

# **Environmental microbiology and its application**

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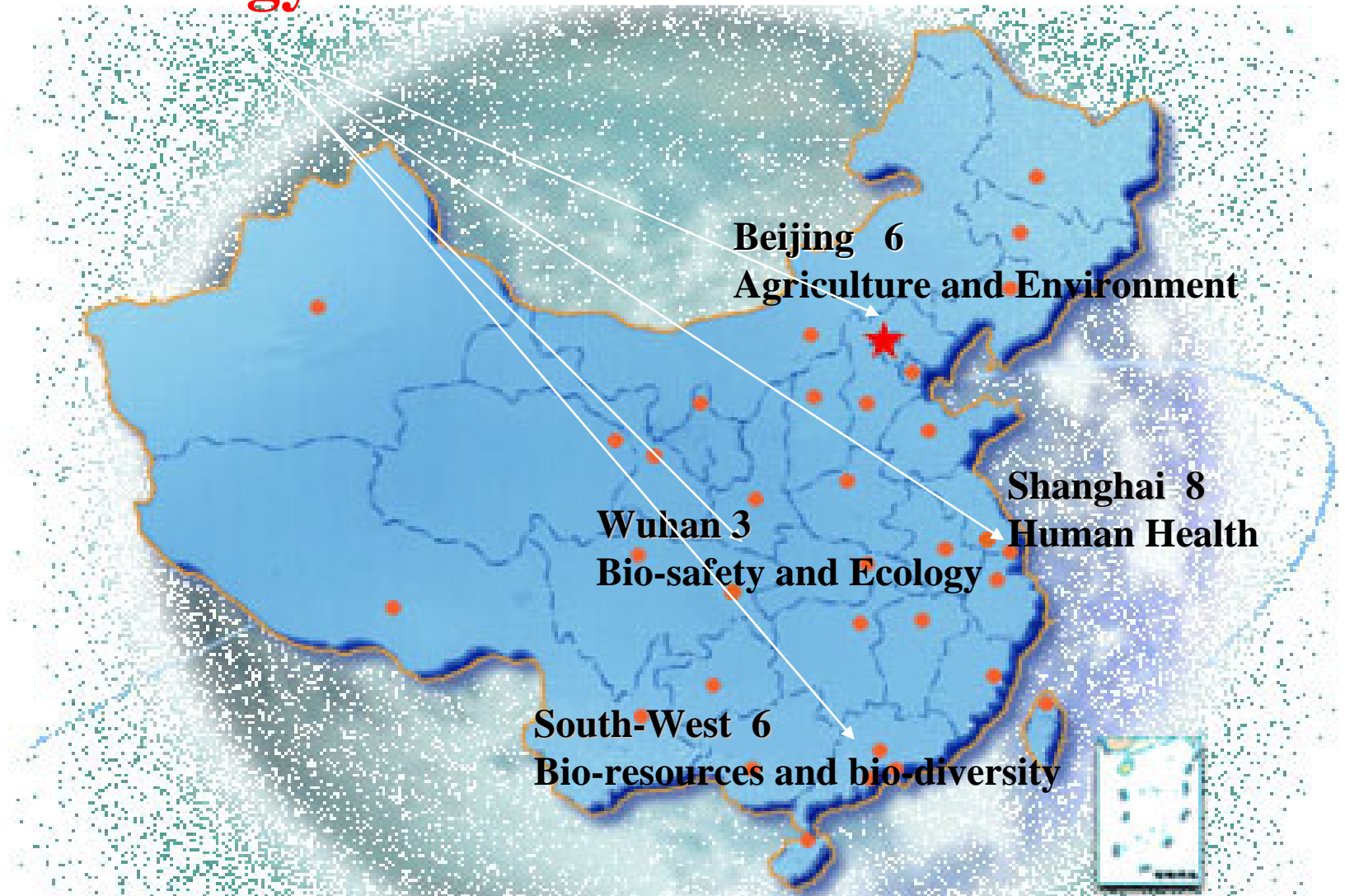
**18th, March, 2008**





