

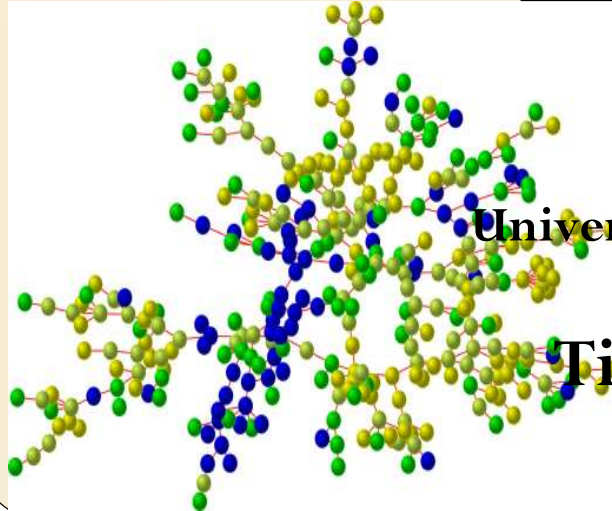


Politechnica University  
Timisoara, Romania

# The II Workshop - IPA Project Contamination of surface water by Emerging substances

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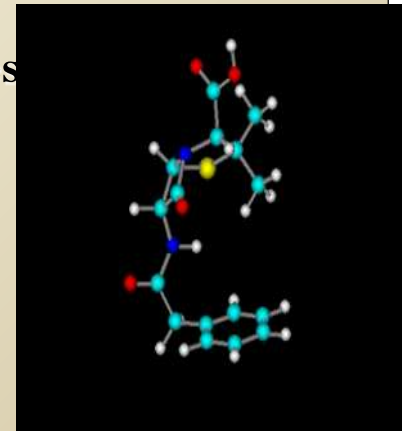
**Obrovski Boris, PhD student**

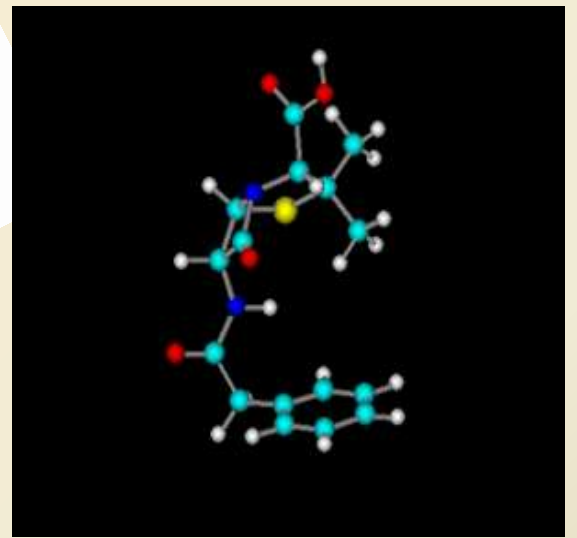
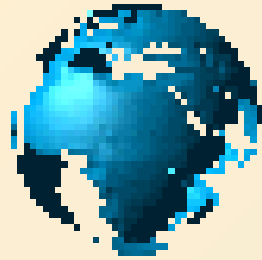


