

# CVL100:Environmental Science(2-0-0) (Tuesday and Friday)

Dr. Arun Kumar, Prof. A.K.Nema and Prof. B.J.Alappat

Course Outline (Jan 2<sup>nd</sup>, 2015)

See Website: <http://web.iitd.ac.in/~arunku/> (teaching activity  
section → CVL100)

Check IITD course email daily for information



भारतीय प्रौद्योगिकी संस्थान दिल्ली  
Indian Institute of Technology Delhi  
Hauz Khas, New Delhi-110016 INDIA

# Course Instructors/outline

- Dr. Arun Kumar ([arunku@civil.iitd.ac.in](mailto:arunku@civil.iitd.ac.in)):  
Water (till minor 1) (33%)
- Prof. B.J.Alappat ([bjalappat@yahoo.co.in](mailto:bjalappat@yahoo.co.in)):  
Solid waste (minor1-minor 2) (33%)
- Prof. A.K.Nema ([aknema@gmail.com](mailto:aknema@gmail.com)):  
Case studies; Environmental Impact Assessment; Life-cycle assessment and Policies (minor 2-major exam)(34%)

# Course objectives

- Introduce environmental concepts
- Increase awareness of environmental issues
- Provide scientific approach to address environmental problems

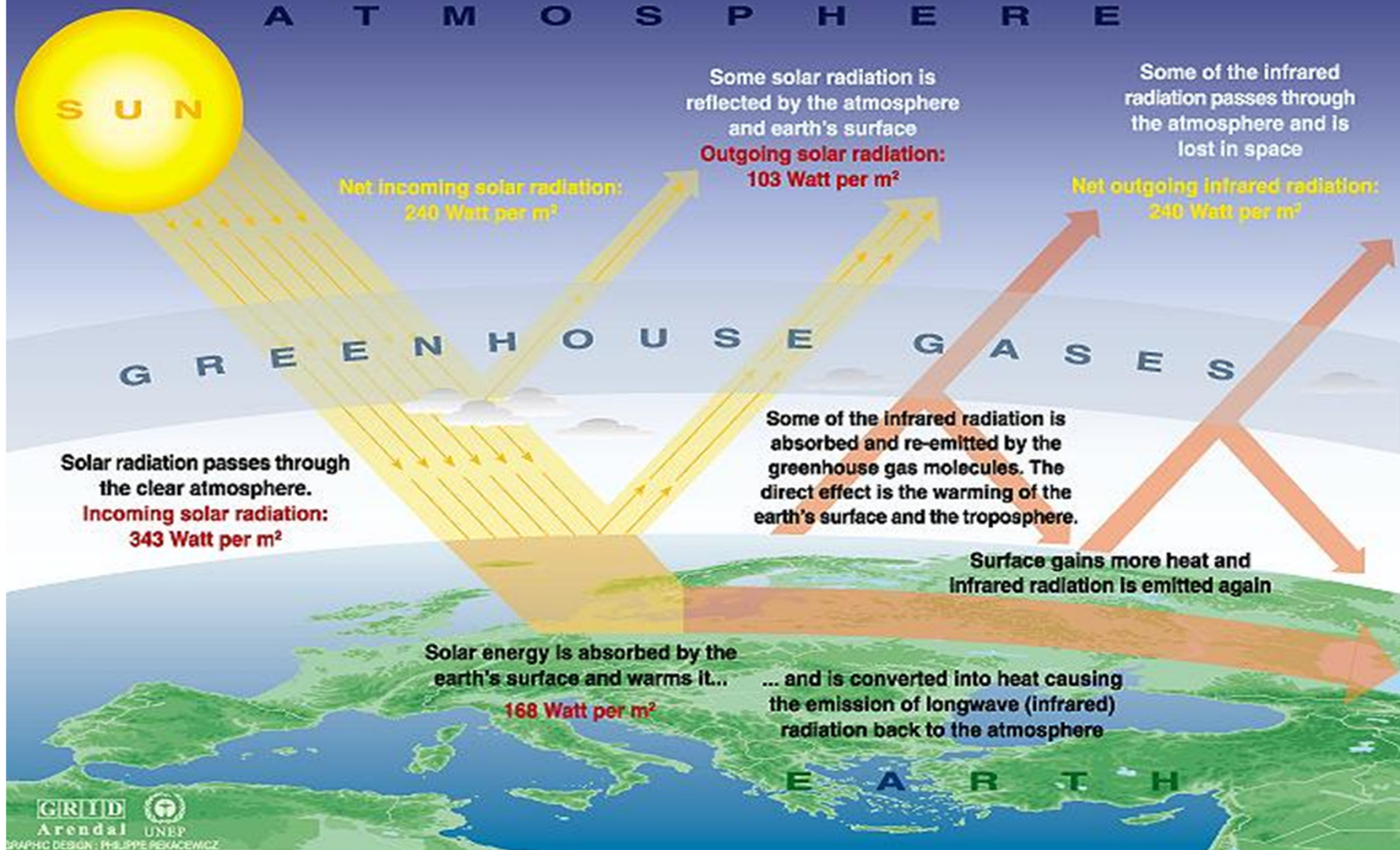
# Attendance policies

- If a student's attendance is **less than 75%**, the student will be awarded **one grade less than the actual grade** that he (she) has earned.
- Students are responsible for checking course email, IITD ArunKumar's website for getting course information regularly.
- **All medical reports should be submitted within one week of absence.**

# Lecture 1: Environment Engineering: What? Why? How? Should we?

Lecture 1 (Jan 2<sup>nd</sup>, 2015)  
by Dr. Arun Kumar ([arunku@civil.iitd.ac.in](mailto:arunku@civil.iitd.ac.in))

# The Greenhouse effect



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

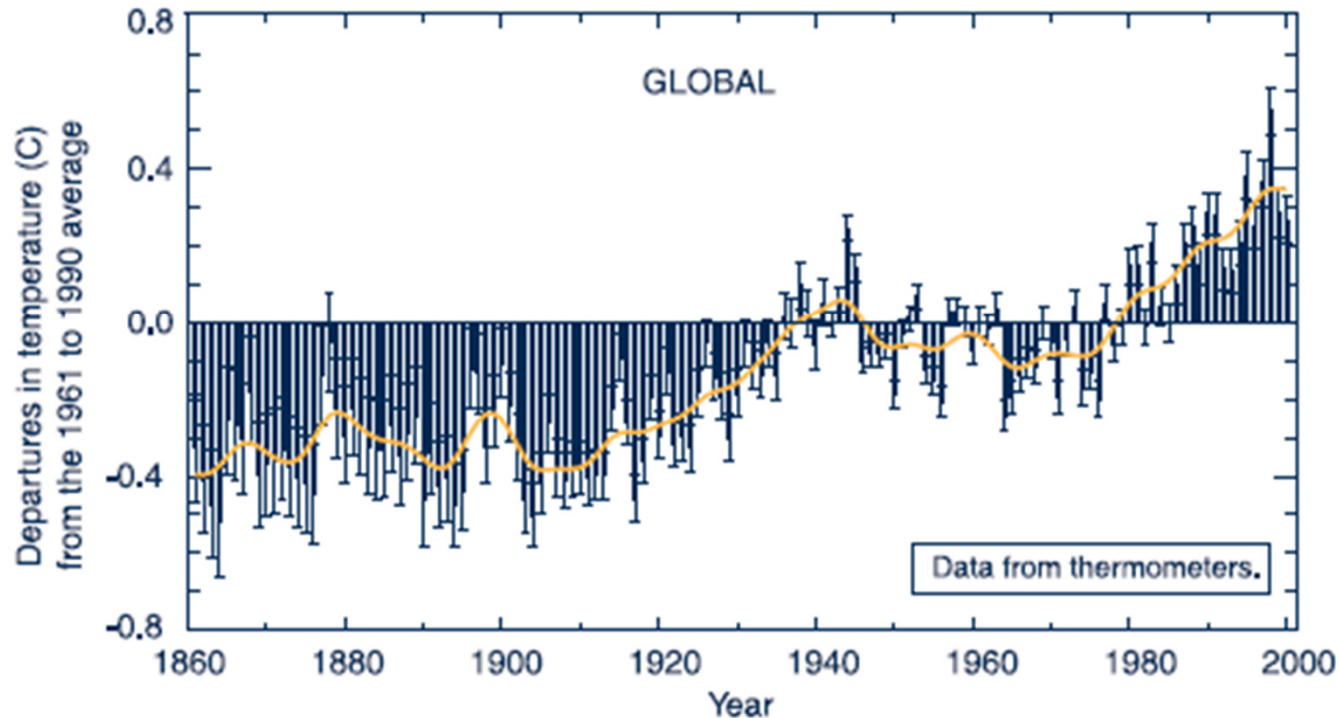
[http://unfccc.int/essential\\_background/feeling\\_the\\_heat/items/3157.php](http://unfccc.int/essential_background/feeling_the_heat/items/3157.php)

