



**环 境 化 学**

**Environmental  
Chemistry**

# **第一章：引言**

## ***Chapter 1: A Brief Introduction***

- How What Why Who Where**
- Environmental sciences**
- Environmental chemistry**
- Environmental pollutants**



**A HOW: A course plain**

**2006年农学院**

**本科生**

**环境化学课程教学计划**

# 教科书：

- 1 环境化学（高等学校面向21世纪课程教材），  
北京：高等教育出版社 1996，主编：戴树桂  
合编：岳贵春 王晓蓉 田世忠 陈甫华
- 2 Environmental Chemistry, 环境化学；上海交  
通大学环境科学与工程学院选编教材
- 3 Environmental Chemistry, S.E.Manahan, FL:  
Lewis Press, 2000
- 4 Environmental Chemistry, S.Baird, New  
York: Freeman 1999

# 学习方式：

- 课时数：36 课时

- 授课方式：

老师讲授 + 提问      中文 + 英文

- 作业：教科书 + 补充材料      交给助教

- 考试形式：

提问讨论发言 (20%) + 作业 (20%)

+ 期末考试 (60%)



# 环境化学论坛：

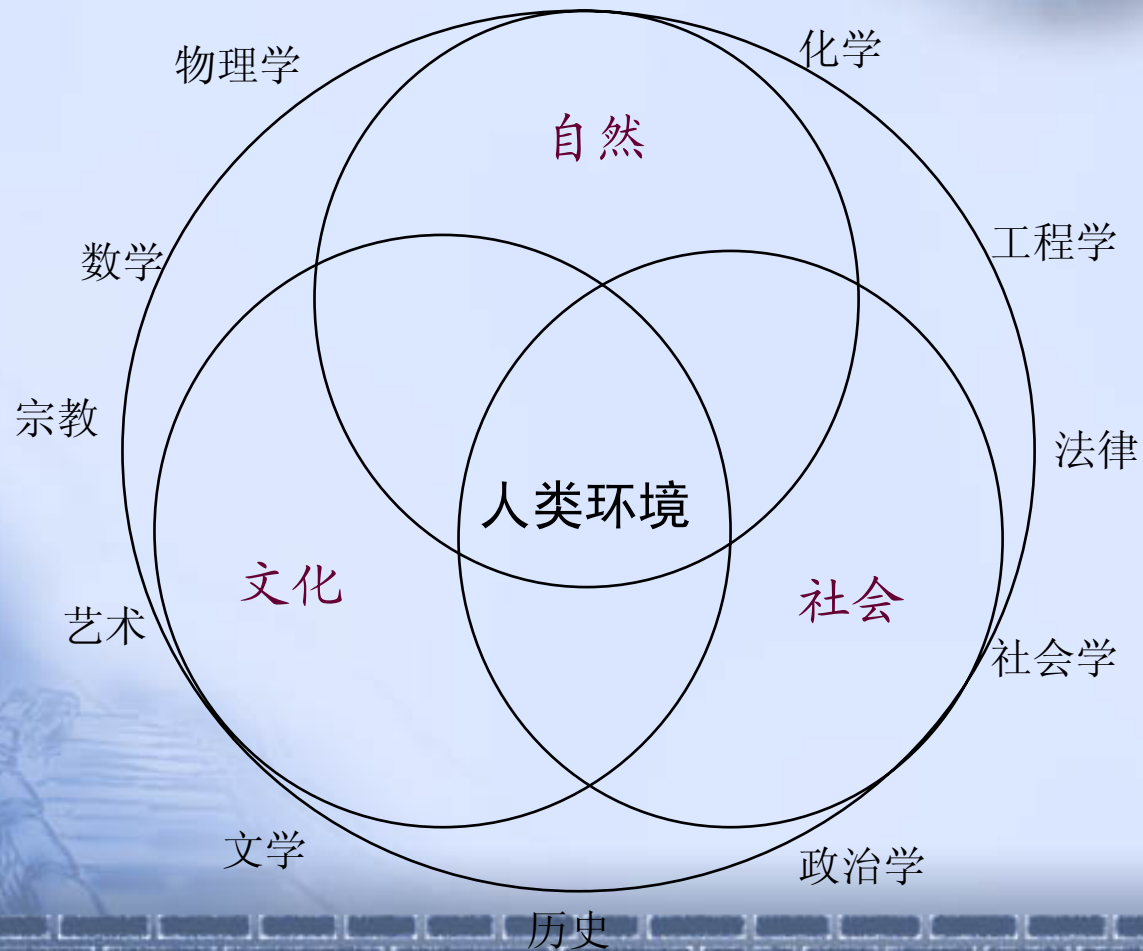
全部课程讲授后进行，全班每2-3人组成一个小组准备，选出代表发言。

# ***B What***

- 1 What is Environment?
- 2 What is Environmental science?
- 3 What is Environmental Chemistry?
- 4 What is the characters of Environmental Chemistry?
- 5 What are included by Environmental Chemistry?
- 6 What is the Ecology?

# 1 What is the Environment?

## 广义的定义1





# ***1 What is the Environment?***

## **广义的定义2**

- 周围事务、状态或者效应的集合，特别是对其他人或者其它事务的存在和发展产生影响的要素。

# 1 What is the Environment?

## 本课程的定义1

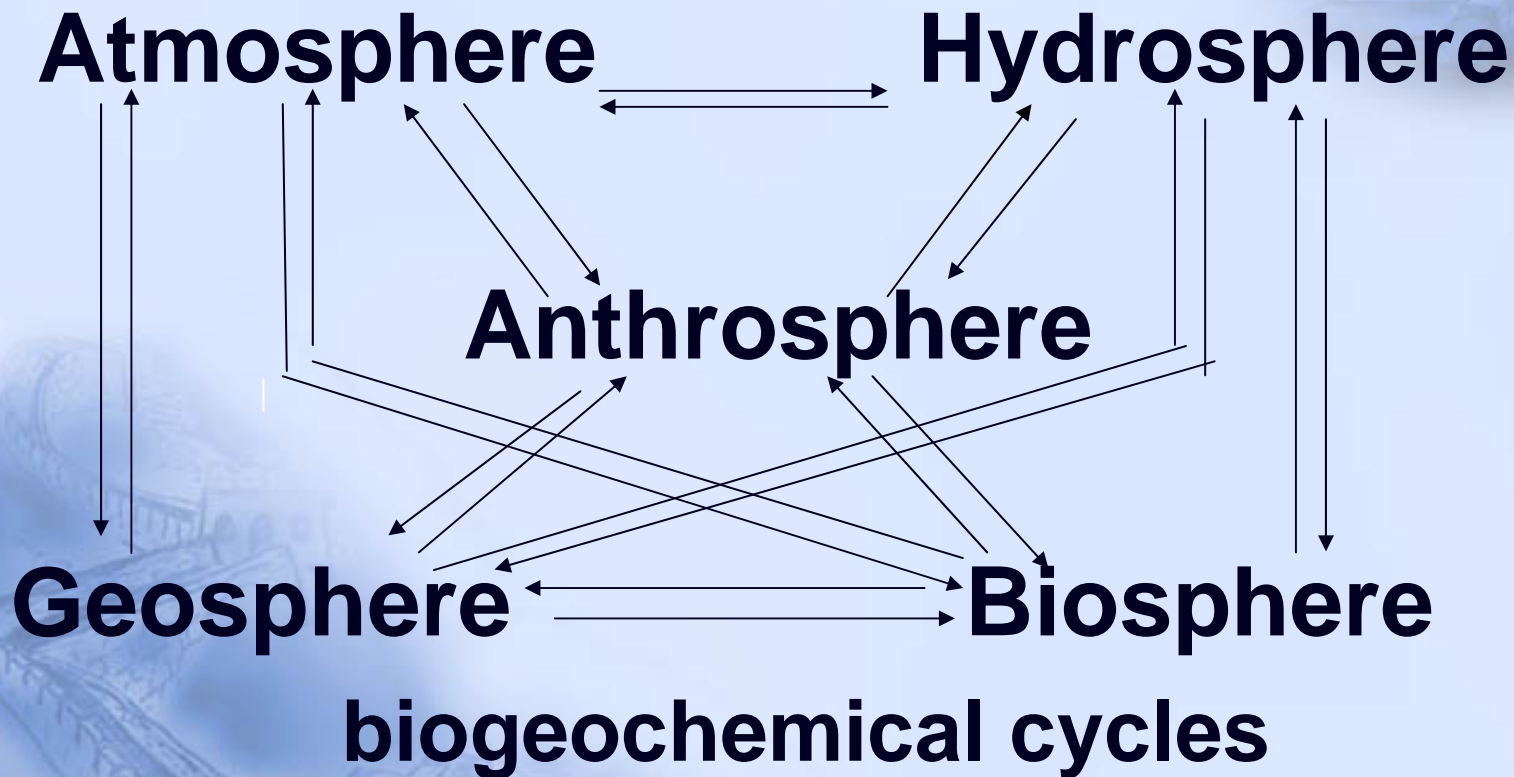
周围的物质世界  $\xrightarrow{\text{影响地球上}}$  生物的生存