UNS, Faculty of Technical Sciences

University of Technology, Bratislava, SK

Timisoara, 29 May, 2014





# CONTENT

**The urban water cycle,**

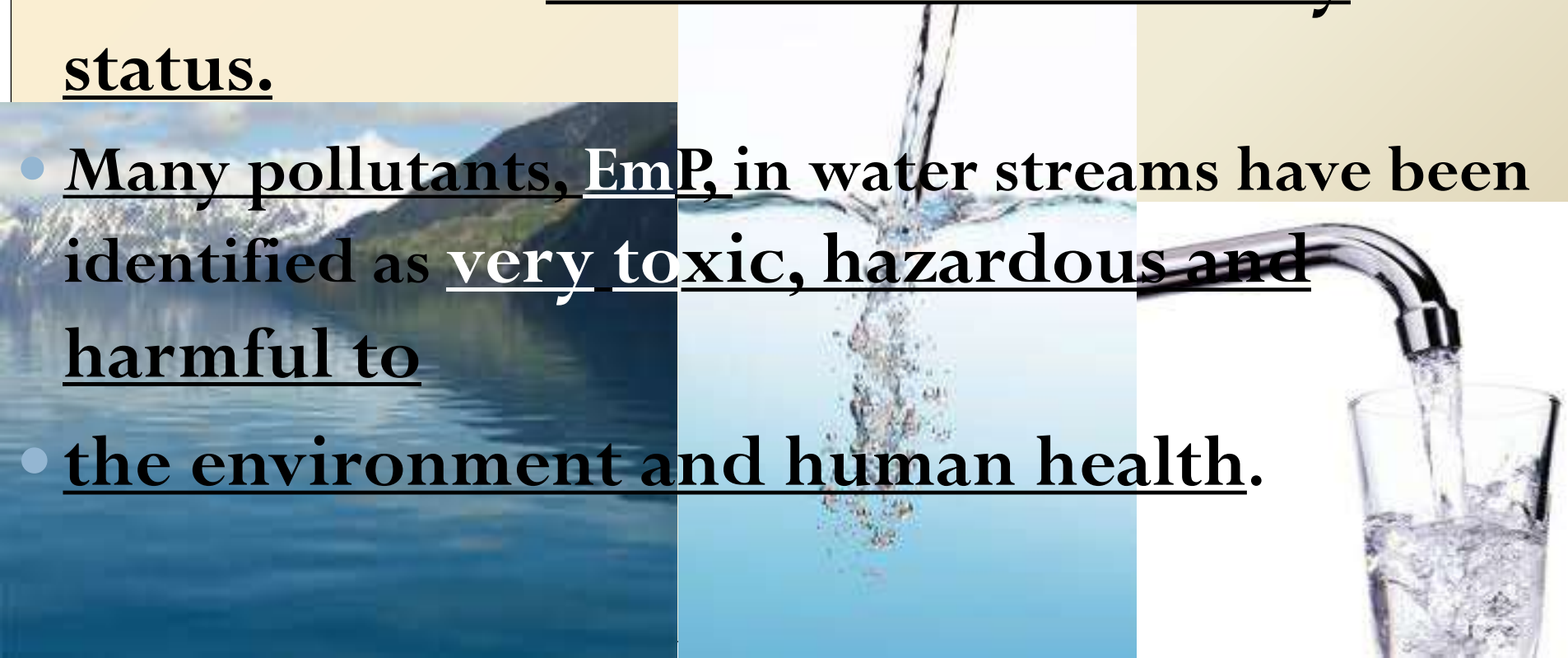
**Surface water**

**The story about EmS**

**Instead of conclusion**

# WATER IS ESSENTIAL FOR LIFE

- Strategic resource for every country and population.
- Its availability and sanitary safety is highly connected with the health and economy status.
- Many pollutants, EmP, in water streams have been identified as very toxic, hazardous and harmful to
- the environment and human health.



# The urban water cycle

⇒ Stages of the  
“urban water cycle”

## 1. Human water usage

- ❏ Municipal
- ❏ Industrial
- ❏ Agricultural

## 2. Wastewater

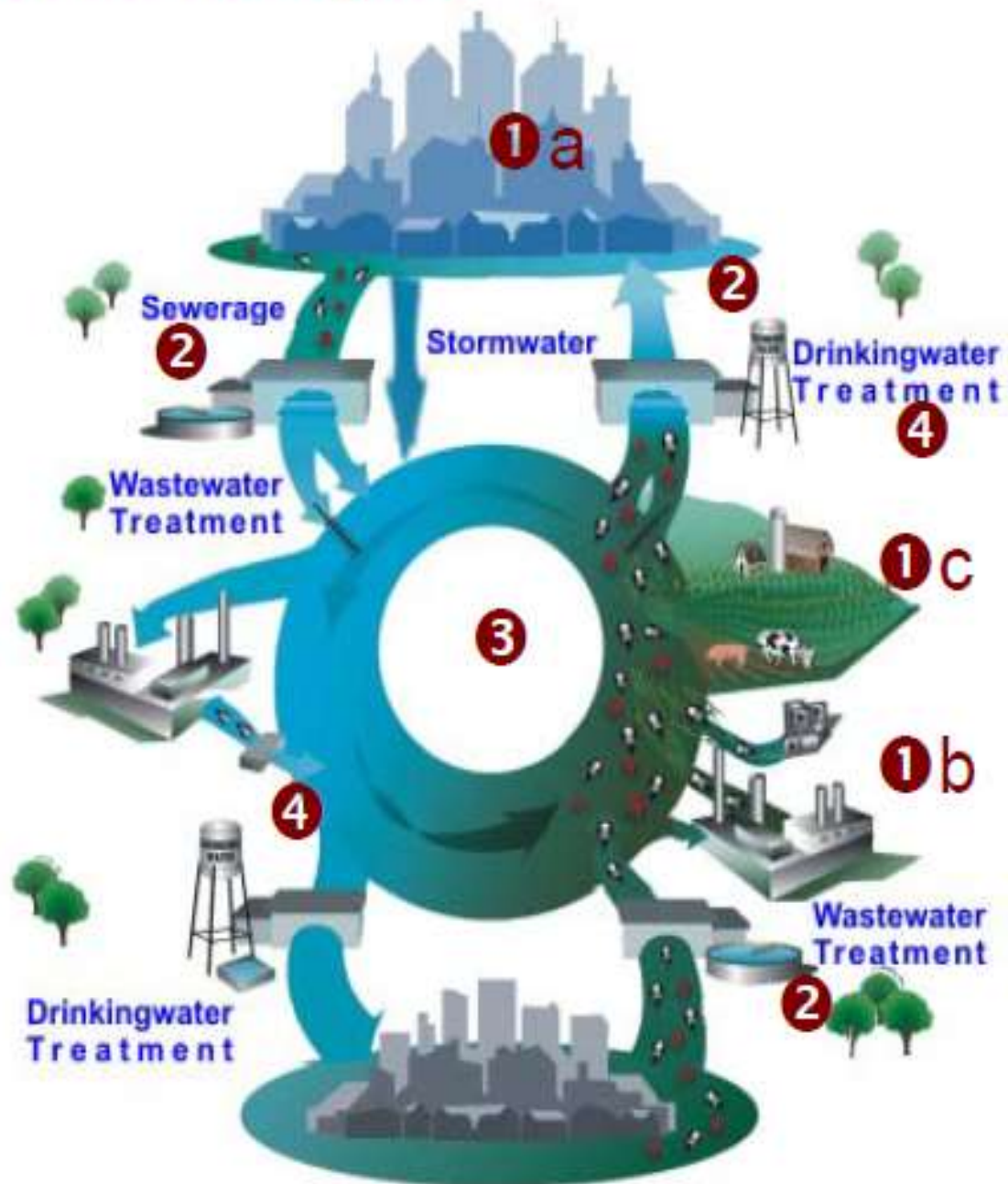
- ❏ Sewerage
- ❏ Storm water overflow
- ❏ Wastewater treatment
- ❏ Sludge disposal