January 5, 2015

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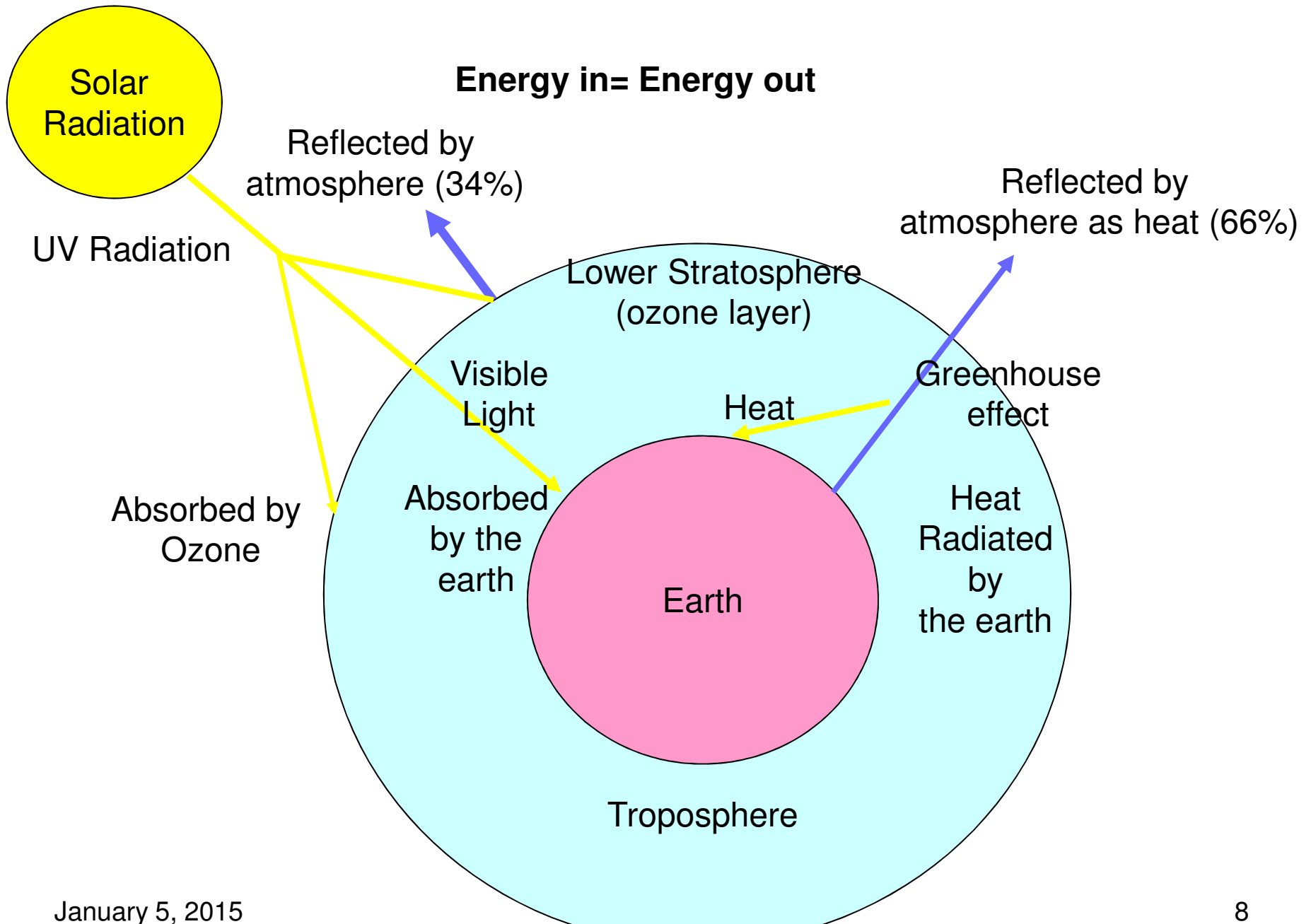
# Combined annual land-surface air and sea surface temperature anomalies (degree C) 1861 to 2000, relative to 1961 to 1990.

## Variations of the Earth's surface temperature for the past 140 years



Two standard error uncertainties are shown as bars on the annual number.

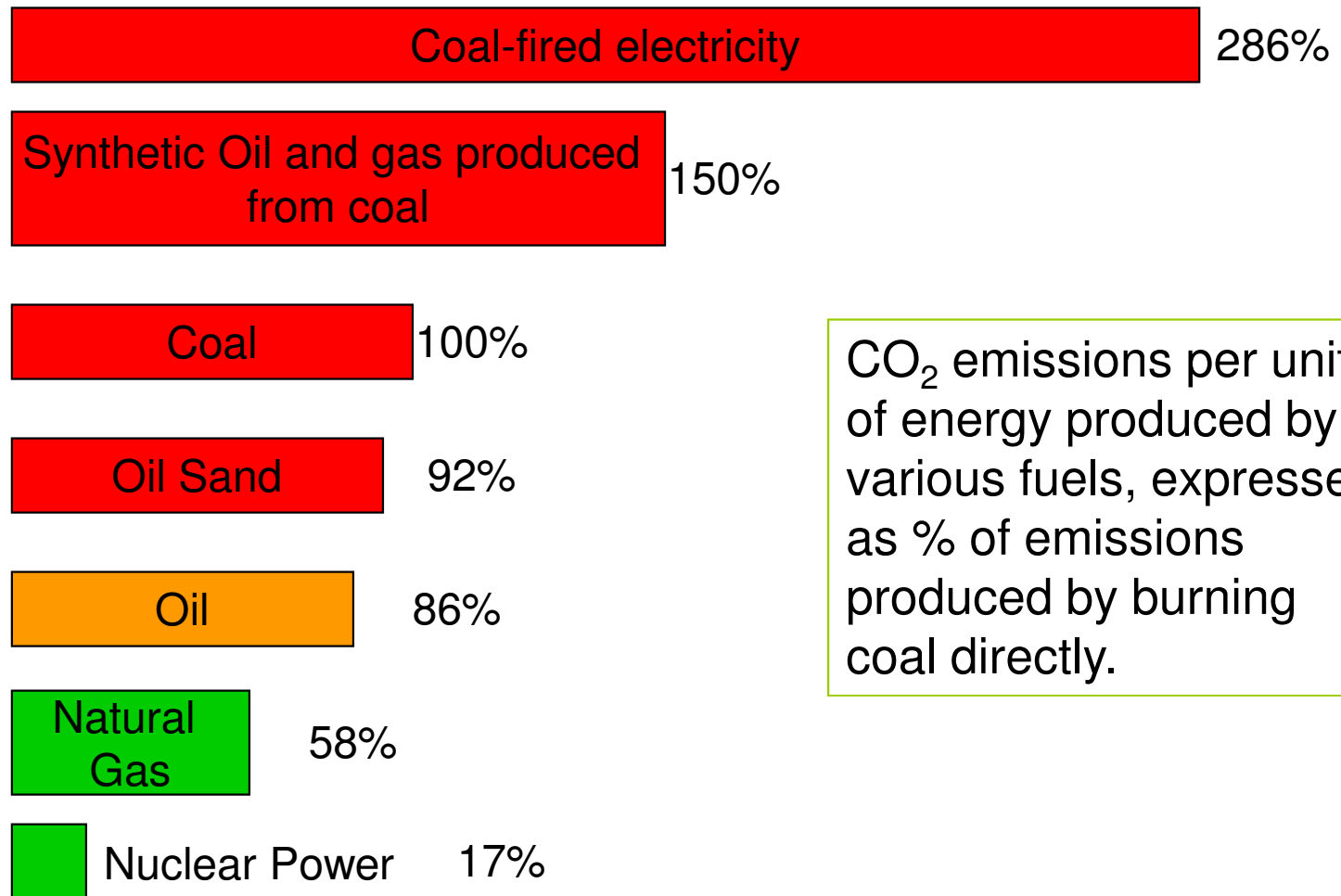
Source: IPCC, "Climate Change 2001: The Scientific Basis. Technical Summary", p 26.



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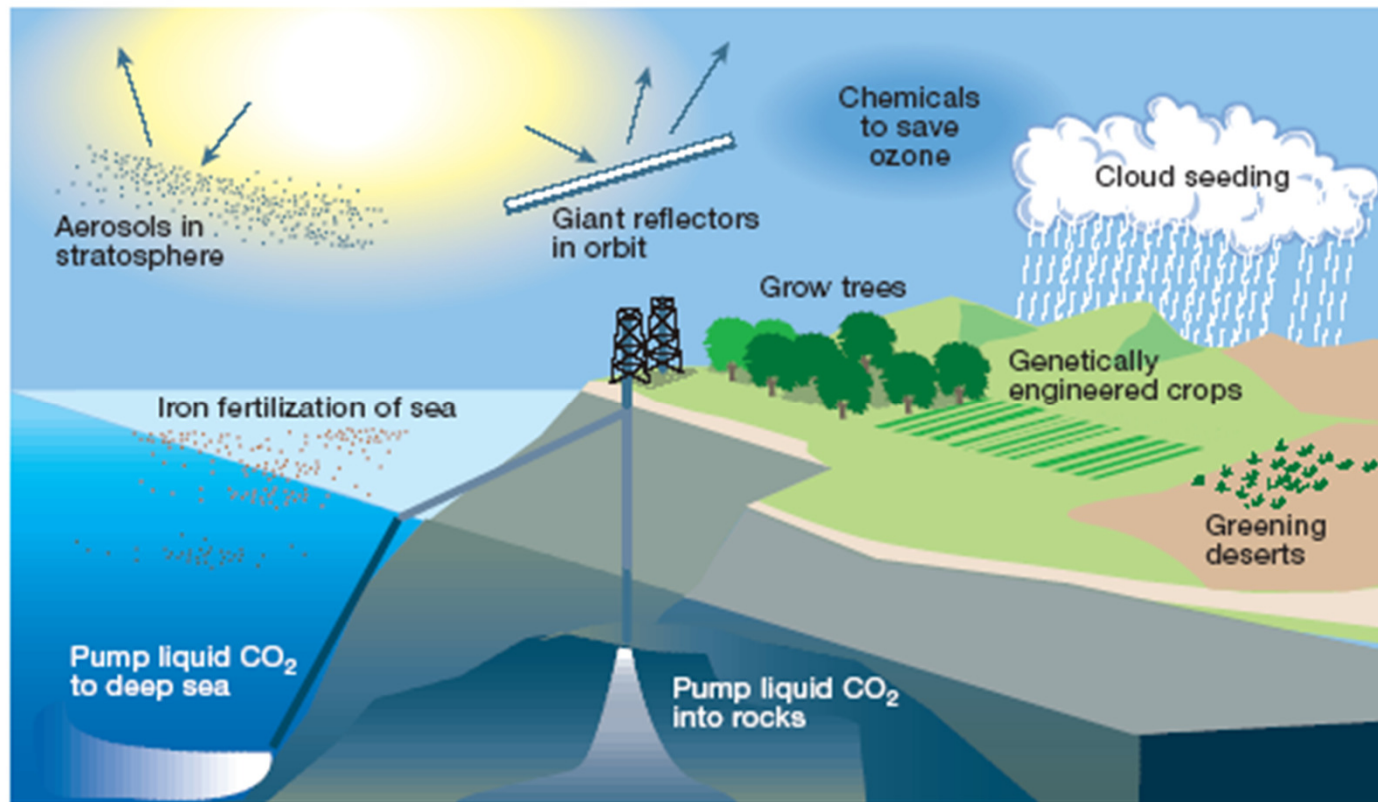




CO<sub>2</sub> emissions per unit of energy produced by various fuels, expressed as % of emissions produced by burning coal directly.