(包括空气、水、土地、海洋、河流、森林等自然物质以及建筑物、高速公路等基础设施)

(包括人类、植物、鸟类、鱼类以及其它生物)

# 1 What is the Environment?

## 本课程的定义2



# *Environment*

- **Air---Atmosphere** (the thin layer of gases covered on Earth's surface. T/E/UV/H<sub>2</sub>O(g))
- **Water---Hydrosphere** (H<sub>2</sub>O: 97% ocean/ice)
- **Earth---Geosphere** (solid earth/soil; lithosphere(岩石圈) 50-100 km; crust (地壳) )
- **Life---Biosphere** (all living entities on Earth)
- **Technology---Anthrosphere**

## ***2 What is the Environmental Science?***

- It is the science of the complex interactions that occur among the terrestrial, atmospheric, aquatic, living, and anthropological environments.
- Study on the earth, air, water, and living environments, and the effects of technology thereon.



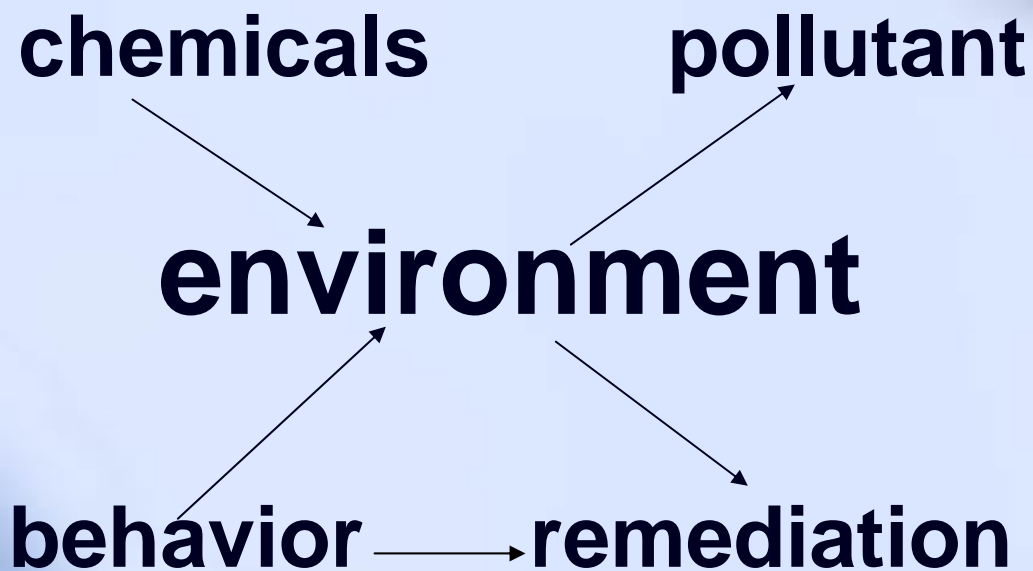
### ***3 What is the Environmental Chemistry?***

Study on the sources, reactions, transport, effects, and fates of chemical species in water, soil, air and living environments, and the effects of technology thereon.