## 3. Natural waters

- ❏ Surface waters
- ❏ Ground waters

## 4. Water supply

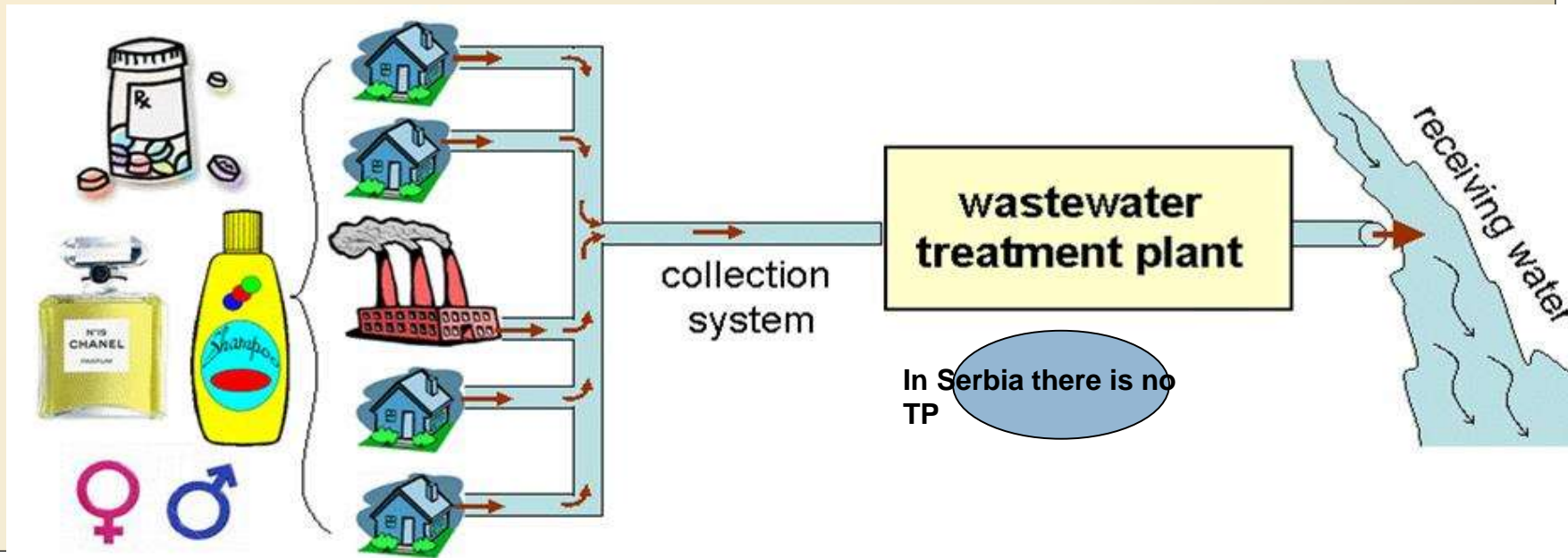
- ❏ Abstraction
- ❏ Water treatment
- ❏ Storage and Distribution



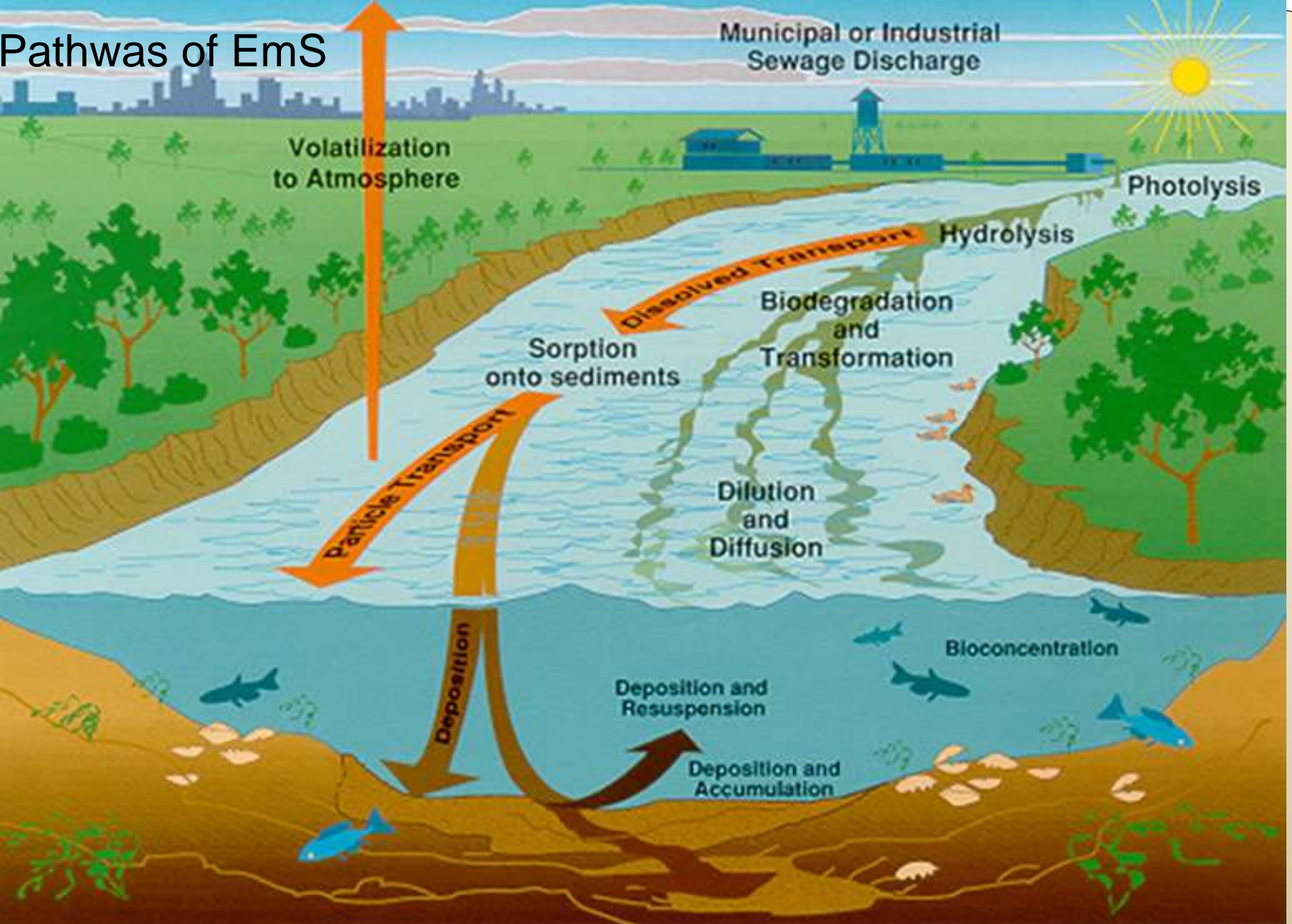


# Em C /S /P

- are derived (produced, generated, used), from industrial, pharmaceutical, domestic, municipal and agricultural wastewater sources and pathways, and dispersed to the environment
- These newly recognized EmP represent a shift in traditional thinking -



# Pathways of EmS



# According to NORMAN EmS

(Network of reference laboratories for monitoring of emerging environmental pollutants)

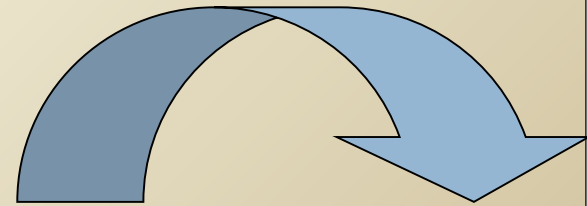
- **EmS** - as substances that have been detected in environment, in very low conc. – ppb, ppt, but - are currently not included in routine monitoring programs at EU level
- and whose fate, behavior and (eco) toxicological effects are not well understood.