Source: Living in the Environment: *Principles, Connections and Solutions*, G. Tyler Miller, Jr., 4th Edition, THOMSON Brooks/Cole. 2005, p 361.

# Schematic representation of various climate-engineering proposals



Source: Keith, D.W. (2001). Geoengineering. *Nature* **409**, p 420.

# PUBLIC HEALTH

1. What is Public Health
2. Some Public Health Statistics (general concerns)
3. Some Public Health Statistics (economics)
4. Emerging Issues in Public Health
5. Summary of Waterborne Disease History
6. Global Concerns

# Adverse Effects on Human Health

- **Direct**

Infections,  
Toxicity,  
Carcinogenesis  
Other disease acute or chronic

← Effects on HUMANS

- **Indirect**

Eutrophication,  
Oxygen depletion - Hypoxia,  
Harmful algal bloom formation,  
Aquatic toxicity,  
Accumulation in fish and sediments,  
Bioaccumulation,  
Endocrine disruption,  
Antibiotic resistance development

← Effects on  
ECOSYSTEMS

# Diseases



Disease	Morbidity (Episodes per Year)	Mortality (Deaths per Year)	Relationship to Water Supply & Sanitation
Diarrhea from drinking water	1 billion	3.3 million	Unsanitary excreta disposal, poor personal and domestic hygiene, unsafe water
Malaria	400 million	1.5 million	Poor water management and storage, poor operation of water points and drainage
Dengue fever	1.75 million	20,000	Poor solid waste management, water storage, and operation of water points and drainage

Source: U.S. Public Health Service. 1996. "WHO Warns of Inadequate Communicable Disease Prevention." *Prevention Health Reports*. 111:296-297.

# Water Pollution



Ben Osborne

b.in,



un Ku  
(aranka@civil.mta.com)

# Drinking Water Safety and Human Health

## Worldwide:

13,000,000 deaths per year  
35,000 per day

80% of sickness in the world is  
caused by inadequate water supply or  
sanitation



# A cholera outbreak in London



In 1849 Dr. John Snow discovered that drinking water from a contaminated pump resulted in the spread of cholera (water was contaminated with sewage)

# Dr. John Snow (1813-1858) and Cholera



*Vibrio  
cholerae*

[http://i.esmas.com/image/0/000/004/263/VibrioCholerae\\_NT.jpg](http://i.esmas.com/image/0/000/004/263/VibrioCholerae_NT.jpg)  
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# Pathogenic Microorganisms

- Viruses
- Bacteria
- Protozoa
- Helminths  
(worms)



January



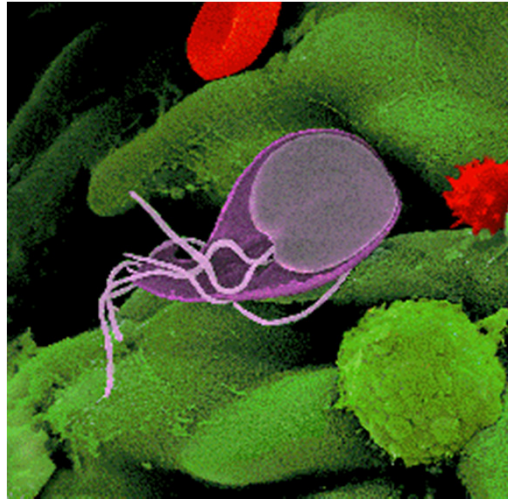
(arunku@civil.iitd.ac.in)

# Pathogenic Microorganisms in Water

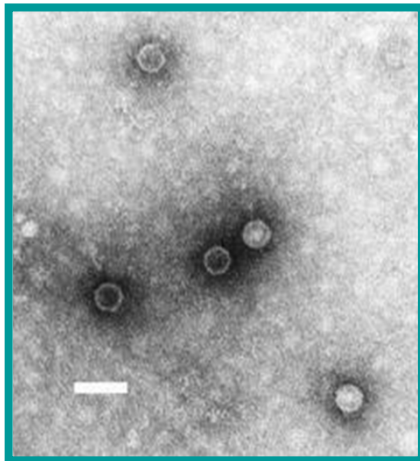
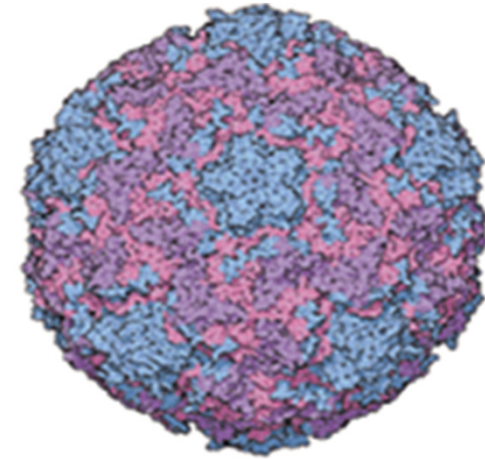
## Bacteria



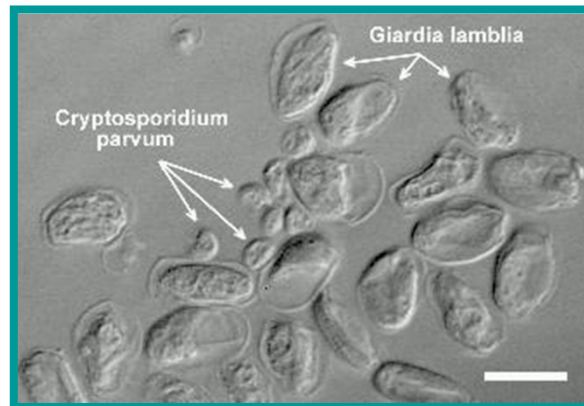
## Parasites



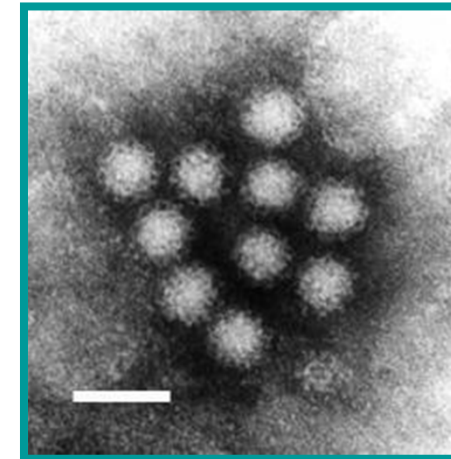
## Viruses



Poliovirus  
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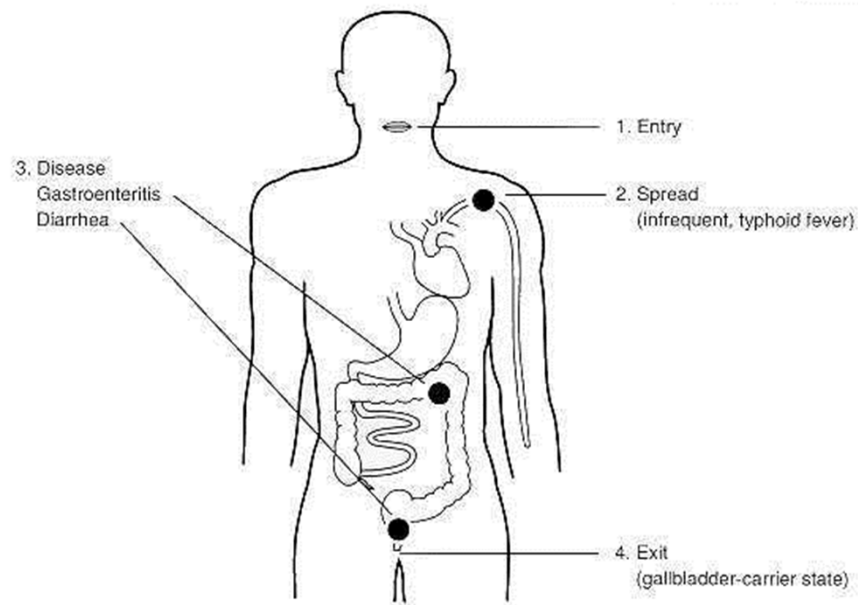


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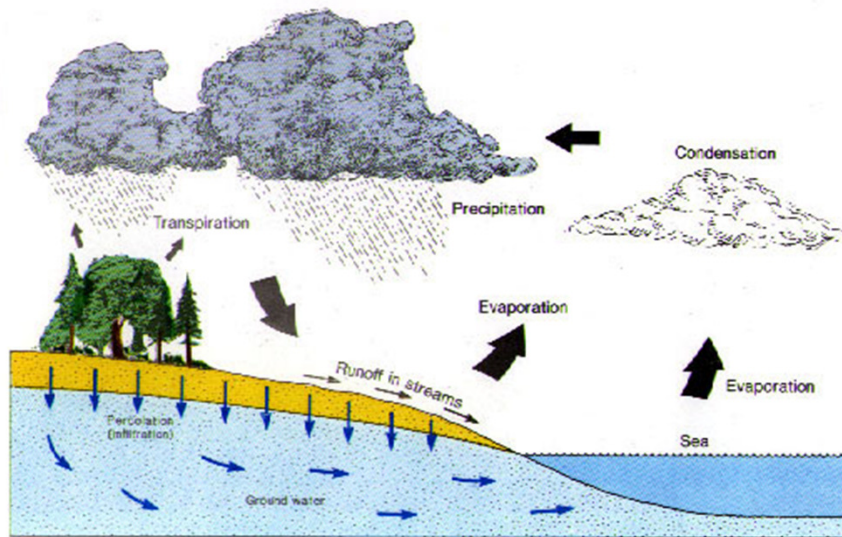
Norwalk virus (norovirus)  
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# Enteric Pathogens



