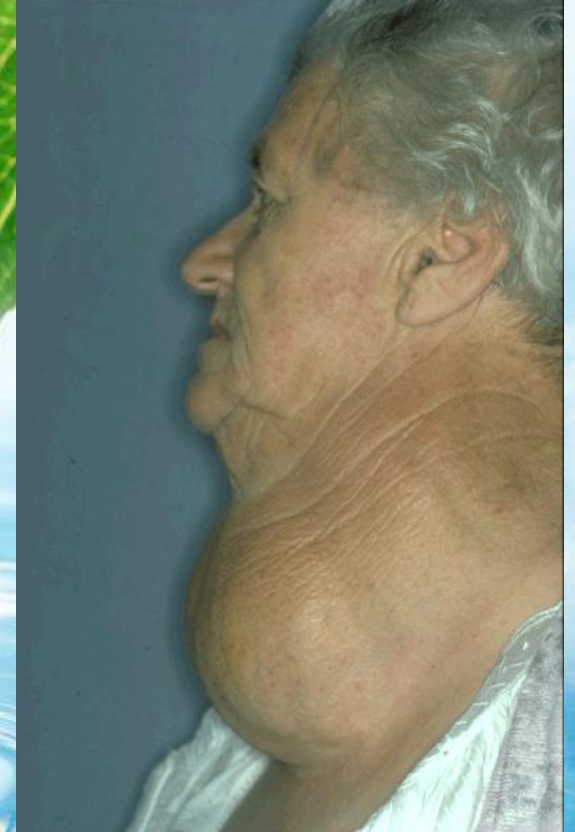
**No iodine deficiency (goiter < 5%)**

# Iodine deficiency goiter

When iodine deficiency is a compensatory enlargement of the thyroid gland - formed goiter

Long-lived iodine deficiency leads to the formation of thyroid nodules

In some individuals formed the functional autonomy of the thyroid gland, most often seen in multinodular toxic goiter



# Consequences of chronic iodine deficiency

- Pregnancy and breast-feeding thyroid dysfunction in women, violations of intellectual and physical development
- children's age learning disabilities, developmental disorders, euthyroid goiter
- Adults memory loss, infertility, fatigue
- Mature multinodular toxic goiter



WORKING TOGETHER  
WE CAN PREVENT MENTAL RETARDATION FROM  
IODINE DEFICIENCY

- Social preventive measures of endemic goiter include the use of **iodated salt**. As little as 10 grams of iodinated potassium is usually added per 1 ton of table salt and that is enough to provide the daily intake of iodine which is 100–200 mkg.

# Methods of iodine preventive maintenance

- **The mass** – introduction of salts of potassium (iodide or potassium iodate) in the most widespread food:
- In bread;
- In water;
- In salt



# Methods of iodic prevention

- **The individual** – prescribe transferred a strumectomy, persons with existence of goitrogenic factors in a life or production.
- Prescribe an antistrumin or iodide a potassium in a dose not less than 150-200 mgk per day.

# Environment importance of water

- About 2.8 billion people, more than 40% of the world's population, experience some form of water scarcity.
- Access to drinking water is a continuing serious global water issue, particularly for the poor. Some 1.6 billion people have limited access to water.
- Even in water-rich areas, if the local water is polluted and there are no economically viable alternatives, access is effectively denied. Over one billion people in the world lack access to safe water supplies.





# Environment importance of water

## The process of self-cleaning

- The process of self-cleaning of open reservoirs proceeds under the influence of various factors.
- **These factors are:**
  - hydrological - dilution and mixing of contaminants with the bulk of the water;
  - mechanical - sedimentation of suspended particles;
  - physical - the effect of solar radiation and temperature;
  - biological - complex processes of interaction of aquatic plant organisms with the constituent parts of the incoming wastewater;
  - chemical - the conversion of organic substances into minerals (mineralization).

# Environment importance of water



In the 20<sup>th</sup> century the intensity of water pollution as a result of human activities has increased considerably.