# Biology Institutes of Chinese Academy of Sciences

## 23 Biology Institutes





# Wuhan Institute of Virology, CAS

- ◆ **Year founded: 1956**
- ◆ **150 staff members and 200 students**
- ◆ **24 research groups**





# Microbes in Our Lives

- ◆ **Microbes (microorganisms)** – Living things that individually are too small to be seen with the unaided eye.
- ◆ They include:
  - ◆ Bacteria
  - ◆ Archaea
  - ◆ Fungi (yeasts & molds)
  - ◆ Protozoa
  - ◆ Algae
  - ◆ Viruses



# Outline

- I. Microorganisms and Microbiology**
- II. Microbial degradation of xenobiotics**
- III. Possible Applications**



# Extreme Environments and Extremophiles



Black smoker



Permafrost regions



Solar salterns



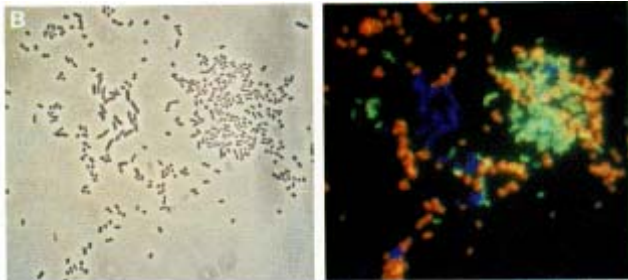
Hot springs

## Records for Extremophiles

- ◆ Hottest: 121 °C!
- ◆ Deepest: 2 miles underground in caves
- ◆ Most salty: 5.2 M NaCl (saturation)
- ◆ Most acidic: pH 0.8
- ◆ Most radiation: 1.5 million rads



# ~99% of the Microbes on Earth are Uncultured



Habitat	Culturability (%)
Seawater	0.001–0.1
Freshwater	0.25
Mesotrophic lake	0.1–1
Unpolluted estuarine waters	0.1–3
Activated sludge	1–15
Sediments	0.25
Soil	0.3

