## Exam IV

Exam IV will be offered on Wed. Dec. 5 in class

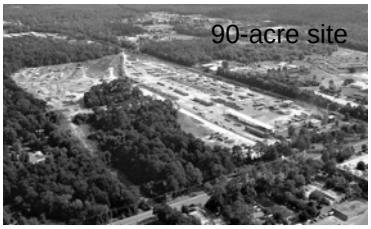
It will also be offered during the regularly scheduled time

Thursday, December 13th

Study Guide will be posted this afternoon

## A toxic neighbor

contaminated with a mix of wood-treating chemicals

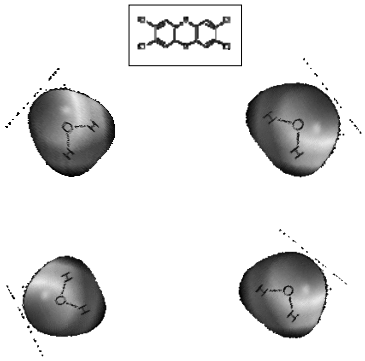



Gainesville Sun – November, 30th

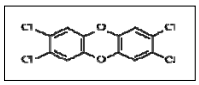
Tests show **arsenic and dioxins in the soil** at levels exceeding state cleanup standards

Dioxin ½ life in soils: 10 – 30 years

## Organic Chemicals

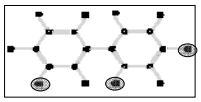


Dioxin



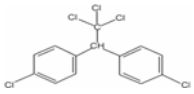
0.2 µg/L

PCB



10-31 µg/L
(50% Cl)

DDT



insoluble

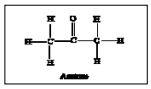
Principally carbon, hydrogen

## Improving Solubility

Organic Solvents

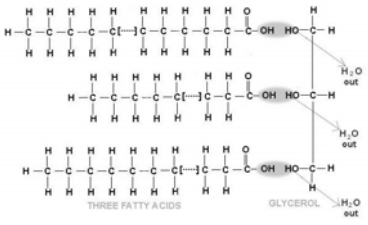
Soap/detergents

**Structural similarity between the chemical and the solvent.**



Hexane

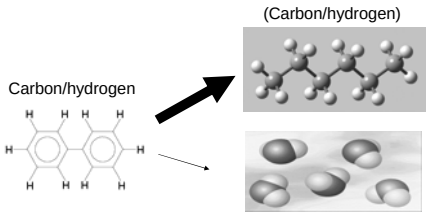
Lipids and Solubility




**Structural similarity between the chemical and the solvent.**

## Solubility

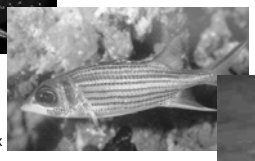
A chemical's solubility in lipids or organic solvents is inversely proportional to its solubility in water.




## Consequences

## Bio-Accumulation

Water and phytoplankton to zooplankton: 800 x

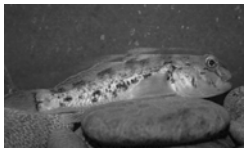


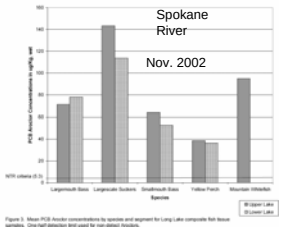
Zooplankton to fish: 31 x

Fish to eagle: 4.8x

Overall: 120,000 times original concentration

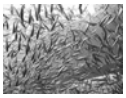
## PCBs



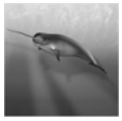



Smallmouth bass - 1100-1800 ppb
Round gobies - 200-800 ppb
Zebra mussels - 100 ppb

## Toxaphene Biomagnification

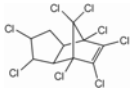
Seawater  0.0003 ppb

Arctic cod muscle  14 - 46 ppb

Narwhal blubber  2440 - 9160 ppb

## Other Hydrocarbons

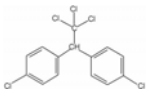
1983



Chlordane

Chlordane
**Mirex**
DDT
Dieldrin

1972



DDT

Non-point source
Biomagnified

## Mirex

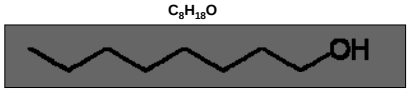

highest levels ever recorded in a living organism.