Industrial waste, sewage, discharges from the human body and landfills for toxic and radioactive waste in seas and oceans is the main source of water pollution nowadays.

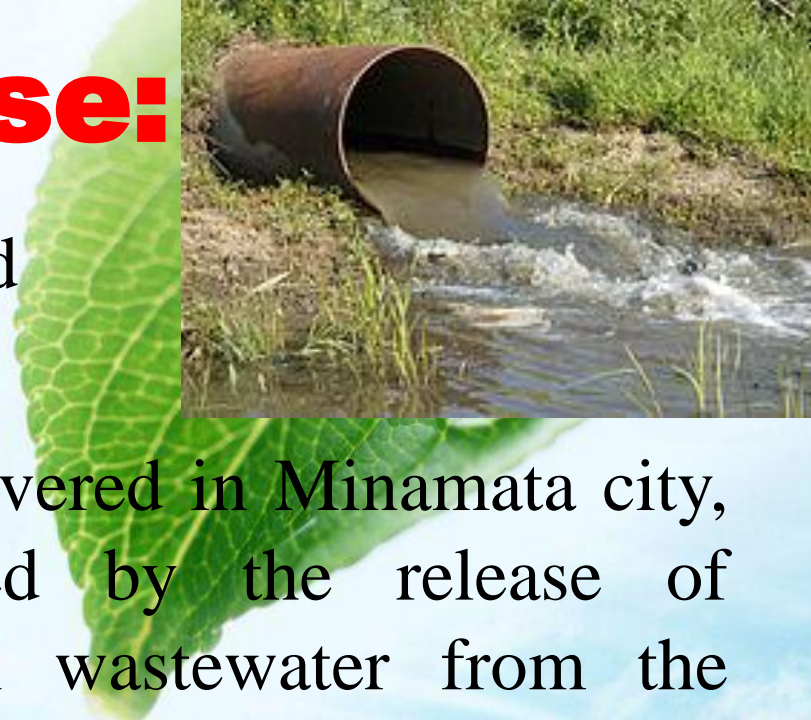
These human activities have an unfavourable effect on water biota and the health of a person.

- Environmentally related diseases are diseases which occur under the influence of anthropogenic factors on the human body.

# Minimata disease:

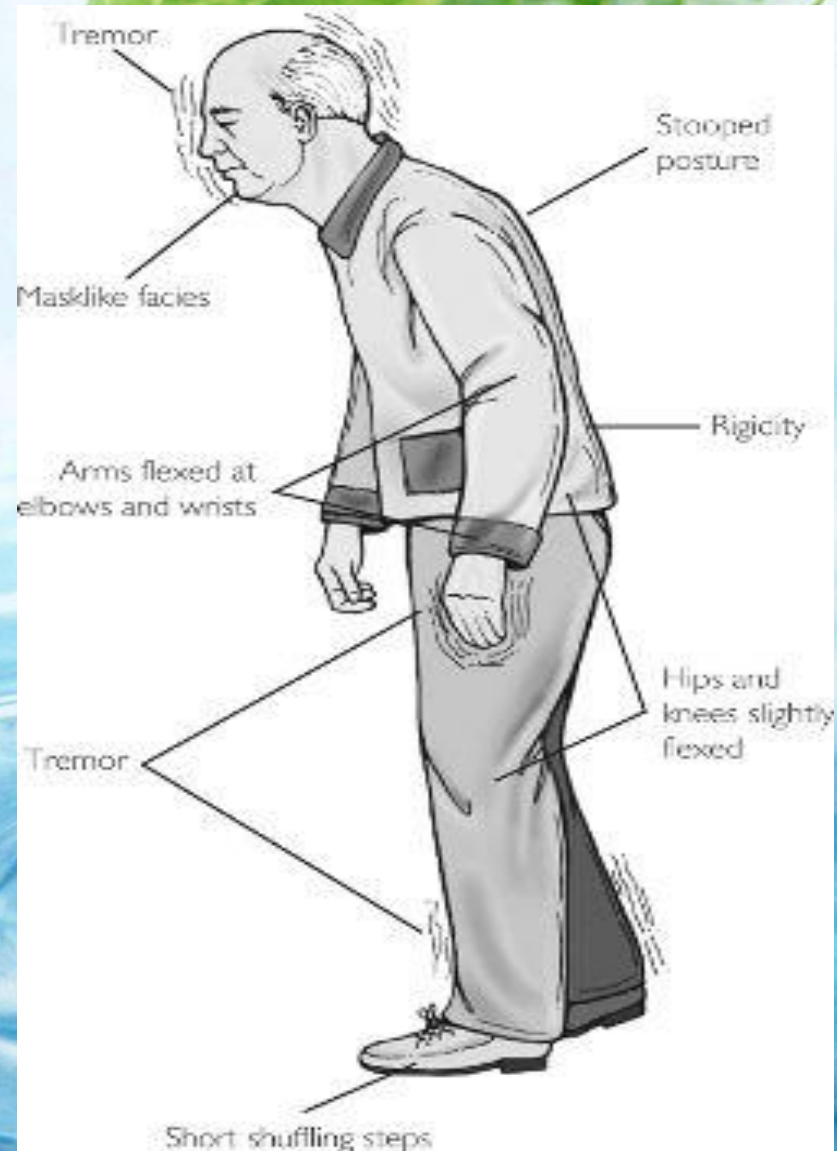
is determined by polluted sea and river fauna with mercury.