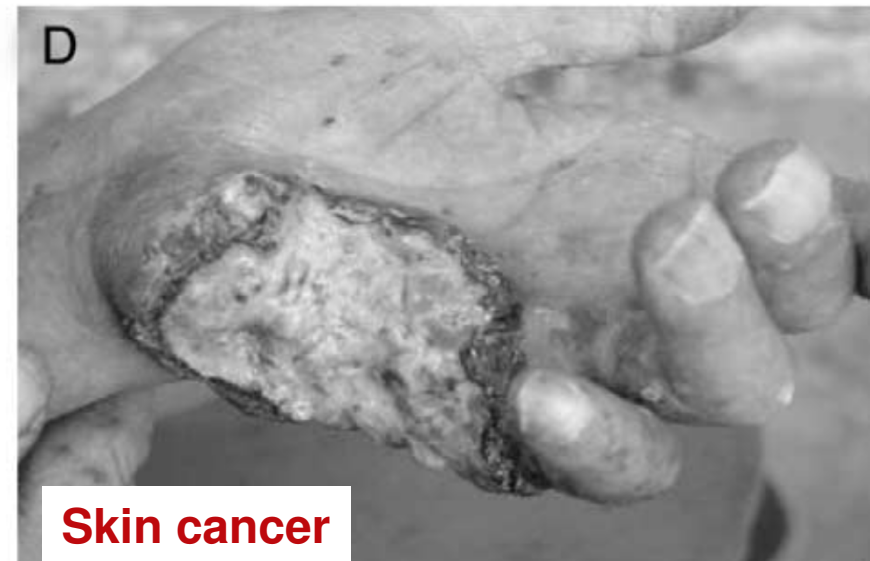
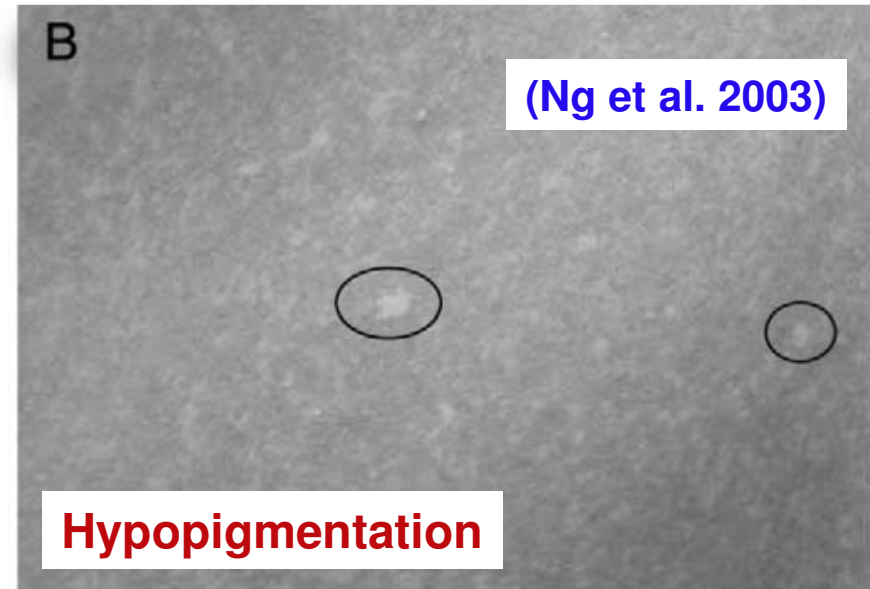
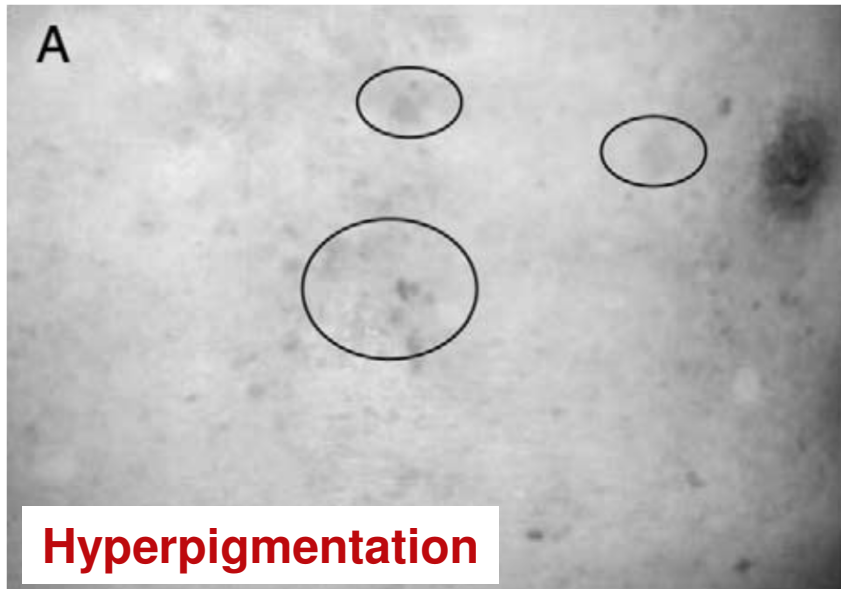
- Exposure is via ingestion
- Primary site of infection is gastrointestinal tract
- Gastroenteritis symptoms
  - Nausea
  - Vomiting
  - Diarrhea
  - Fever
- May spread to other sites (blood, liver, nervous system)
- Shed in fecal material
- “Fecal-oral” route of transmission

# Transport of Enteric Viruses (Wong, K.; MSU)



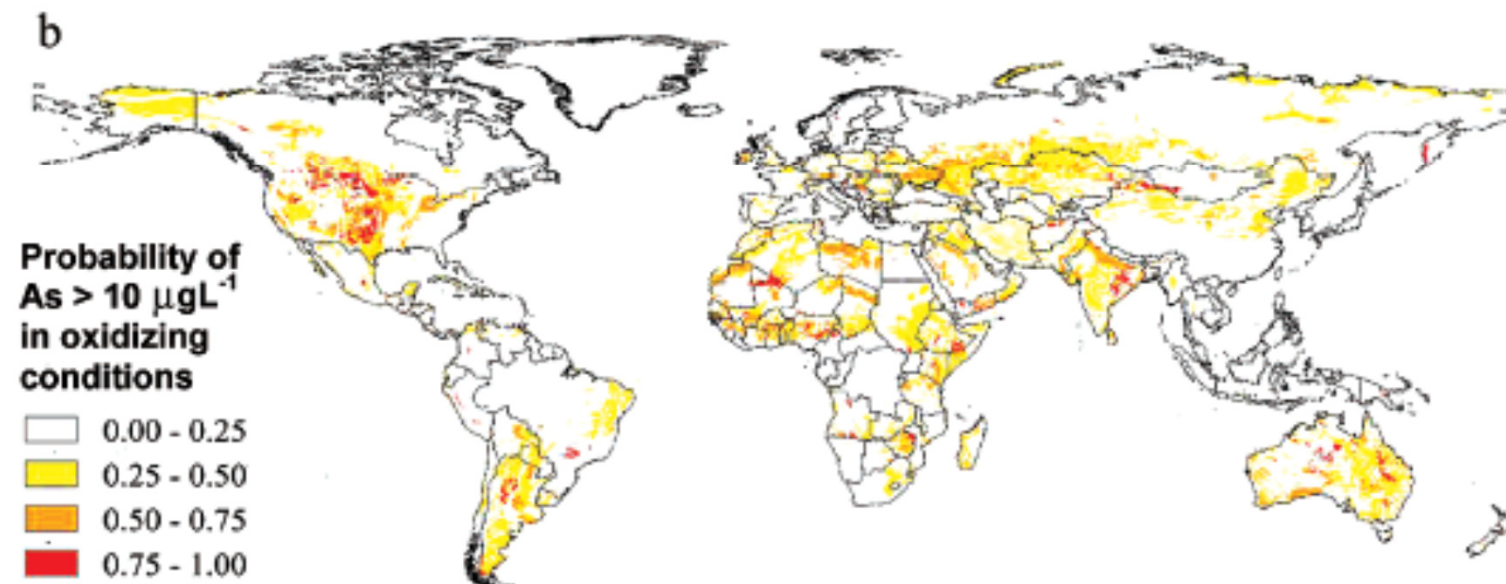
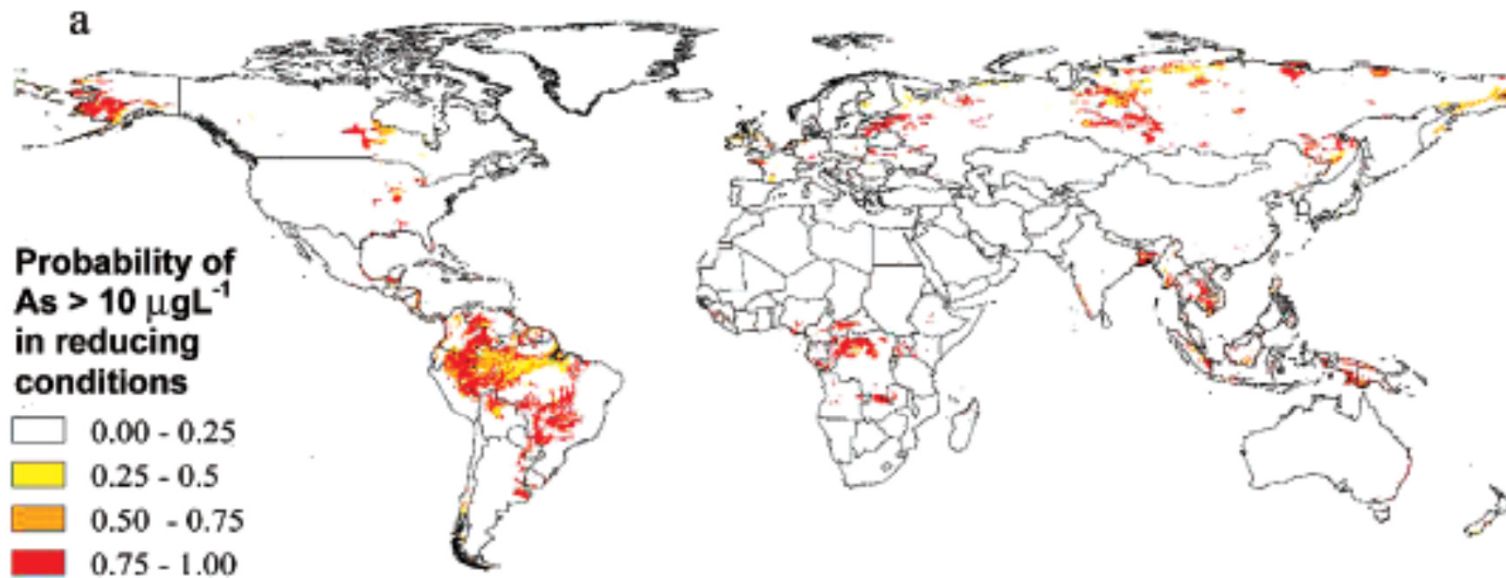
- Viruses can contaminate the surface water and groundwater by runoff and infiltration.