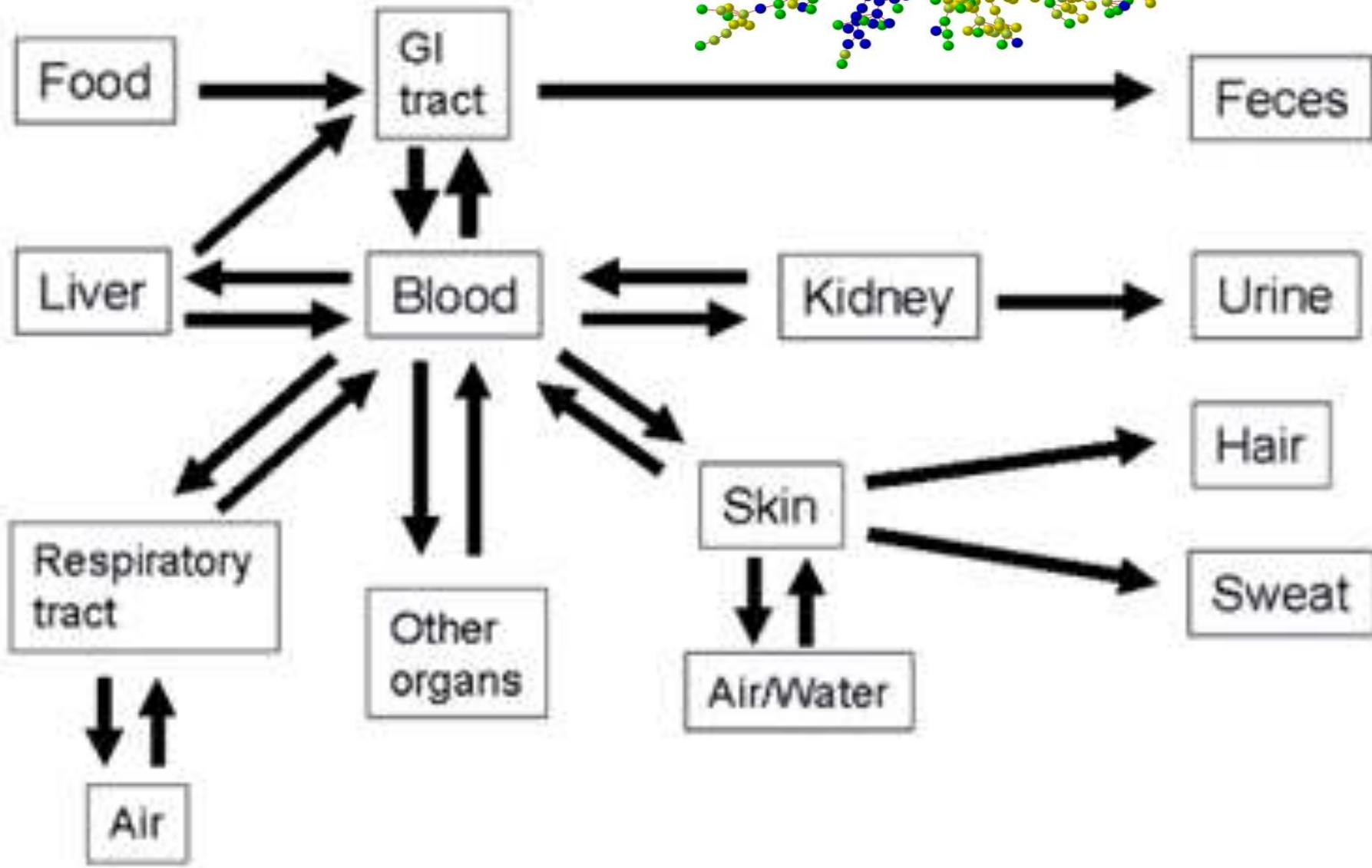
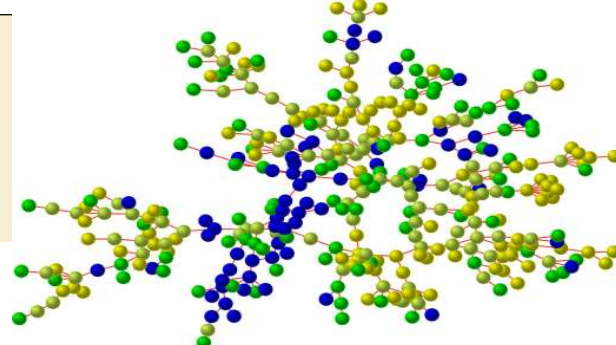


- Around 98% of the commercially available compounds are NOT inventoried and are unregulated substances,
- no - their environmental fate, transport, and toxicological effects !!!
- pseudo-persistence!

**EmC are detected in**







## EmS very toxic

- found in a wide array of consumer goods, including pharmaceuticals, FR, personal care products-PPCP...
- EmS may - low concentrations between ppm, ppb and ppt in surface/ ground water, domestic/industrial wastewater, agricultural runoff, reclaimed water, drinking HOH (Danube)...
- Many of EmS also may be found in soils & in air.
- They are a fact of modern, industrialized living.
- Hazardous, carcinogenous... (TER., MUT.)