Minamata disease was first discovered in Minamata city, Japan in 1956. It was caused by the release of methylmercury in the industrial wastewater from the Chisso Corporation's chemical factory, which continued from 1932 to 1968. This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay and the Shiranui Sea, which when eaten by the local population resulted in mercury poisoning.



# Minimata disease

- Symptoms include ataxia, general muscle weakness, sensory disturbance in the hands and feet, damage to vision and hearing, weakness, and in extreme cases, paralysis and death.



# Pure water must fulfil the following conditions:

- It should be colorless
- It should be free from smell
- It should be free from taste
- It should not contain an excess of salts causing hardness of the water, not harmful metals such as lead, or other injurious chemicals





All waters are divided into fresh, containing more than 1 g / l of salts, mineralized, containing from 1 to 50 g / l and more than 50 g / l.

Prolonged use of water containing a large amount of minerals leads to changes in the body. So, the population constantly consumes water containing chlorides, sulfates and sodium salts, there is a decrease in urine output, water retention in tissues, edema, violation of the water-electrolyte balance. The most pronounced pathological changes occur with the use of sea water, containing 10 to 3 g / l of salts.

# Sulfates

- No more than 500 mg/l
- Minerals that contain sulfate include magnesium sulfate (Epsom salt), sodium sulfate (Glauber's salt), and calcium sulfate (gypsum).
- At high levels, sulfate can give water a bitter or astringent taste and can have laxative effects.



# Are there health risks for humans who drink water containing sulfate?

- People unaccustomed to drinking water with elevated levels of sulfate can experience diarrhea and dehydration. Infants are often more sensitive to sulfate than adults. **As a precaution, water with a sulfate level exceeding 400 mg/L should not be used in the preparation of infant formula.** Older children and adults become accustomed to high sulfate levels after a few days.





# CHLORIDE

- Chloride in surface and groundwater from both **natural** and **anthropogenic sources**, such as run-off containing road de-icing salts, the use of inorganic fertilizers, landfill leachates, septic tank effluents, animal feeds, industrial effluents, irrigation drainage, and seawater intrusion in coastal areas.
- **No more than 350 mg/l/**

# Water HARDNESS

- It is total concentration of calcium and magnesium ions

0 – 4 mg/l - soft

4 – 8 mg/l - moderately hard

8 – 12 mg/l - hard

12 above - very hard

Surface water is softer than ground water



# What does it mean if I have hard water?

- Hard water causes scaling in hot water systems, kettles, electric irons and domestic appliances. Scaling of heating elements shortens their life and makes appliances less efficient.
- Hard water produces less lather from soap, washing up liquid and washing powders. It also leaves 'tide marks' on basins, sinks, baths and toilets and a scum on the surface of hot drinks, especially tea brewed in the cup with a teabag (due to the air and oil in the tea).
- If less will have a low buffering capacity and be more corrosive to pipes.