Amann, Ludwig and Schleifer, Microbiol. Rev. 59, 1995



# Persistence of Herbicides and Insecticides in Soil

## *Substance*

## *Time for 75-100% disappearance*

### **Chlorinated insecticide**

DDT

4 years

Chlordane

5 years

### **Organophosphate insecticide**

Malathion

12 weeks

Parathion

1 week

### **Herbicides**

2,4-D

4 weeks

2, 4,5-T

20 weeks

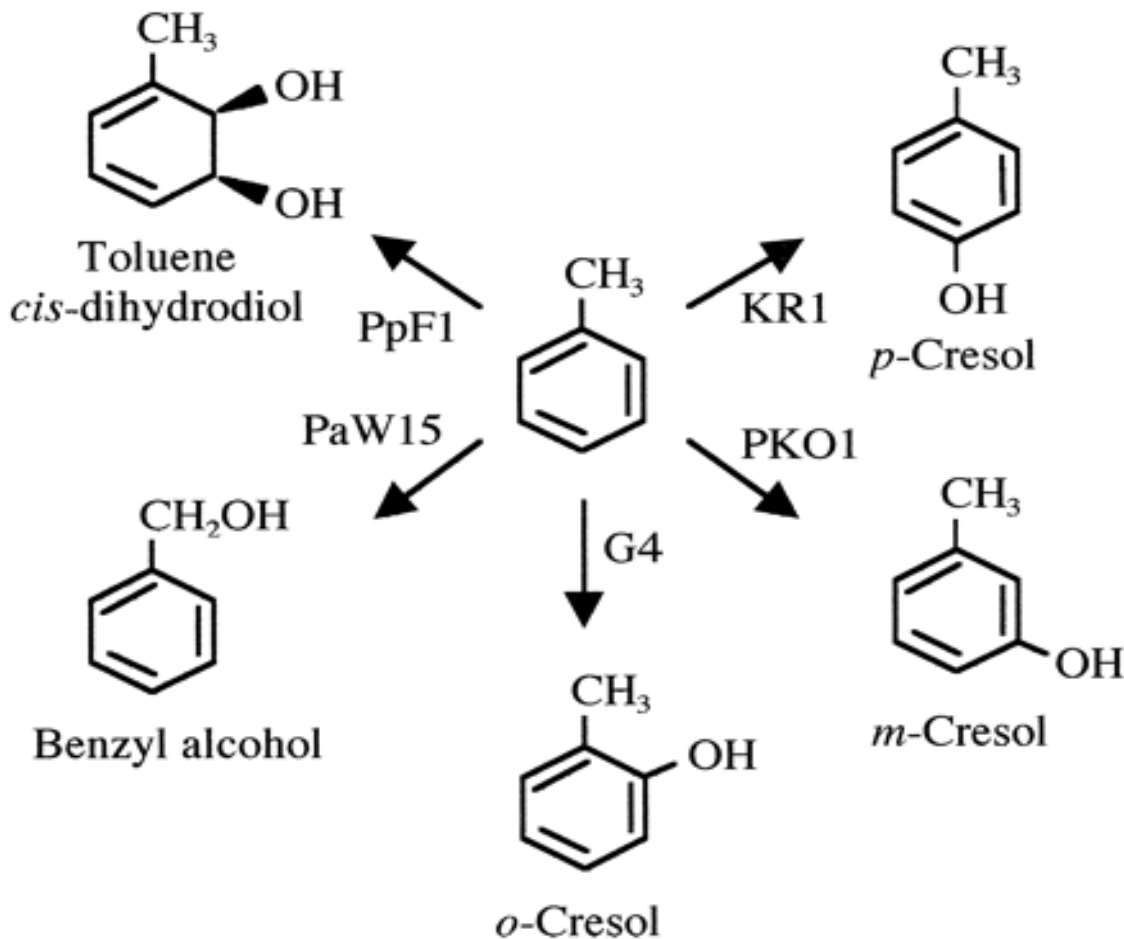
Atrazine

40 weeks