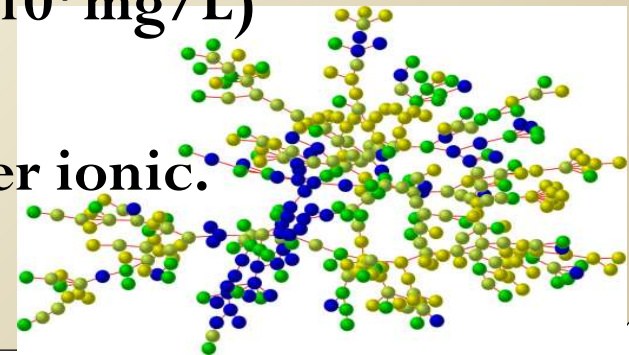
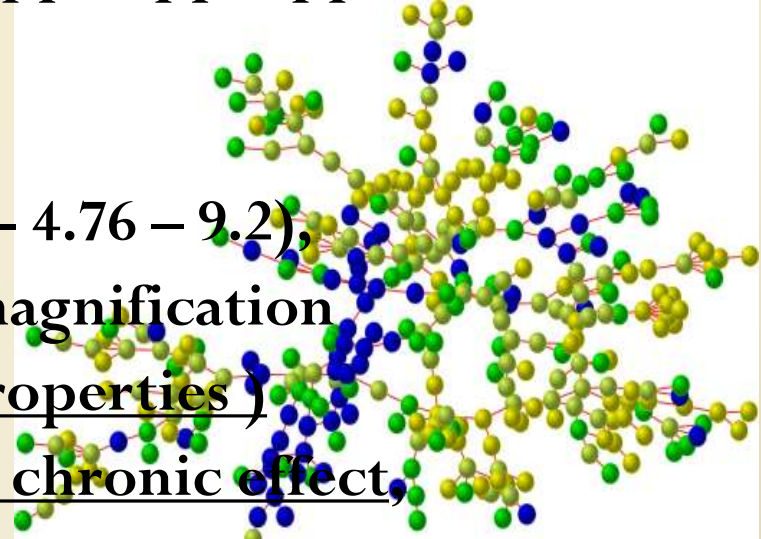


# Emerging – magic word !

- According to **NORMAN**
- 750 different EmS / C / P
- 25 class & 79 sub-classes
- Emerging research, monitoring, effect, philosophy...
- List is open and dynamic ....

## Physicochemical characteristic of EmS

- Low doses occurrence and effects - ppm, ppb, ppt and lower
- Pseudo - persistency / persistency,
- Stability low / non degradability,
- Hydro/lipo philicity - ( $\text{Log } K_{ow} = -4.76 - 9.2$ ),
- Bioconcentration / accumulation / magnification
- Binding to proteins – (biological properties)
- Toxicity with hazardous and rather chronic effect,
- Endocrine modelulating / disruption, with teratogenic and carcinogenic consequences within low / sublow doses,
- Volatile, non - or semivolatile compounds,
- water / lipid soluble molecules ( $0.06 - 3.1 \cdot 10^4 \text{ mg/L}$ )  
polar / nonpolar molecules,
- Neutral, acidic, basic, and ionic or zwitter ionic.



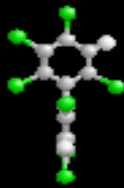


# Pseudo-persistence

- Persistence is one of the most important criteria in the environmental assessment of chemicals.
- Even if there is some degree of degradation of EmS, the parent compounds will nevertheless be present at constant levels in the environment if the input rate is higher than their rate of degradation or mineralization.
- This can be called second order persistence or pseudo persistence -  $V_{input} \geq V_{degradation}$

# Screening and target analyses

- Within NATO Project
- By Screening analyses we detected more than 150 Organic and inorganic chemicals in the samples of the surface water of the Danube River, in the vicinity of Novi Sad.
- Target Analyses – quantitatively - more than 30 organic toxic chemicals



## 150 organic Em compounds

- It was detected more than 150 different emerging organic compounds -phthalates, indeno derivatives, alkyl substituted benzenes, naphthalene and phenol derivatives, PAHs, hormones, triphenyl phosphate), caffeine and others EmS are found in the Danube-NS SW in very low concentrations, ppb/ppt !!!