## 较为普遍接受的环境化学定义

- 一门研究化学物质在环境介质（大气、水体、土壤、生物）中的存在、化学特性、行为和效应及其控制的化学原理和方法的科学。

### ***3 What is the Environmental Chemistry?***



# ***4 What is the characters of Environmental Chemistry?***

**Basic principles of chemistry are shown in environmental:**

- **more complicated & difficult**
- **atom/molecular of pollutant**  
atom/molecular of chemicals
- **system. Is open to environment.**  
system is isolated from outside (in beaker)

- **与环境科学其它分支学科的区别：**  
从化学的角度阐述和解释环境的结构、功能、状态和演化过程及其与人类行为的关系。
- **与化学科学其它分支学科的区别：**  
以环境问题为研究对象，阐述和解释环境问题的化学本质，为调控人类活动的行为提供科学依据。



# ***5 What are included by Environmental Chemistry ?--- main points***

- Matter & energy as well as their cycles  
Water, soil, gas, living & technology
- Human impact and pollution

# ***Energy and its cycle***

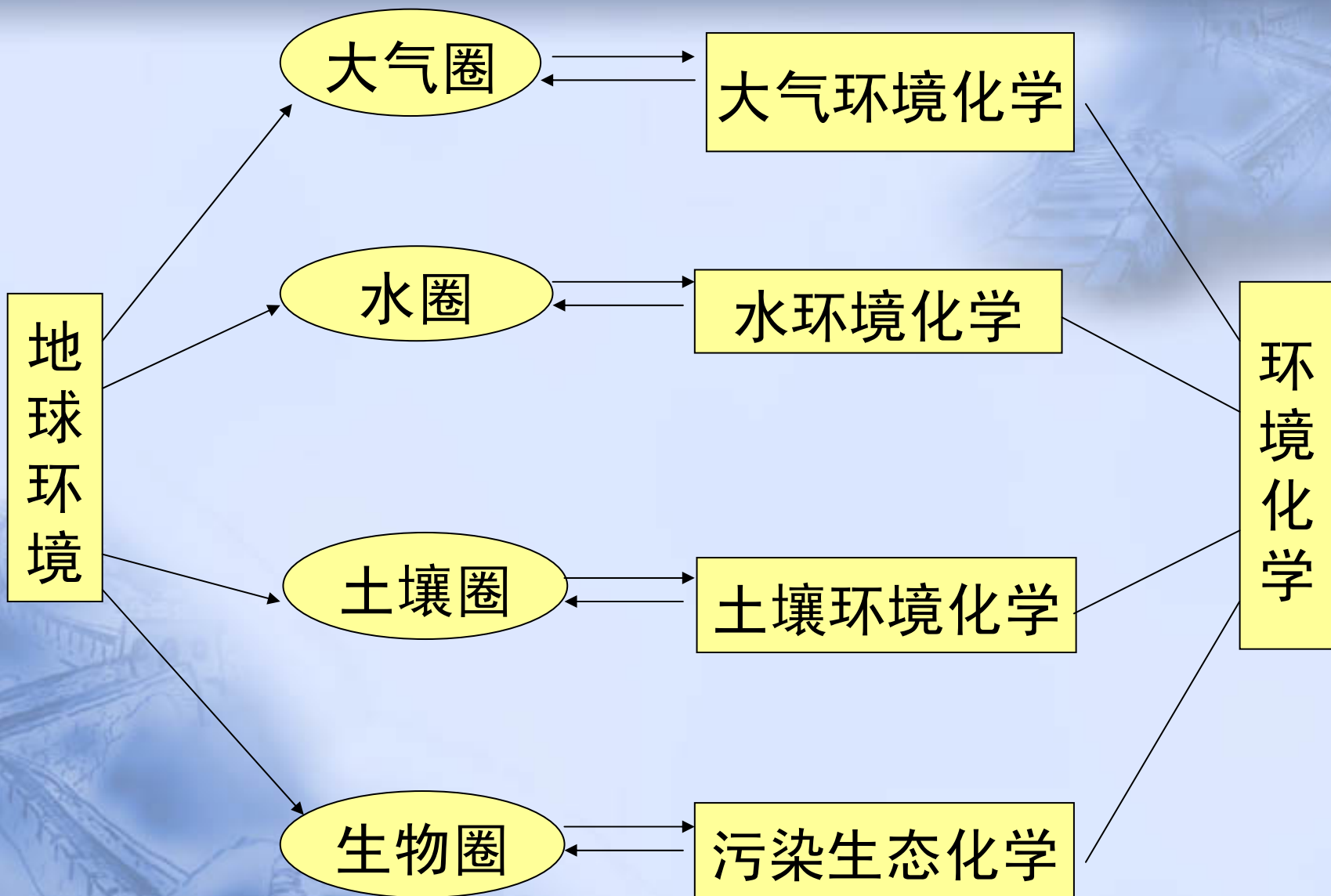
- Source: sun Fig.1.2, P12
- Light and electromagnetic radiation: visible light, UV & IR radiation, microwaves, radio waves, gamma & X-rays
- Energy flow and photosynthesis in living system: solar E./green plants/ photosynth./chem. E.
- Energy utilization:  
fossil fuels/reason of environm. Problem  
renewable energy/solar energy & biomass