# Arsenic



# Arsenic in World

*Amini et al. (2008)*





# Pharmaceuticals in Indian waters?

RESEARCH ARTICLE

Open Access

## Antibiotics and antibiotic-resistant bacteria in waters associated with a hospital in Ujjain, India

Vishal Diwan<sup>\*1,2</sup>, Ashok J Tamhankar<sup>3,4</sup>, Rakesh K Khand:  
Rama V Iyer<sup>6</sup>, Karin Sundblad-Tonderski<sup>7</sup> and Cecilia Ståhl



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)



Journal of Hazardous Materials 148 (2007) 751–755

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

Short communication

## Effluent from drug manufactures contains extremely high levels of pharmaceuticals

D.G. Joakim Larsson<sup>a,\*</sup>, Cecilia de Pedro<sup>a</sup>, Nicklas Paxeus<sup>b</sup>



Contents lists available at ScienceDirect

Ecotoxicology and Environmental Safety

journal homepage: [www.elsevier.com/locate/ecoenv](http://www.elsevier.com/locate/ecoenv)



Mutagenicity and genotoxicity of tannery effluents used for irrigation at Kanpur, India

Mohammad Zubair Alam<sup>a,\*</sup>, Shamim Ahm



Contents lists available at ScienceDirect

Food and Chemical Toxicology

journal homepage: [www.elsevier.com/locate/foodchemtox](http://www.elsevier.com/locate/foodchemtox)



Sperm motility in the fishes of pesticide exposed and from polluted rivers of Gomti and Ganga of north India

Pratap B. Singh \*, Vikash Sahu, Vandana Singh, Santosh K. Nigam, Hement K. Singh

Department of Zoology, Tilak Dhari College, Jaunpur 222002, India

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# Pharmaceuticals in Natural Waters



*Pharmaceuticals, hormones, and other organic wastewater contaminants were measured in 139 streams during 1999 and 2000.*



Kolpin *et al.*, 2002  
*Environ. Sci. Technol.*

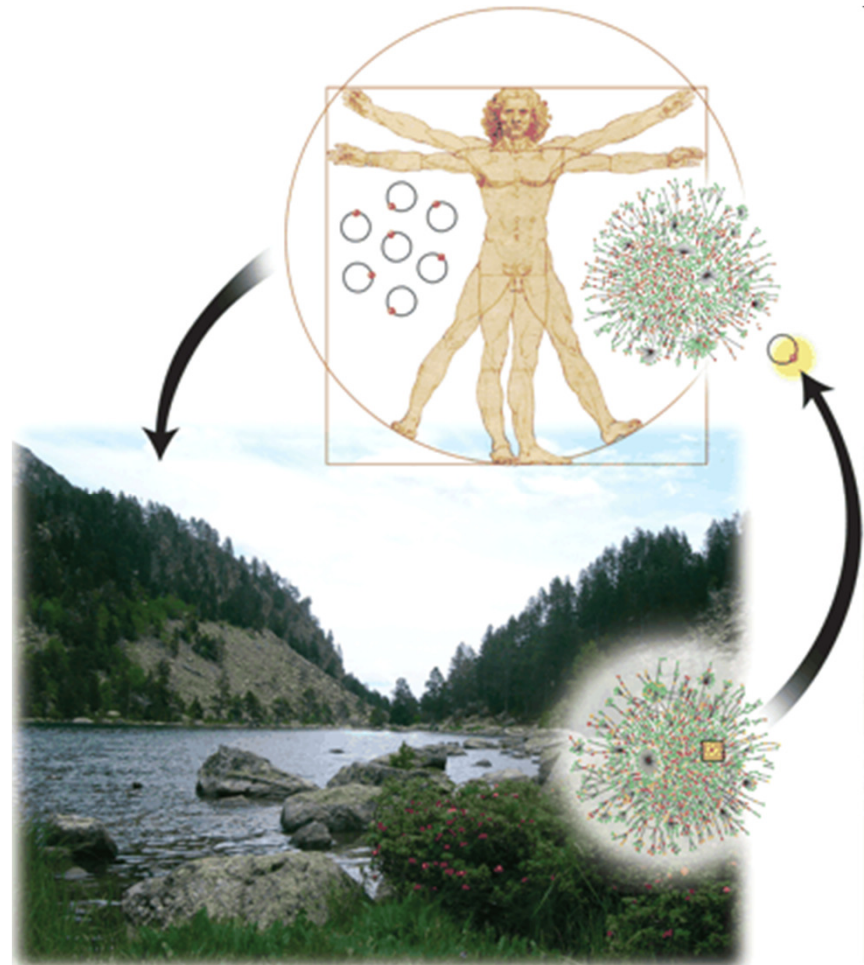
# Personal Care Products: Issue?

- Non-biochemically active
- Consumer products applied to body
  - fragrances
  - preservatives
  - sunscreens
  - insect repellents
  - antiseptics



# Antibiotic resistance genes (ARGs) : Spreading???

- Sharing ARGs between microbes by horizontal gene transfer (HGT)
- Multiple antibiotic resistant (MAR) superintegrons
- DNA can be sorbed/protected by soil/clay compartments from DNase



# The Cuyahoga River

In 1969:

- Oil slicks on Cuyahoga's surface caught fire, burned for 8 days
- Fireboats sent to battle blaze, spread fire when water from river was used



<http://www.cuyahogalandfill.com/SpecColl/croe/accfire.html>



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<http://www.epa.state.oh.us/dist/nedo/1.jpg>

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# Eutrophication



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# Harmful Algal Blooms (HABs)