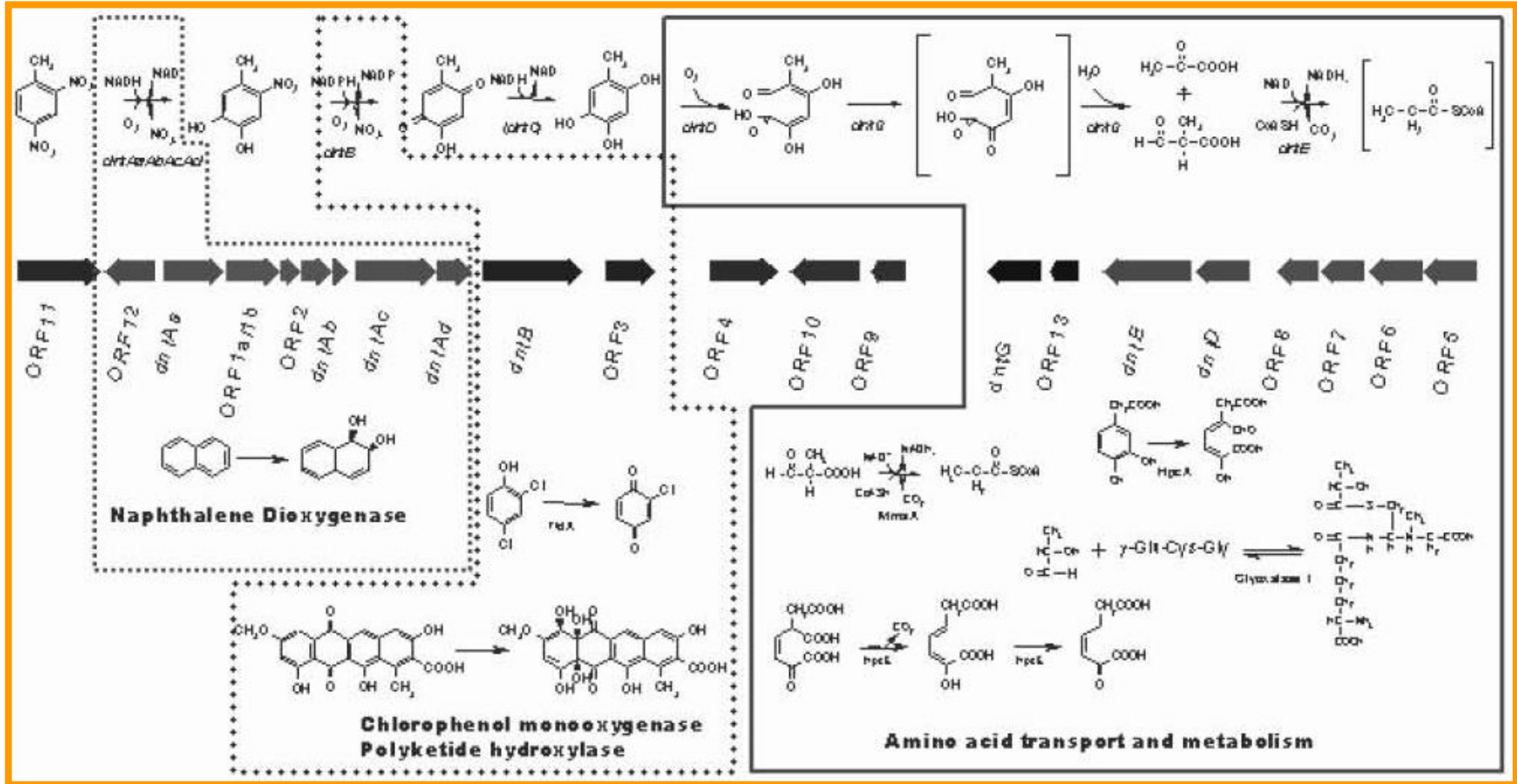
# Diversity for the Degradation of Toluene



Initial reactions in the five bacterial pathways for aerobic degradation of toluene in strains *P. putida* F1, *P. putida* PaW15, *B. cepacia* G4, *R. pickettii* PKO1, and *P. mendocina* KR1.



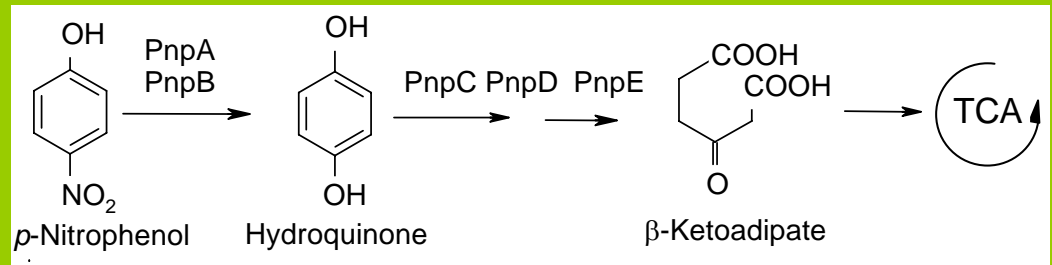
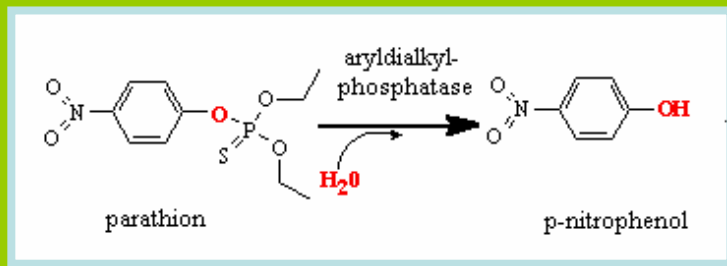
# Evolution of Catabolic Pathways for Degradation of 2,4-Dinitrotoluene