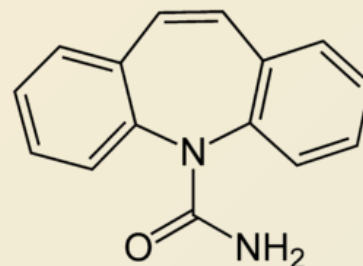




# The Universe of Chemical Pollutants

- Carbamazepine – anticonvulsant

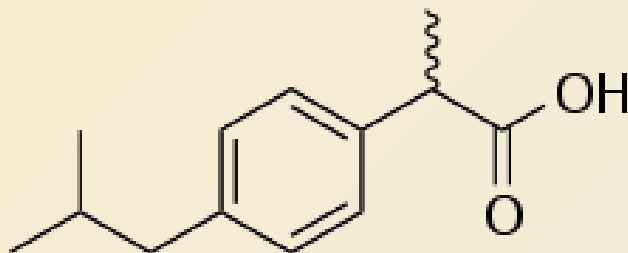
- Log Kow= 2,25



- Ibuprofen - nonsteroidal anti-inflammatory drug

- 3,5

- 4,51

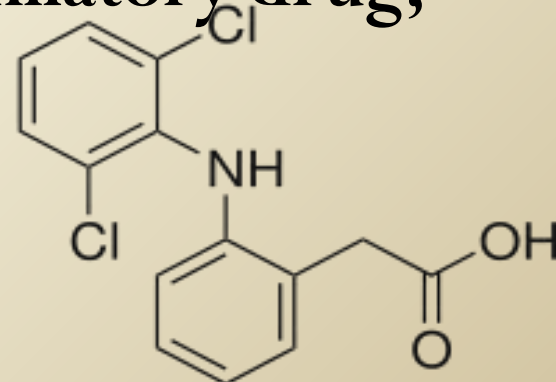


- Diclofenac- nonsteroidal anti-inflammatory drug,

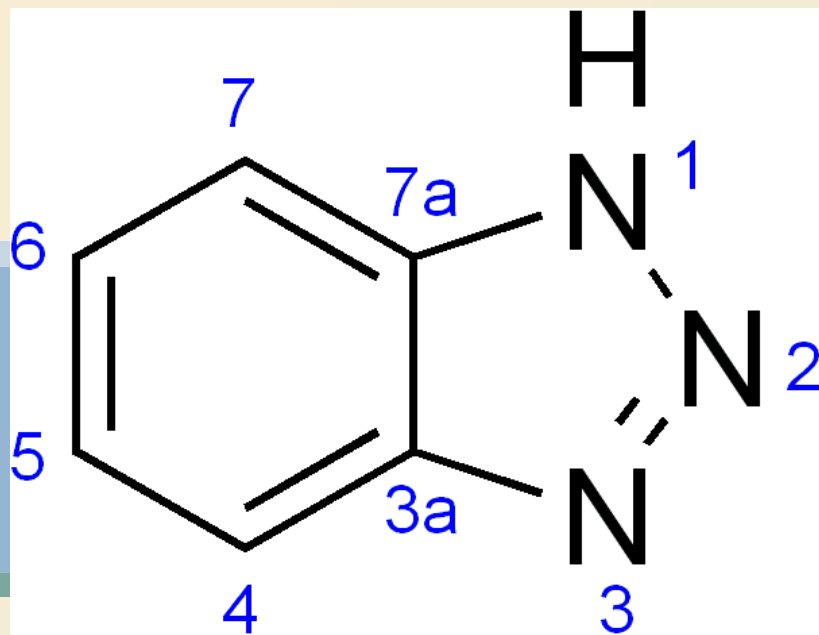
- **We detected: caffeine**

- **Benzotriazole (Danube, sw)**

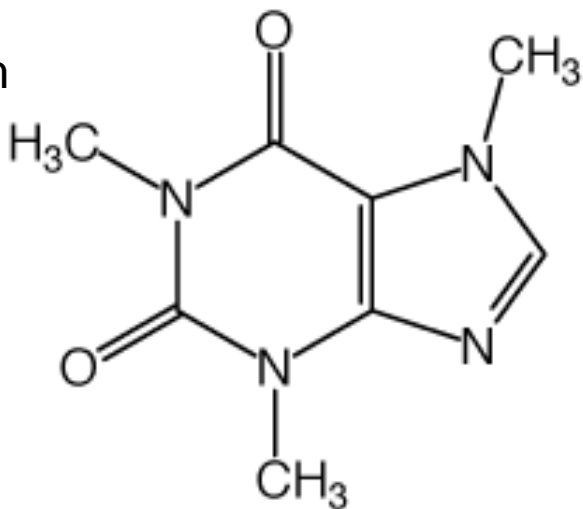
- **The international Project**



# We detected

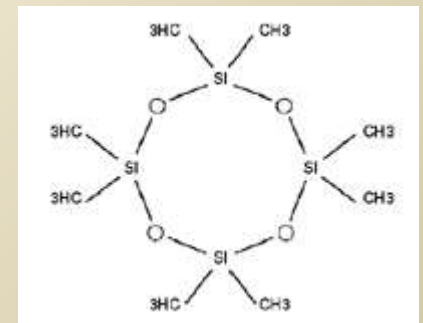
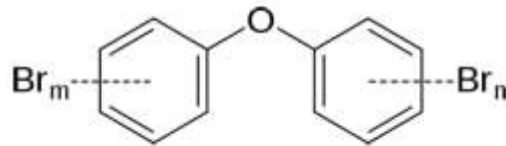


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# Global organic contaminants:

- Pharmaceuticals and personal care products
- Endocrine-modulating compounds
- Polybrominated diphenyl ethers - PBDEs,
- Hexachlorobutadiene – HBCDs,
- Perfluorooctanesulfonic acid – PFOS.
- Perfluorooctanoic acid -PFOA,
- Siloxanes



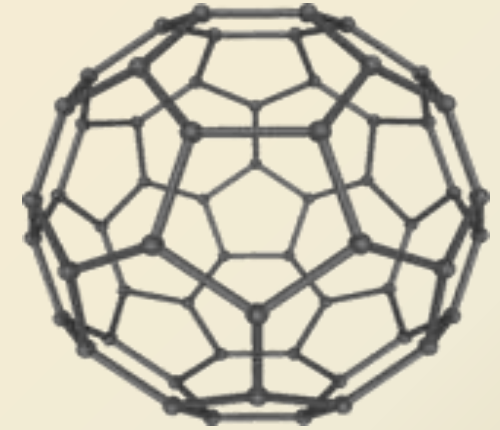
- Nanomaterials - are natural and man-made structures, ranging in size from 1 nanometer (nm) to 100 nm,
- widely used in nano-therapeutic - pharmaceuticals, drug delivery, cosmetics, personal care products, energy storage products, fabrics, lubricants, and even recreational equipment such as golf balls.