*Microcystis sp.* bloom

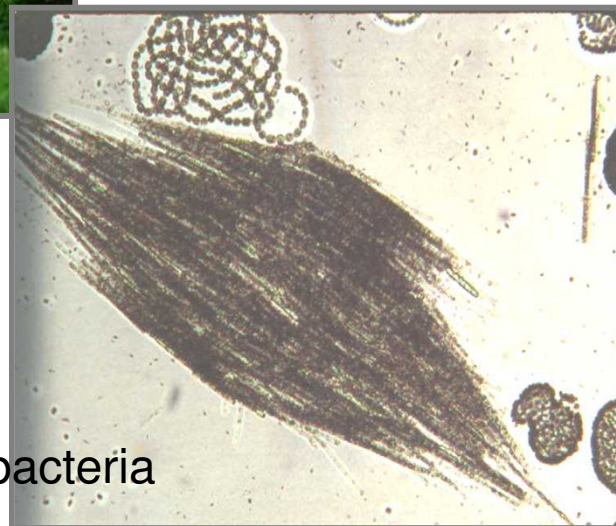


HAB

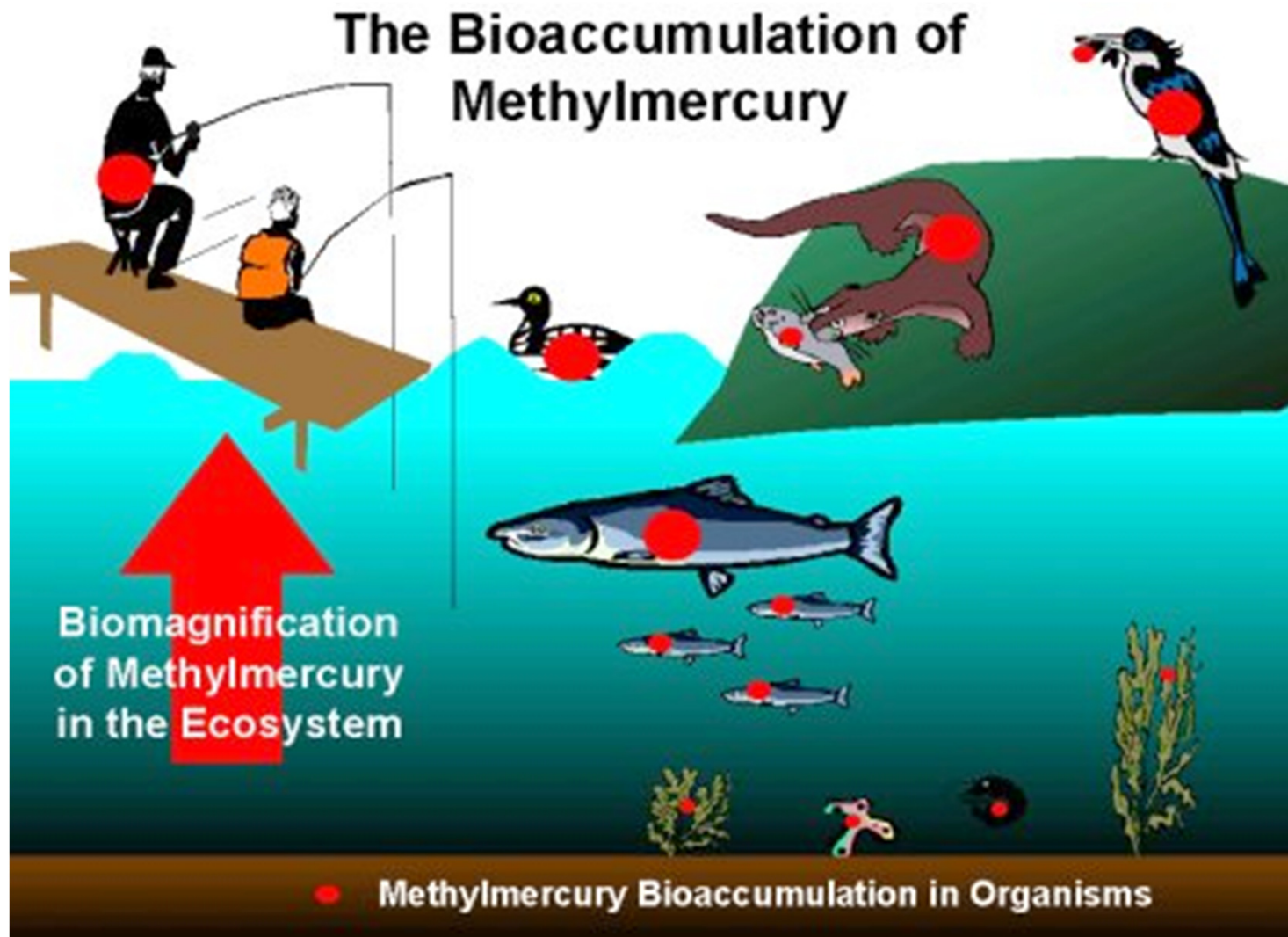


*Anabaenopsis sp.* bloom

mixture of cyanobacteria  
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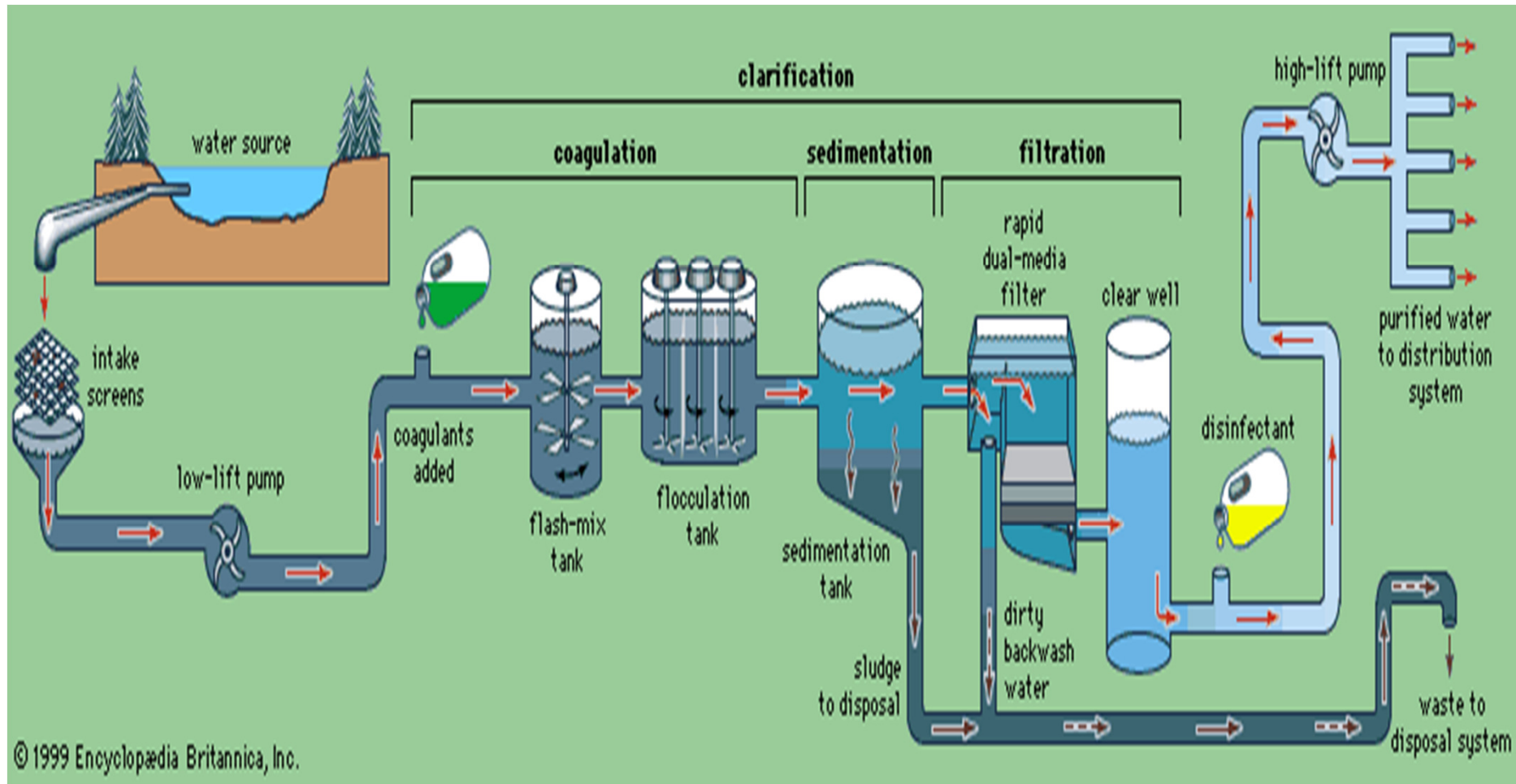


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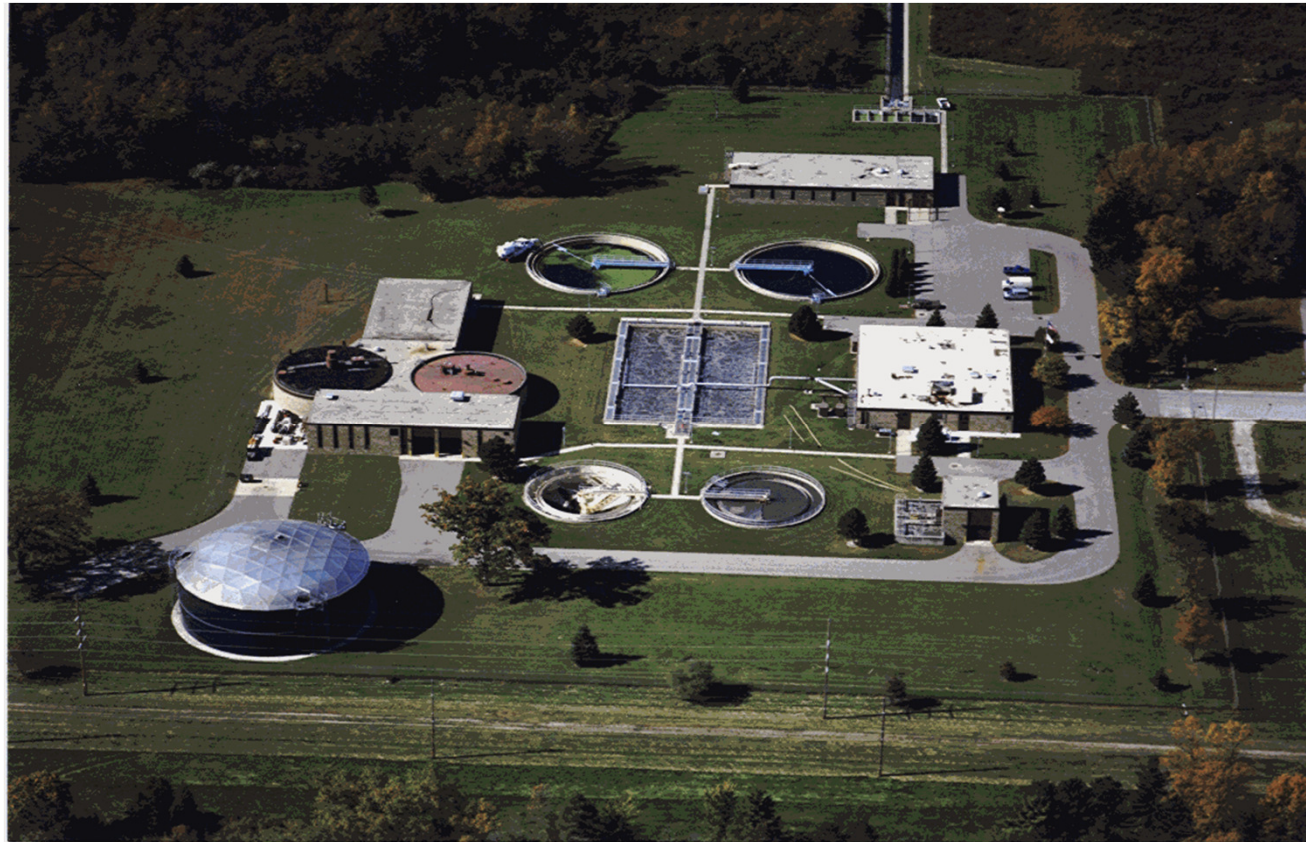