# ***Matter and its cycle***

- Basic: elemental cycles/C, N, S, P, O/mineraliz.  
biogeochemical cycles/power: solar E.
- Exchange among spheres:  
Fig.1.3 & Tab.1.1
- Endogenic(内源的) & exogenic cycles: Fig.1.4
- Large number of toxic chemicals, their bio-geo-chemical processes and remediation procedures

# ***5 What are included by Environmental Chemistry ?--- scientific catalog***

- **Environmental Analytical Chemistry :**  
**organic; inorganic**
- **Environmental Chemistry in Spheres:**  
**atmosphere; aquatics; soil; ecologic chemistry**
- **Environmental Engineering Chemistry :**  
**Pollution-Control Chemistry**  
**gas; water; solid waste**





## ***6 What is the Ecology?***

Deal with the relationships between living organisms with their physical environment and with each other.

- the environm. and the demands it places on the organisms in it.
- organisms and how they adapt to their environmental conditions.

# ***Ecosystem:*** organisms & their environms.

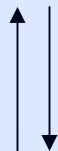
- habitat(栖息地) /niche(小生境)
- Ecology: terrestrial environm./freshwater environm./marine environm./symbiotic(共生) environm.
- Population: explosion/crash
- Ecosystem ecol./population ecol.
- Descriptive ecol./fundamental ecol./applied ecol.

# C Why

- 1 Why could the Environmental Chemistry be developed?
- 2 Why should we study Environmental Chemistry?

