Toxic Metals in the Environment

- Metals are "conserved." Not created or destroyed. An inorganic element like a metal always remains that element.

- Metals serve many useful purposes, and some (like iron and zinc) can be important nutrients for living organisms when used in the proper dose.

- Most metals become toxic at high concentrations, and some metals (like lead and mercury) are toxic at very low levels and have no known nutritional benefits.

- Metals come from natural or human sources, or a combination of both.

The Metals of Greatest Environmental Concern

antimony	**Sb**
arsenic	**As**
barium	**Ba**
cadmium	**Cd**
chromium	**Cr**
copper	**Cu**
lead	**Pb**
mercury	**Hg**
nickel	**Ni**
silver	**Ag**
thallium	**Tl**
zinc	**Zn**

Metalloids

arsenic	**As**
selenium	**Se**

Non-Metal Inorganics

ammonia	**NH_3**
cyanide	**CN**
hydrogen sulfide	**H_2S**

Human Production of Synthetic Chemicals

- ~~100~~,000 chemicals are in daily use
- 1,000 - 1,500 new chemicals are manufactured each year (most are organic)
- Industry worldwide produces ~150 kg/capita/yr of organic chemicals
- That is equivalent to 40 g/m^2/yr for every square meter of the earth's surface
- That is within one order of magnitude of the total photosynthetic production of organic carbon (primary production) on earth (~300 g/m^2/yr)

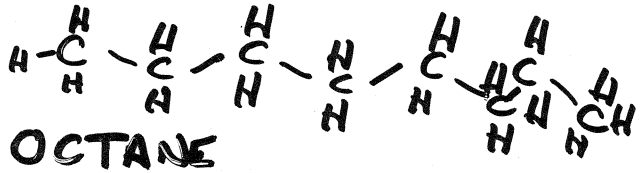
In other words, humans synthesize nearly as much organic material as all the plants on earth.

ORGANIC POLLUTANTS

> ~~80~~100,000 organic cmpds in common use

CAN'T KNOW ALL,
but should know
MAJOR CATEGORIES
AND RELATED SOURCES

E.g. Hydrocarbons



like OCTANE

Long "chain" of C & H atoms

found in: FUELS — Gasoline
Jet Fuel, kerosene

LIGHT FUELS: Small (short chain hydrocarbons)

Gasoline

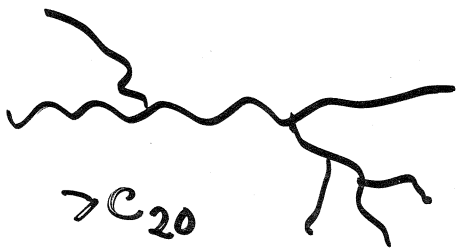
Butane, pentane hexane, octane

HEAVY FUELS:

Diesel Fuel Oil Heating Fuel

C_{10} - C_{20}

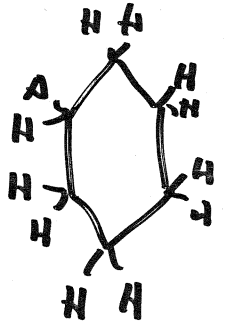
GREASES TARS Very long Chains



$>C_{20}$

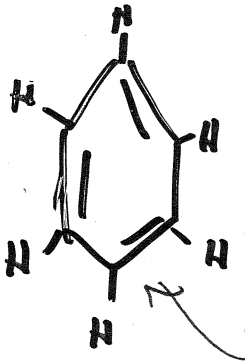
AROMATIC COMPOUNDS

HAVE BENZENE-LIKE RINGS



CYCLOHEXANE

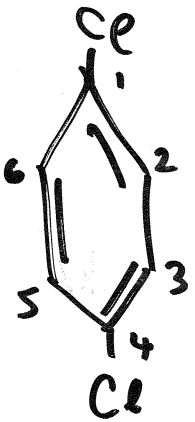
C_6H_{12} (NOT AROMATIC)



BENZENE

C_6H_6 (AROMATIC)

"Aromaticity" due to alternating double bonds.



1,4 dichloro-benzene

$C_6H_4Cl_2$

TPH = Total Petroleum Hydrocarbons

Carbon range refers to the amount of petroleum hydrocarbons in a specific section of a chromatogram based on the retention time of pure alkanes such as hexane, heptane, octane etc., i.e. C6-C7, C7-C8, C8-C9 etc. Pure straight chain hydrocarbons (alkanes) have retention times that increase regularly with the number of carbon atoms. These retention times are used to divide a chromatogram into carbon ranges: C8-C10 indicates that we are talking about the part of the chromatogram between the retention time of Octane (eight carbon atoms) and Decane (ten carbon atoms)

The TPH of a Carbon Range is defined as the area of a range of the sample compared to the area of the same range of the reference standard.

The carbon ranges of some typical products:

LIGHT

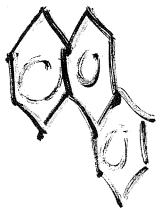
C4-C12	Gasoline
C4-C16	Jet Fuel JP-4
C9-C16	Kerosene, Fuel Oil No 1
C9-C20	Diesel No 2
C11-C20	Fuel Oil No 2
C12-C32 ,	Fuel Oil No 6, Bunker Oil
C18-C40/C50	Motor Oil
C4-C40/C50	Crude Oil

HEAVY

"FUELS"

PAH: Polycyclic Aromatic Hydrocarbons

Naphthalene



Pyrene

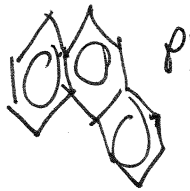
Chrysene

PAH : Polycyclic aromatic hydrocarbons

BENZENE
(mono-cyclic)

NAPHTHALENE

"POLYCYCLIC"



PYRENE