# Water Treatment



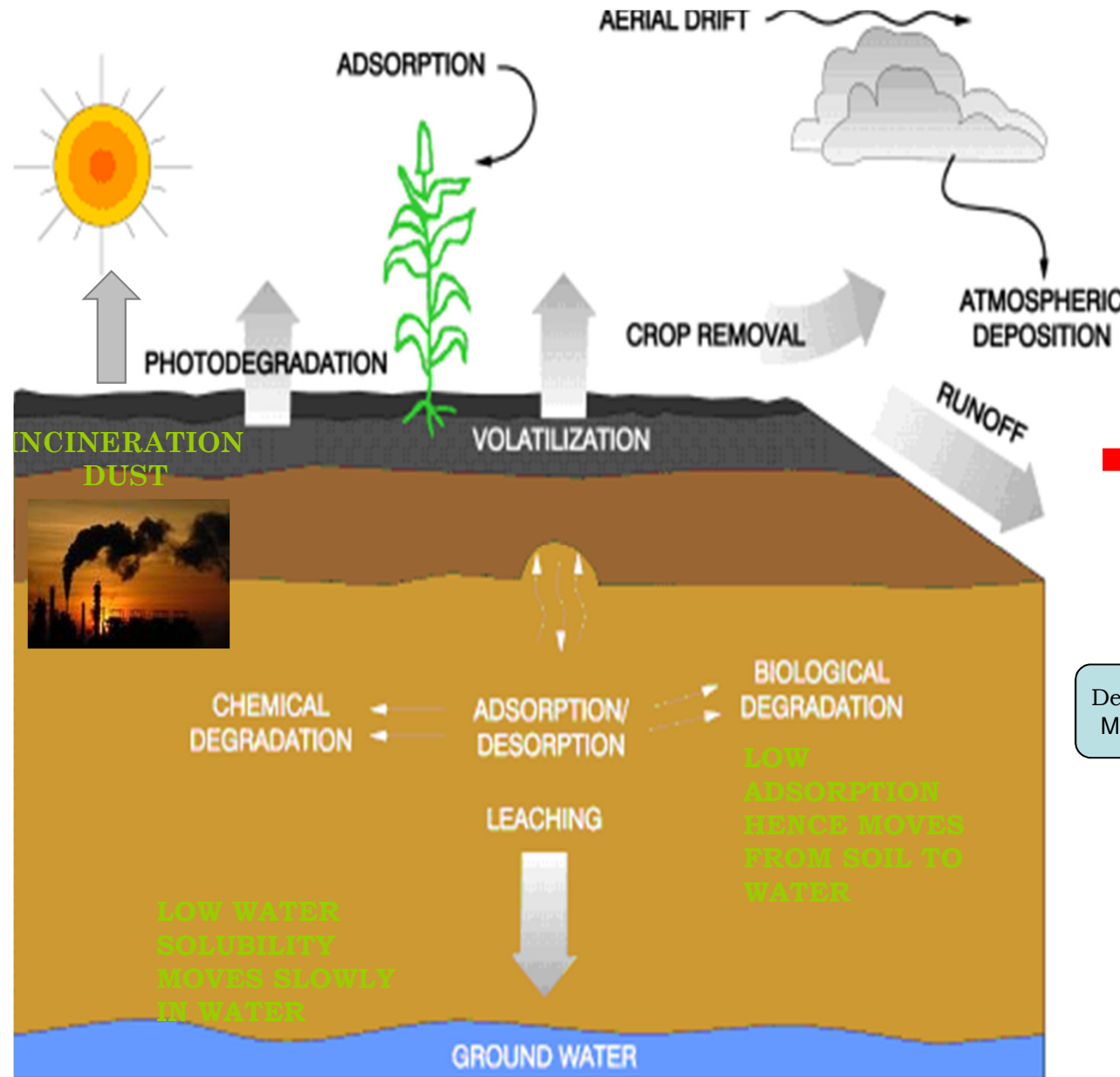
# Wastewater Management



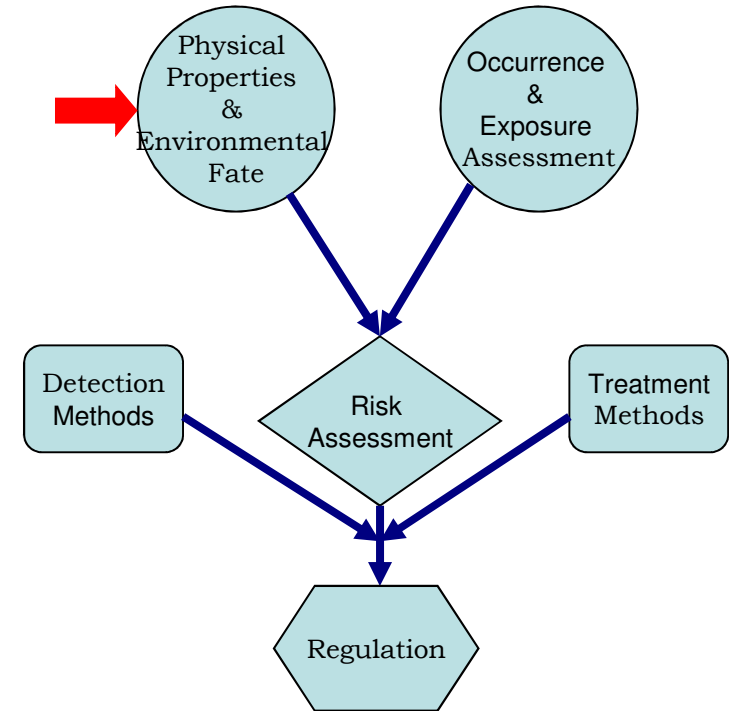
[www.economowocusa.com/wastewater.gif](http://www.economowocusa.com/wastewater.gif)  
January 5, 2015

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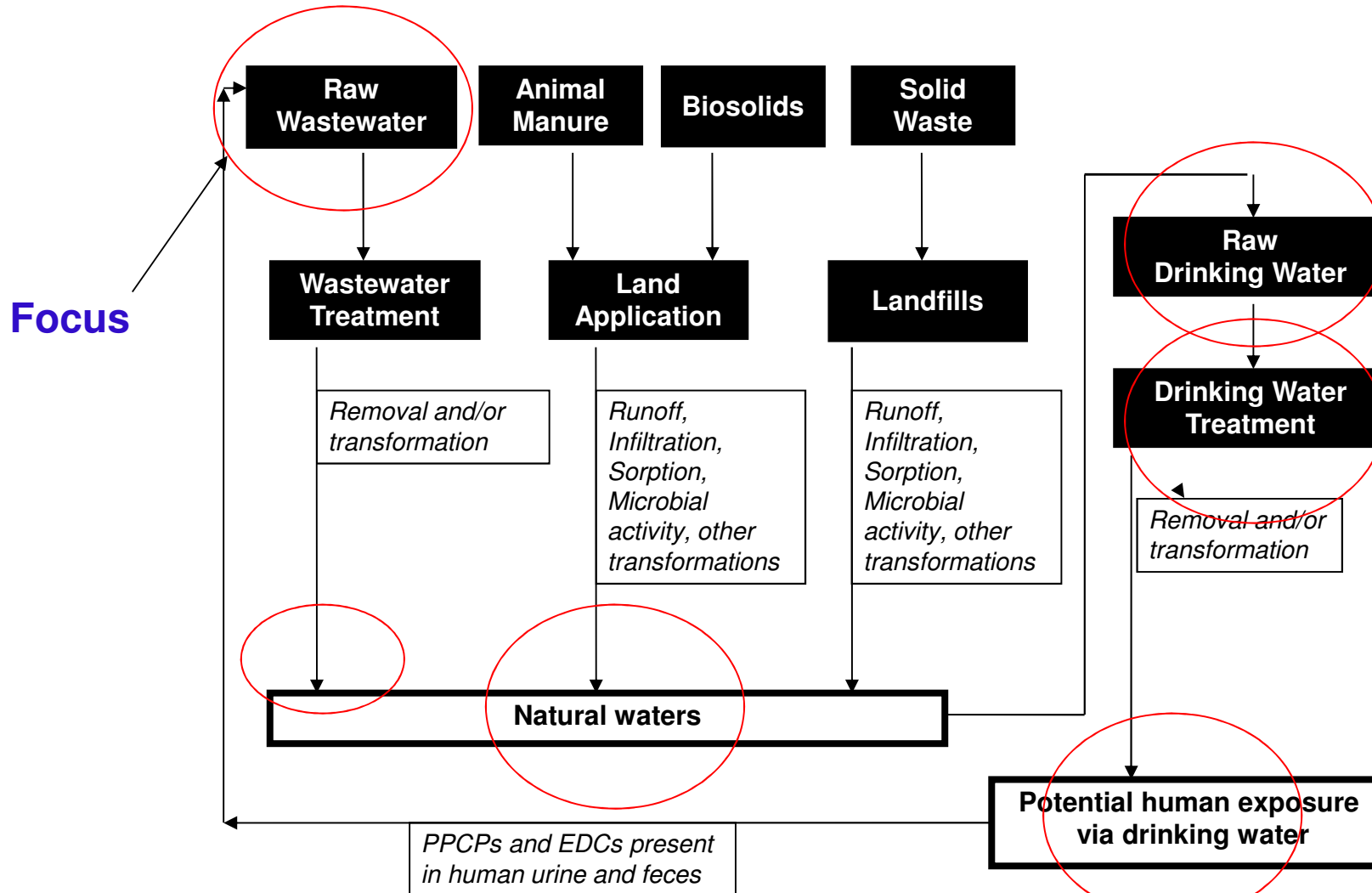
# Physical Properties & Environmental Fate