1 Why could the Environmental Chemistry be developed?

**Development of Industry/Economy**



**Environmental problems**



**Chemistry / Chemicals**

## 2 Why should we study Environmental Chemistry?

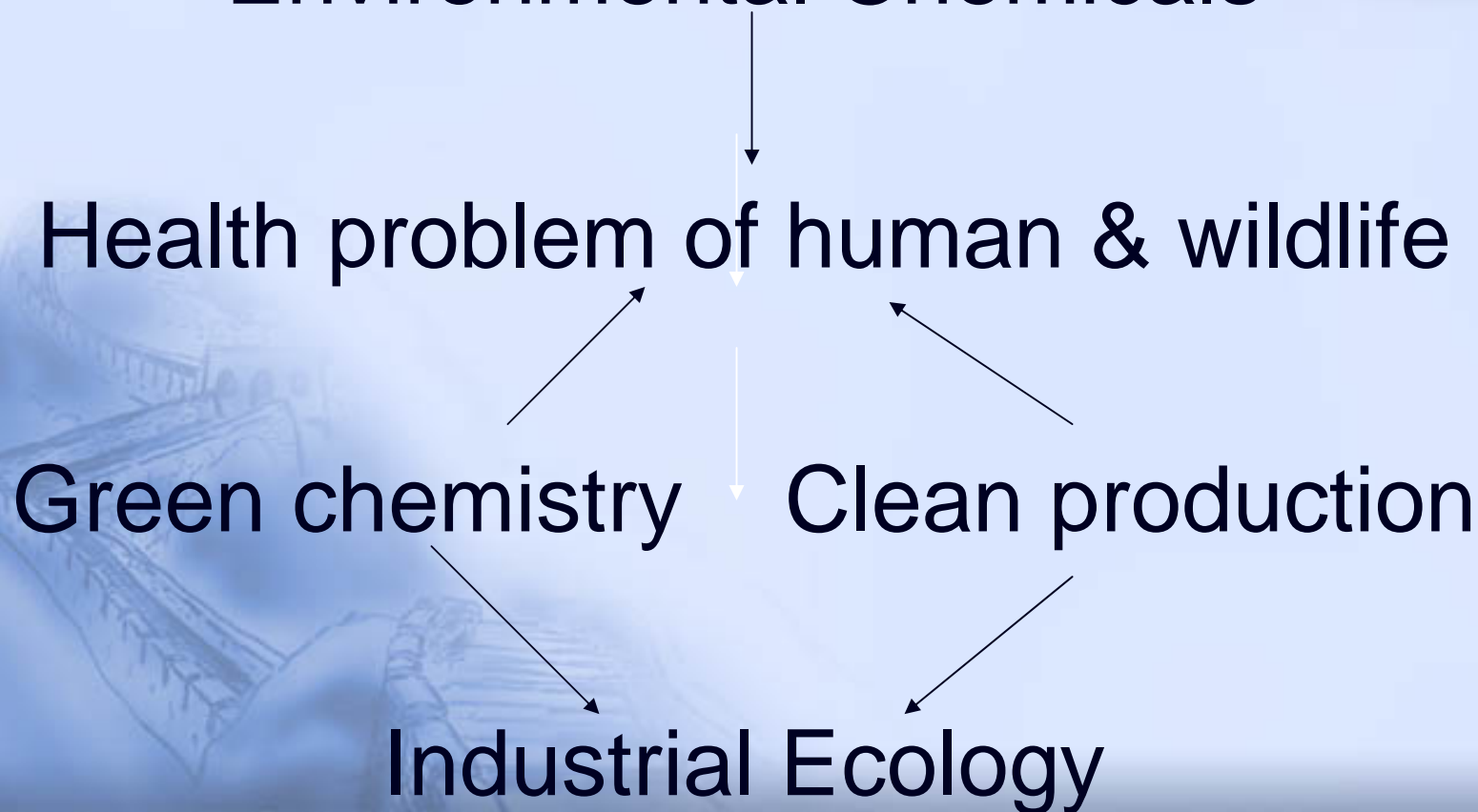
Environmental Chemicals

Health problem of human & wildlife

Green chemistry

Clean production

Industrial Ecology





# ***D Who***

- Who should study?  
you are the main actors.
- Whom should we transport our knowledge to?  
publics, policy maker, chemicals maker

# ***E Where***

1 Where to study?

course, working

2 Where to use our knowledge?

environment, working

# 环境污染物

——环境化学研究的对象：

**Environmental Pollutants  
--- the Research Objectives in  
the Environmental Chemistry**

# 1 the Defination :。

- Human active/harm. Effect on environm: concentr.>natural
- 进入环境后使环境的正常组成和性质发生直接或间接有害于人类的变化物质。人类的生产和生活活动产生。
- Source / receptor
- Hazardous substances
- 边界的不确定性

## ***2 the Classes:***

- Environmental Sphere:  
**Atmosphere, Aquatics, Soil.**
- Forms of Pollutants:  
**Gas, Liquid, Solid.**
- Properties of Pollutants:  
**Chemical, Physical, Biological.**



# 3 Sources:

- Industry: 点源。

数量大，成分复杂，毒性强。酸，碱，油，重金属，有机物，毒物，放射性物质，微生物，寄生虫

- Agriculture: 面源。

农药，化肥，细菌，微生物

- Transportantion: 移动性。

噪声，污染物的排放和泄漏

- Municipal Life: 面源。

生活污水，垃圾，燃煤释放

# ***4 Chemical Pollutants:***

- Elements: Pb, Hg, Cd, Halogen, O<sub>3</sub> .....
- Inorganics: MeCN, CO, NO<sub>x</sub>, H<sub>2</sub>S, SO<sub>x</sub>
- Organics & Hydrocarbon: PAH
- Metal-organics: MeHg, Tri-butyl-tin
- O-organics: Phenol, Organic Acids
- X-organics: CCl<sub>4</sub>, PCBs
- N-organics: TNT, NO<sub>2</sub>-Ar.
- S-organics: CH<sub>4</sub>HS, S-alcohol
- P-organics: P-pesticides, P-toxic gas

## ***5 Priority Pollutants: Black List***

- 在众多污染物中筛选出潜在危险大的作为优先研究的控制对象，称之为优先污染物。
- 中国水中优先控制污染物黑名单：14类  
68种

## ***6 Turnover and Transportation of Environmental Pollutants in Environmental Media:***

- **Transportation:**

Mechanic; Physi-chemical (solu./precipit.,  
ox./red., adsorp./desorp. ) ;

Biological (food-chain/biol.amplif.accumul.)