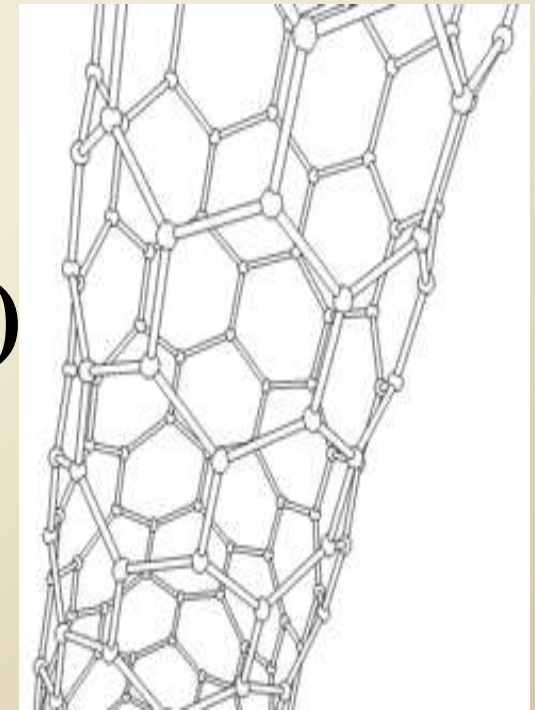


# Nanoparticles

NanoMats

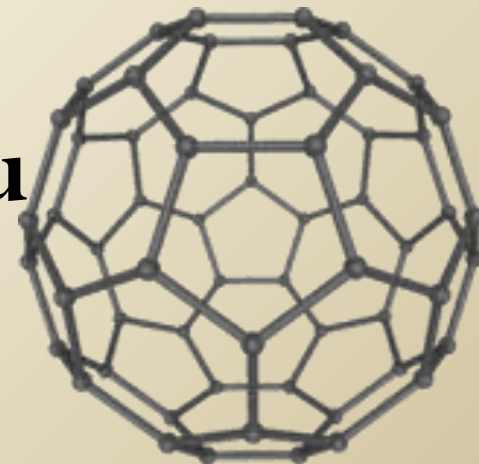


- **Fullerenes (a.k.a. buckyballs)**
- **Nanotubes**
- **Quantum dots**
- **Nanopowders (metal oxides)**
- **Natural particles (e.g., soot)**



# Nanoparticles

- **Chemical and physical properties change at nano scale -**
- **Magnetization, charge capacity, melting point, hardness**
  - **Matter may now act as a catalyst or semiconductor**
  - **Non-ferrous metals like Au**
  - **and silver**
  - **can become magnetic**



# Toxicity



- Toxicity of most nano
- products has not been determined
  - Different toxicological properties from parent compound
  - Cross biological membranes and blood-brain barrier

# What is new?

**Old Pollutant – New Concern  
Newly identified -Unregulated**

due to improved analytical techniques-

UPHC(TOF)MS/MS – EmS detected

- **Highest Propensity for Adverse Effects**

**Possess structural stability, short  $\frac{1}{2}$ -life)**

- **Lipophilic (bioaccumulative)**
- **Cause acute or chronic toxicity**
- **Pseudo persistent substances**
- **Very low concentr. - ppb, ppt or lower**

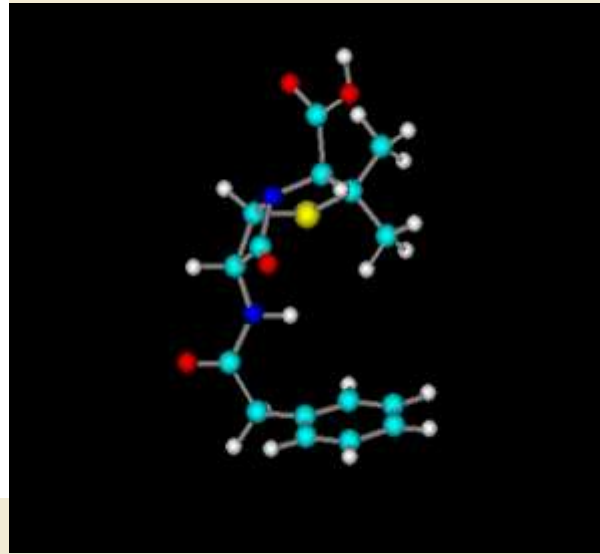
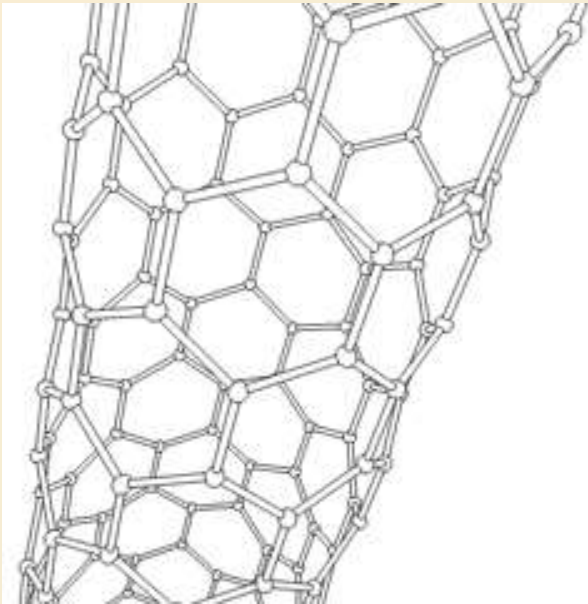
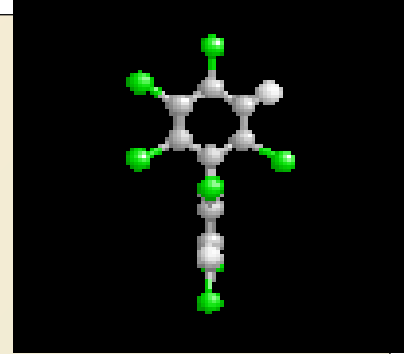


# Em chemicals

- Chemicals are a part of modern life and are present in all spheres of human life.
- The biggest number of organic and inorganic chemicals belongs to emerging chemicals.
- EmS contribute to our well being, high life expectancy and economic prosperity.