- Water solubility – 32-40 mg/L
- Weakly volatile
- Low sorption to soil

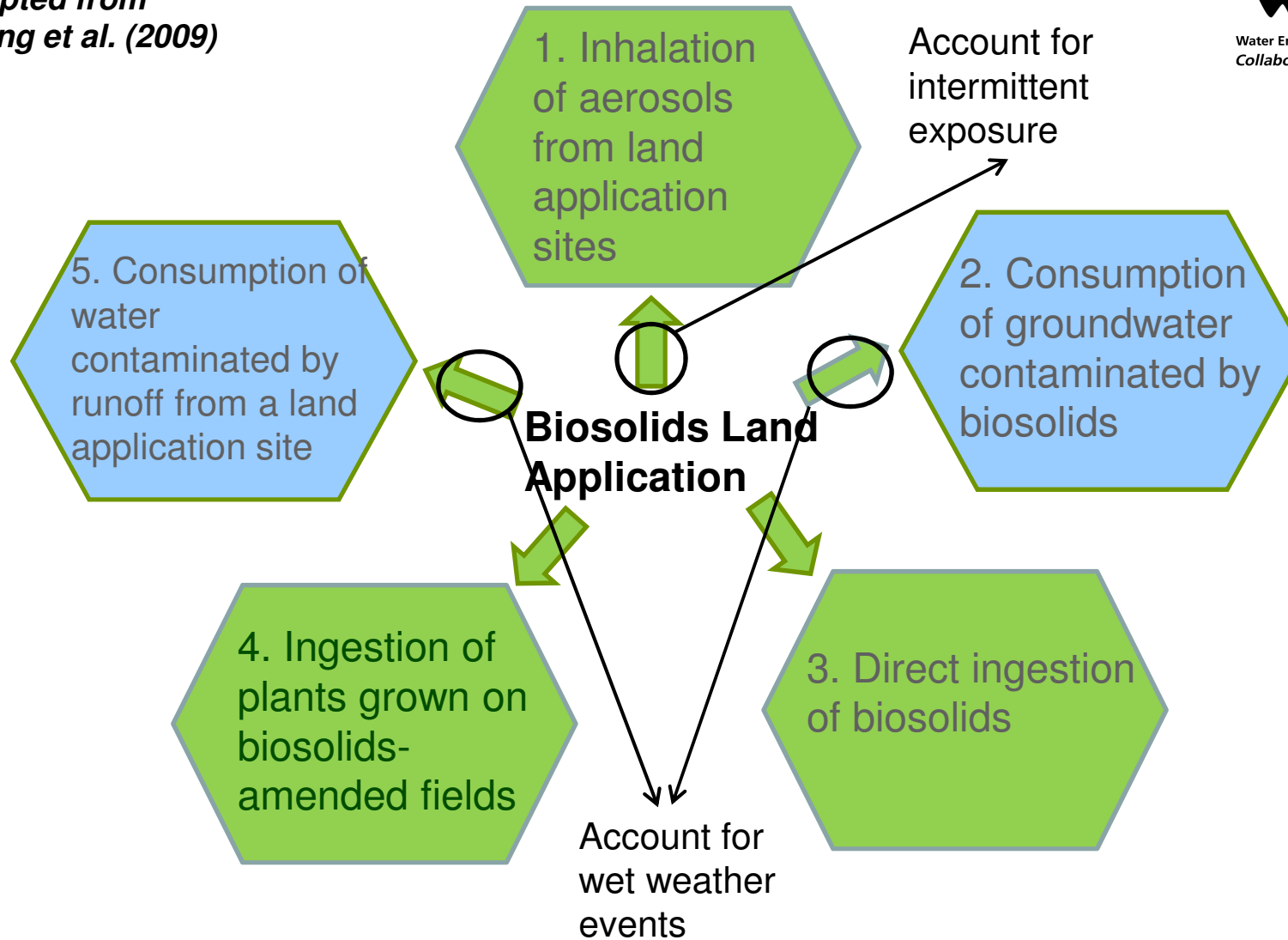


# Emerging Contaminants in Environment



# Biosolids-associated pathogens after land application activities

Adapted from  
Zhang et al. (2009)



# Environmental Engineer at work!



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# Sampling and fun!!



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# Uncertainties, Research Need, and More work!!



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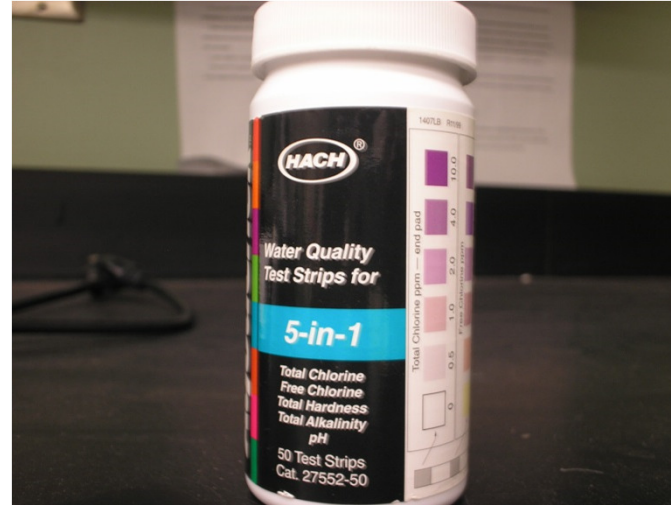
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# Why do we measure in EnvEngg.

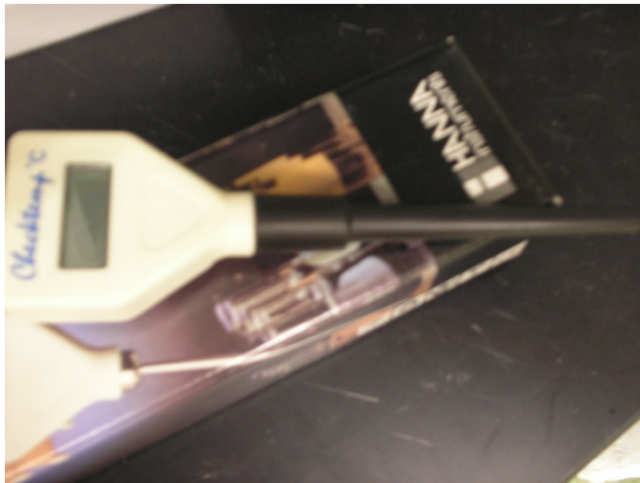
- Quality of what we want to treat
- Quality of finished product
- Performance of process
- Environmental/health impact
- Air
  - Emissions
  - Ambient
- Water & Wastewater
  - Supply/raw
  - During treatment
  - Discharge/Distribution
- Land
  - Solid & Haz Waste
  - Leachate impacts
  - Air impacts



Water



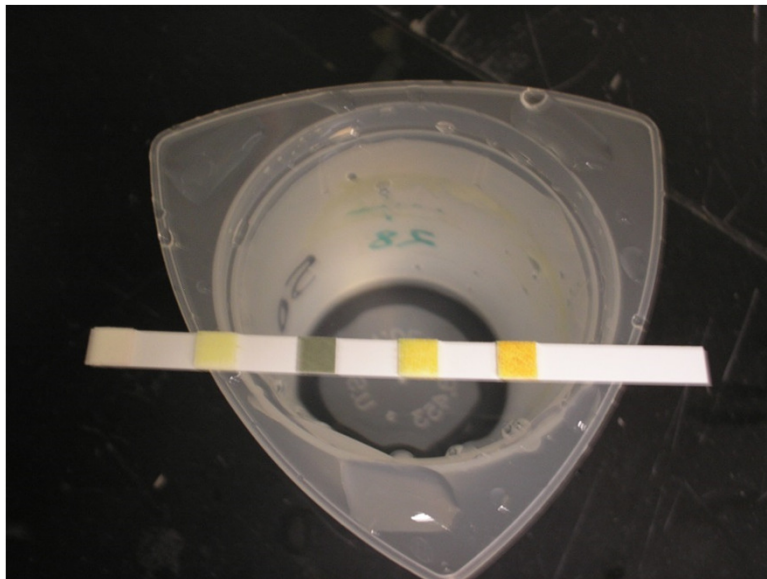
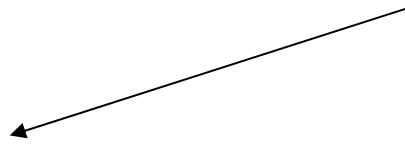
Test Kit



Thermometer



Test strip in Water





# STRAIN OF 1997

YOU ARE THE NEXT CLASS OF  
DRUG-RESISTANT BACTERIA. AS  
HUMANS CONTINUE TO ABUSE AND  
OVERUSE ANTIBIOTICS, YOUR RANKS  
WILL SWELL. SO, GO OUT THERE  
AND MUTATE! AND REMEMBER:  
THAT WHICH DOES NOT KILL US  
MAKES US STRONGER!!



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**Thank You !!!!**

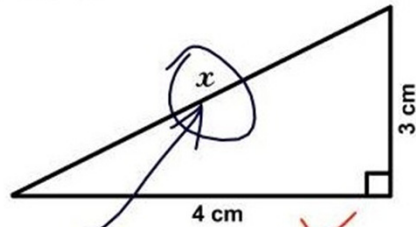
# Questions

- Name three environmental problems in this room, in your hostel and in Delhi city?
- What do you think about the Env. Eng. career? And why.
- Spend 5 minutes

# Next class: tuesday

# Questions?

3. Find  $x$ .



Here it is ~~X~~ O

# Questions and attendance

- Name three environmental problems in this room, in your hostel and in Delhi city?
- What do you think about the Env. Eng. career? And why.
- Spend 5 minutes