# Heavy Metals

A green leaf with water droplets is positioned in the upper right corner, with a single drop falling into a blue pool of water below it, creating concentric ripples. The background is a soft-focus blue sky with white clouds.

- Present as minerals in soil and rocks of earth
- Human activities

Battery – Lead & Nickel

Textile - Copper

Photography – Silver

Steel production – Iron

# Organic Impurities

- The sources of Organic Impurities are:
- Sewage that has leaked into the water supply
- Animal excreta or vegetable refuse
- Water from marshes would naturally be expected to contain quantities of organic impurities



## NITRATE

Increasing level of nitrate is due to

- Agricultural fertilizers, manure, nitrogenous material, sewage pollution
- Maximum permissible limit 45 mg / l



Hygienic requirements for drinking water may be divided in following groups:

- 1. Microbiological and parasitological indicators
- 2. Generalized indicators and pollution content
- 3. Organoleptic properties
- 4. Radiation safety

# 1. Microbiological and parasitological indicators

Indicator	Unit	Norm
Thermotolerant coliform bacteria	Amount of bacteria in 100 ml of water	None bacteria
Common coliform bacteria	Amount of bacteria in 100 ml of water	None bacteria
Microbe value	Number of colony-forming bacteria in 1 ml	No more than <b>50</b>
Cysts of lamblia	Number of cysts in 50 l of water	None bacteria
Number of colibacilli (coli-index)	Number of colibacilli in 1000 ml of water	No more than <b>10</b>

## 2. Generalized indicators and pollution content

Indicators	Units	Norms (not more than)	Hazard indicators	Rate of hazard
Hydrogen (H) quotient	pH	6-9		
General mineralization (dry residues)	mg/l	1000 (1500)		
General hardness of water	mole/l	7.0 (10)		
Permanganate water oxidizability	mg/l	5.0		



# Inorganic substances

Indicators	Units	Norms (not more than)	Hazard indicators	Rate of hazard
Nitrates (NO <sub>3</sub> )	mg/l	45		3
Iron (Fe)	mg/l	0, 3 (1, 0)		3
Sulfates (So <sub>4</sub> )	mg/l	500		4
Chloride (Cl)	mg/l	350		4
Lead (Pb)	mg/l	0, 03		2
Fluorine (for climatic regions)				2
1-2	mg/l	1,5		
3	mg/l	1,2		

# 3. Organoleptic properties

Indicators	Units	Norms
Smell	Points	Not more than 2
Taste	Points	Not more than 2
Colour	Degrees	Not more than 20 (35)
Turbidity	mg/l	Not more than 1, 5 (2)
Turbidity	mg/l (according to kaolin/china clay)	Not more than 2

## pH

It is the measure of hydrogen ion concentration

Neutral water pH-7

Acidic water has pH below 7

Basic water has pH above 7

Desirable limit 6.5-8.5

# 1.4. Radiation safety

<b>Hazard indicators</b>	<b>Units</b>	<b>Norms</b>	<b>Indicators</b>
General $\alpha$ -radioactivity	Bq/l	0, 1	Radiation
General $\beta$ -radioactivity	Bq/l	1, 0	Radiation

# ORGANOLEPTIC INDEX

INDEX	Unit	WHO	USEPA	EC	СанПиН (Russian Sanitary Standard)
SMELL	point	—	—	--	<b>2</b>
TASTE	point	—	—	—	<b>2</b>
COLOUR	degree	<b>15</b>	<b>15</b>	<b>20</b>	<b>20</b>
TURBIDITY	ЕМФ	<b>5</b>	<b>0,5-1</b>	<b>4</b>	<b>2,6</b>
	(according to formazyl Mg/1 (according to kaolin)	-	-	-	<b>1,5</b>
TRANSPARENCY	sm	~	~	--	--