- **Turnover:**

Physical (evapor.,dialys.,coagul.,redioact.)

Chemical (photoreact.,complex.,  
ox./red.) ; Biological (metabolizm, uptake)

- **Reaction and cycling in, at and between Interfaces**



# ***7 Environmental Effects:***

- **Defination:**

自然过程或人类的生产和生活活动会对环境造成污染和破坏，从而导致环境系统的结构和功能发生变化，谓之环境效应。自然环境效应和人为环境效应。

- **Classes:**

Physical: noise, green house

Chemical: acid rain, photochemicalfog

Biological: cancer increased



***Chapter 2 the Anthrospere,  
industrial ecosystems, and  
environmental chemistry***

**第二章 人类圈，工业生态系  
统和环境化学**

1. The anthrosphere
2. Technology and the anthrosphere
3. Infrastructure
4. Dwelling
5. Transportation
6. Communications
7. Food and agriculture
8. Manufacturing
9. Effects of the anthrosphere on earth
10. Integration of the anthrosphere into the total environment
11. The anthrosphere and industrial ecology
12. Environmental chemistry

# ***1 the Anthrospere***

- Definition: a part of the environment made or modified by humans and used for their activities
- Result of technology

# ***Components:***

- struct. Dwelling(住所)
- struct.: manuf./commer./edu./other activities
- utilities: water/fuel/electr. distrib. syst./waste
- struct. transp.: roads/railway/airport
- struct. & other parts of environm. food produ.:  
field-grow. crop/water syst.-irrigate
- machines: auto/farm mach./airplane
- struct. communic.: telephone line/radio transm.
- struct. mines/oil wells

## *2 Technology and the anthrosphere*

- Technology: the ways in which humans do and make things with materials and energy.
- Product of engineering based on scientific principles.
- Engineering:  
mechanical/electrical/electronics/chemical
- Environmentally friendly engineering



# ***9 Effects of the anthrosphere on earth***

- Most toxic POPs : heavy metals/org-Cl
- Range: fig.2.1,P41
- To other 4 spheres

# ***10 Integration of the anthrosphere into the total environment***

- Disturbance on environmental balance by natural disaster(灾难) and pollution
- Gaia hypothesis: organisms modify Earth
- Pre-industry: well with other spheres
- Industry: harm with other spheres
- On pollution: discharge/end-of-pipe/integrate with other spheres Fig.2.1

# ***11 the anthrosphere and industrial ecology***

- Industrial ecology: an approach
  - base: system engineering & ecological principles
  - integrate: production & consumption design/production/use/termination(终端)/service
  - purpose: minimize environmental impact

- Industrial ecosystem:
  - within groups & units enterprises(企业)
  - waste reduced absolute minimum
  - energy and materials utilized each others through a process of industrial metabolism
  - analogous to a natural ecosystem
  - connect with time, space and economy
  - A key: symbiotic relationship/facile(流畅的)  
material & information



- Industrial applications of industrial ecology:
  - increased use: environmentally friendly  
(Rand S&T Policy Inst.) products and service
  - companies' research interest:
    - not: end-of-pipe (traditional pollution control measures of remediation/effluent treatment/pollutant monitoring and analysis)
    - but: early stage (to increase production efficiency/produce environm. friendly products/provide environm. beneficial service)
  - case studies: Xeron, Intel



- Scenario creation to avoid environmental problems:
  - background: public concern  
new tech. emergence probs.
  - scenario creation: story building to visualize problems and take remedial action before they become unmanageable
  - "to think the unthinkable and speak the unspeakable, not to say what we think will or should happen" (Rand Co.)
  - biotech.
  - "Y2K bug"

# ***12 Environmental Chemistry***

- Strong connection between environ.chem. and industr. ecol.

principles and processes of environ. chem.

design of integrated system of industr. ecol.

minimize the environ. Impact of industr.waste

- Aquatic, Atmospheric, Geosphere,  
Biosphere, Anaysis