Quantification

How can soils help?

## An Important Organic Solvent: Octanol

$C_8H_{18}O$

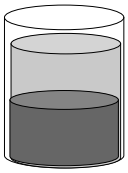


The Octanol-Water Partitioning coefficient

$C_8H_{18}O$


Octanol and water are immiscible

Density: 0.824 g/cm3



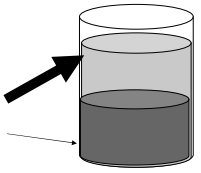
octanol $C_8H_{18}O$

water

## Partitioning

Carbon/hydrogen

$C_{10}H_{20}$



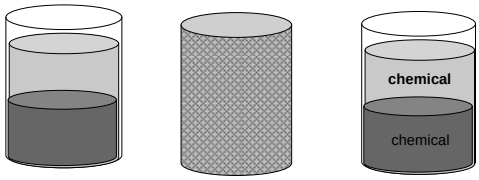
Octanol (Carbon/Hydrogen)

water

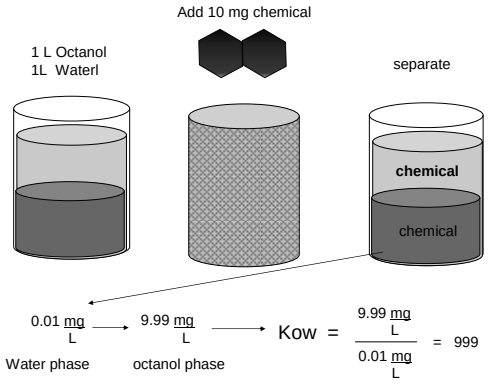
Add 10 mg chemical

1 L Octanol
1L Water

separate




Analyze the water phase for the chemical.
Difference between initial amount and amount in water = amount in octanol
The ratio between the two yields the $K_{ow}$

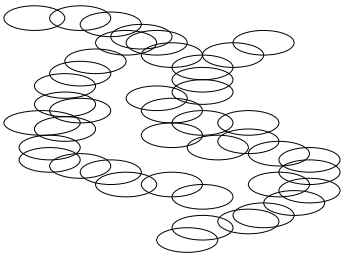



## $K_{ow}$ of some Organochlorine Compounds

| | |
|---|---|
| Dioxin | 6,000,000 |
| PCBs | 2,000,000 |
| DDT | 4,000,000 |
| Dieldrin | 158,000 |
| Toxaphene | 316,000 |

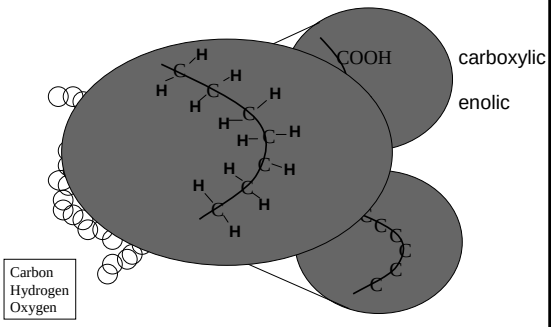
What does this have to do with soils?

## Organic Matter

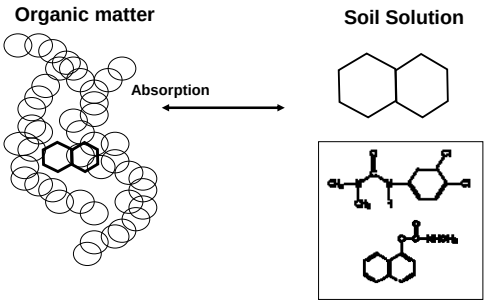



Coiled and convoluted chains of carbon, hydrogen, and oxygen

## Organic Matter



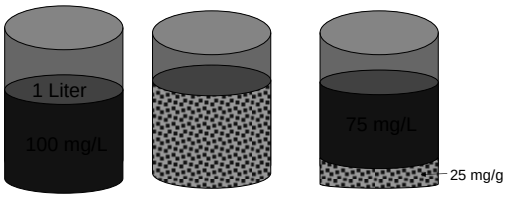

## Partitioning/Distribution



Turn 4 pages

Quantifying Partitioning and Absorption in Soils

## Quantifying Absorption



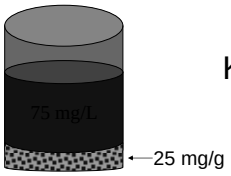

Pesticide solution

1 g Soil added **(10% O.M.)**

Equilibrium

## Distribution Coefficient

$K_d$ = Pesticide on soil (mg/g soil) / Pesticide in solution (mg/L solution)