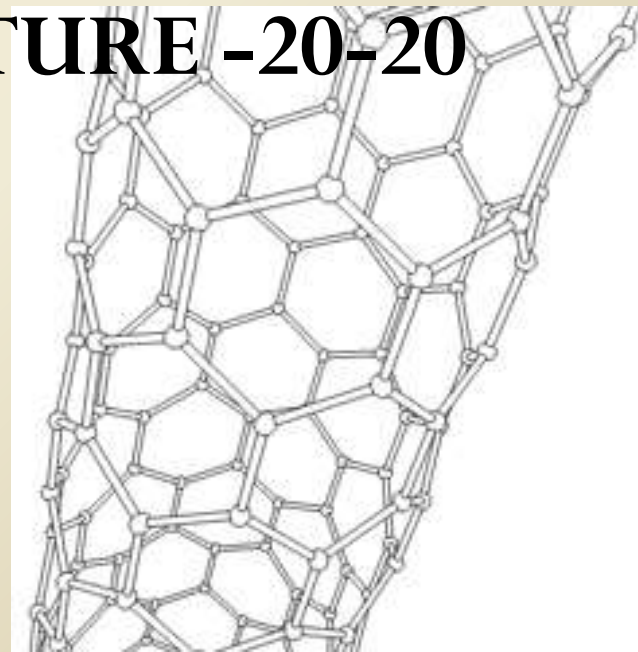
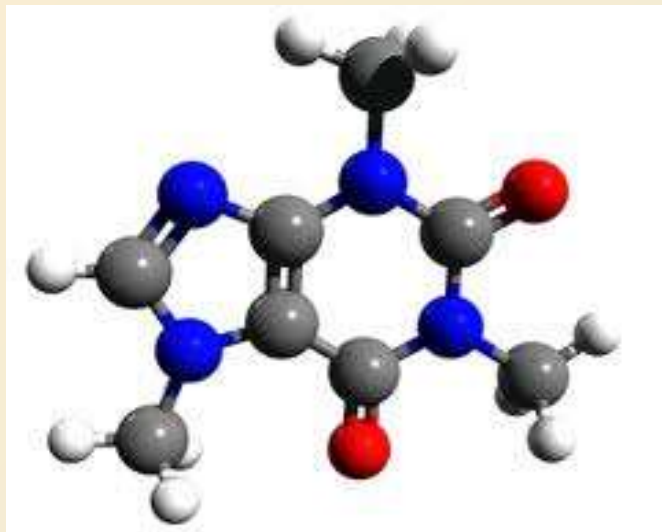


# Instead of conclusion



- **Millions of EmS entering the environment – every year especially in urban areas.**
- **The most common mechanism for EmC - input into the environment - is through wastewater discharges, land application of sewage sludge, landfill leachate...**
- **Potential adverse effects on human health, environment, unknown fate ...**

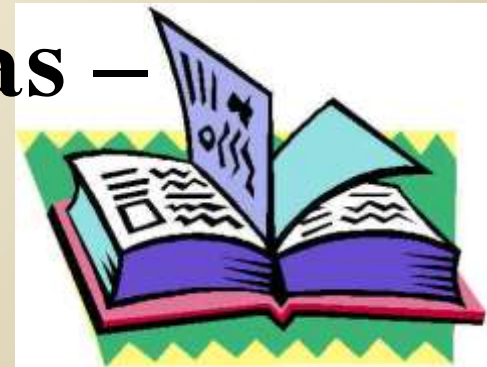
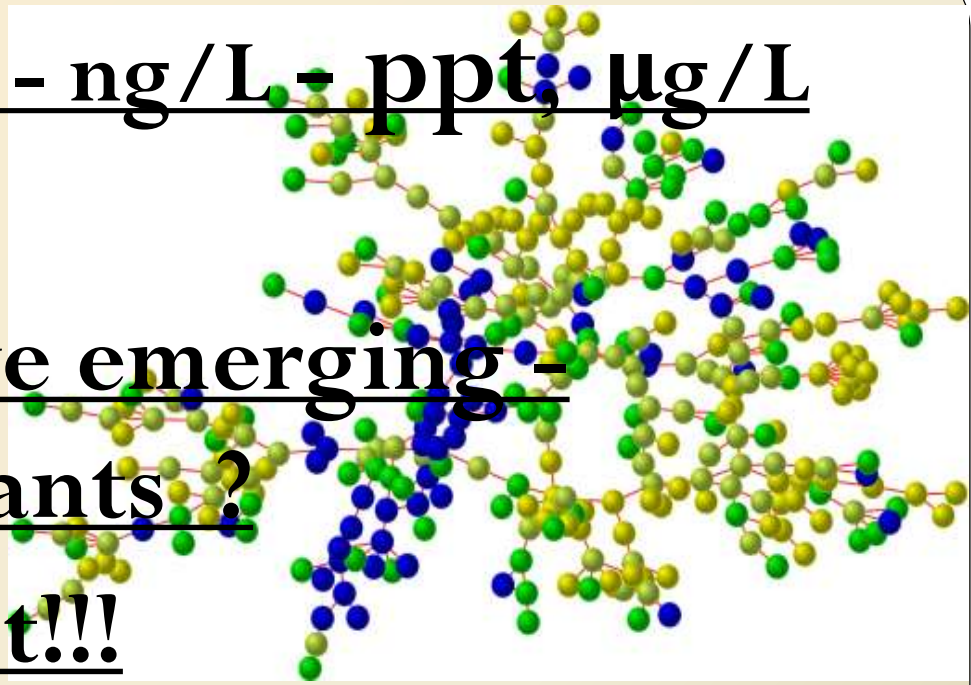
- EmS - additive and synergistic effects
- EmS persist, bioaccumulate, cause endocrine modulation, binding to G protein, chronically toxicity...
- EmS are contaminants in modern urban areas ...
- The Research of the our **FUTURE -20-20**





Range concentration - ng/L - ppt,  $\mu\text{g/L}$   
- ppb.

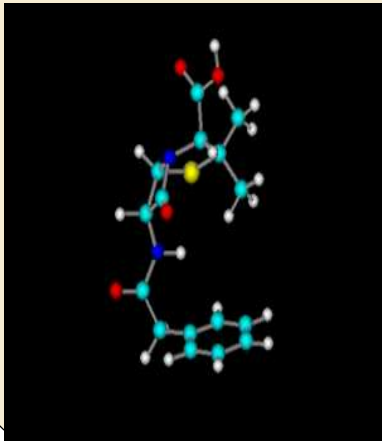
- How we can remove emerging -  
micro, nano pollutants ?
- We do not know yet!!!
- Our responsibility is to seek for ways to deal with the presence of EmS in the environment, urban areas – ground and drinking
- water sources.



# Acknowledgment for financial support

**NATO - Science for Peace Project "Drinking Water Quality Risk Assessment and Prevention in Novi Sad municipality, Serbia" (ESP.EAP.SFP 984087).**

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- Gradska Uprava**



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