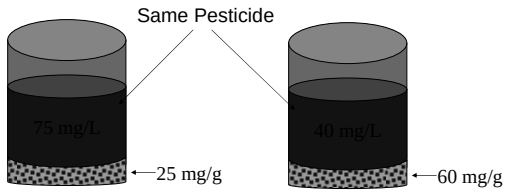

Equilibrium

$K_d = \frac{25\ mg/g}{75\ mg/L} = 0.3\ L/g$

**= 300 mL/g**

**Index for a given soil**

## Two Soils




$K_d$ (1) = $\frac{25\ mg/g}{75\ mg/L}$

$K_d$ (1) = 0.3 L/g

**= 300 mL/g**

$K_d$ (2) = $\frac{60\ mg/g}{40\ mg/L}$

$K_d$ (2) = 1.5 L/g

**= 1500 mL/g**

## Organic Matter and Organic Carbon

**Retention of organic chemicals is strongly correlated with O.C. content**

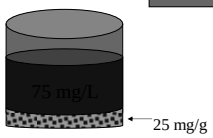
**Organic matter = 40 - 60% carbon**

approximately

50% organic carbon

## Organic Carbon Distribution Coefficient

$$K_{oc} = \frac{K_d}{\text{Fraction o.c.}}$$

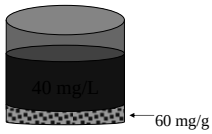



Kd (1) = 3 L/g

10% o.c.

Koc (1) $= \frac{0.3}{0.1} =$ **3 L/g**

**= 3000 mL/g**




Kd (2) = 1.5 L/g

50% o.c.

Koc (2) $= \frac{1.5}{0.5} =$ **3 L/g**

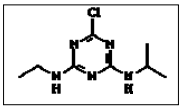
**= 3000 mL/g**

## $K_{oc}$ of some Organochlorine Compounds

| | |
|---|---|
| PCBs | 2,000,000 |
| DDT | 4,000,000 |
| Dieldrin | 158,000 |
| Toxaphene | 316,000 |

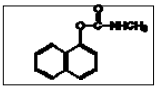
## Modern Pesticides

Atrazine



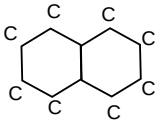
Solubility = 30 mg/L

Carbaryl



Solubility = 40 mg/L

napthalene



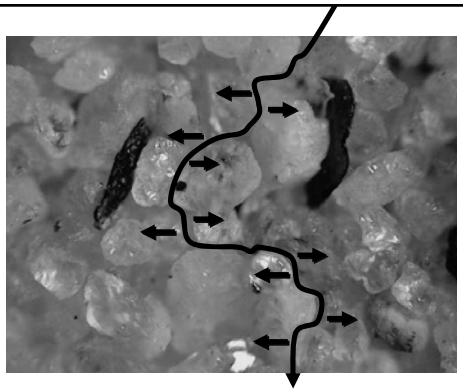
Solubility = 32 mg/L

Practical Range for Some Modern Pesticides

**Koc = 2 – 6000 mL/g**

Dicamba = 2
Malathion = 1800
Chlorpyrophos = 6070

http://soillab.ifas.ufl.edu/cmis/



http://soillab.ifas.ufl.edu/cmis/

## Summary

1. Many organic compound are non-polar
2. Non-polar compounds are weakly soluble in water
3. Non-polar compounds are soluble in organic solvents.
4. Organic matter can behave like an organic solvent
5. $K_{ow}$ describes the distribution of a chemical between the organic solvent, octanol, and the soil solution.
6. $K_{oc}$ describes the distribution of a chemical between soil organic carbon and the soil solution.
7. Koc will impact the movement and distribution of organic chemicals in soils.
8. Organic chemicals degrade. The ½ life is an indicator of the chemicals relative persistence.