Organization and evolution of the 2,4-DNT gene cluster in *Burkholderia cepacia* R34. (Johnson GR and Spain JC, Appl Microbiol Biotechnol 2003, 62:110-123)



# Completely methyl parathion degradation by patchwork assembly of HGT



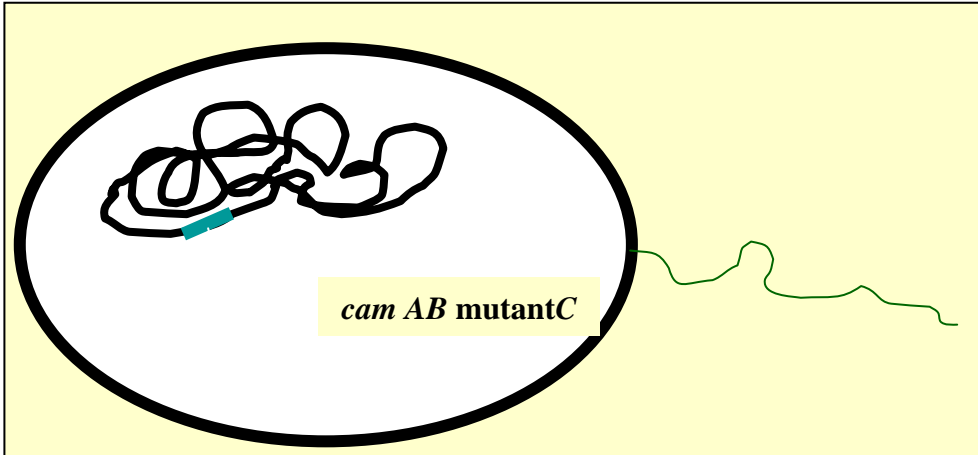
*Pseudomonas WBC-3*

Liu H et al 2005, Biochem Biophys Res Commun, 334:1107

Zhang et al, 2008, submitted

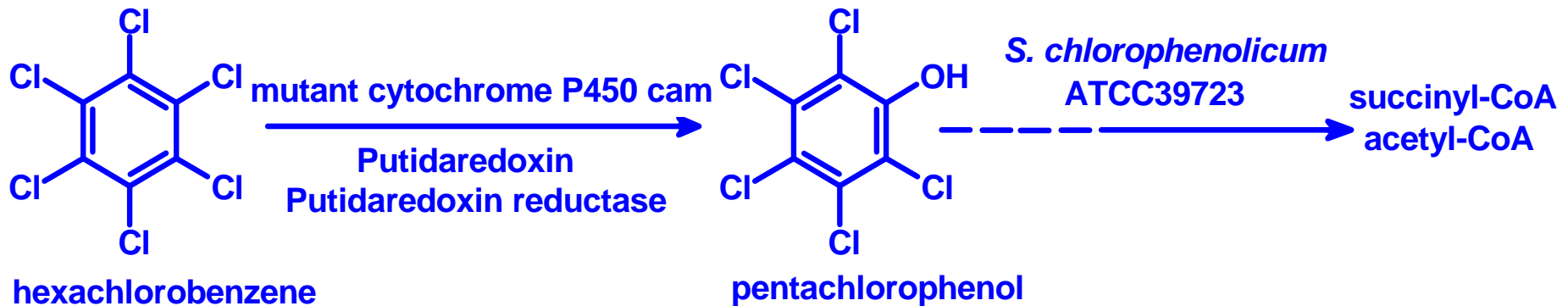


# Conversion of *Sphingobium chlorophenolicum* ATCC 39723 to a Hexachlorobenzene Degradder by Metabolic Engineering



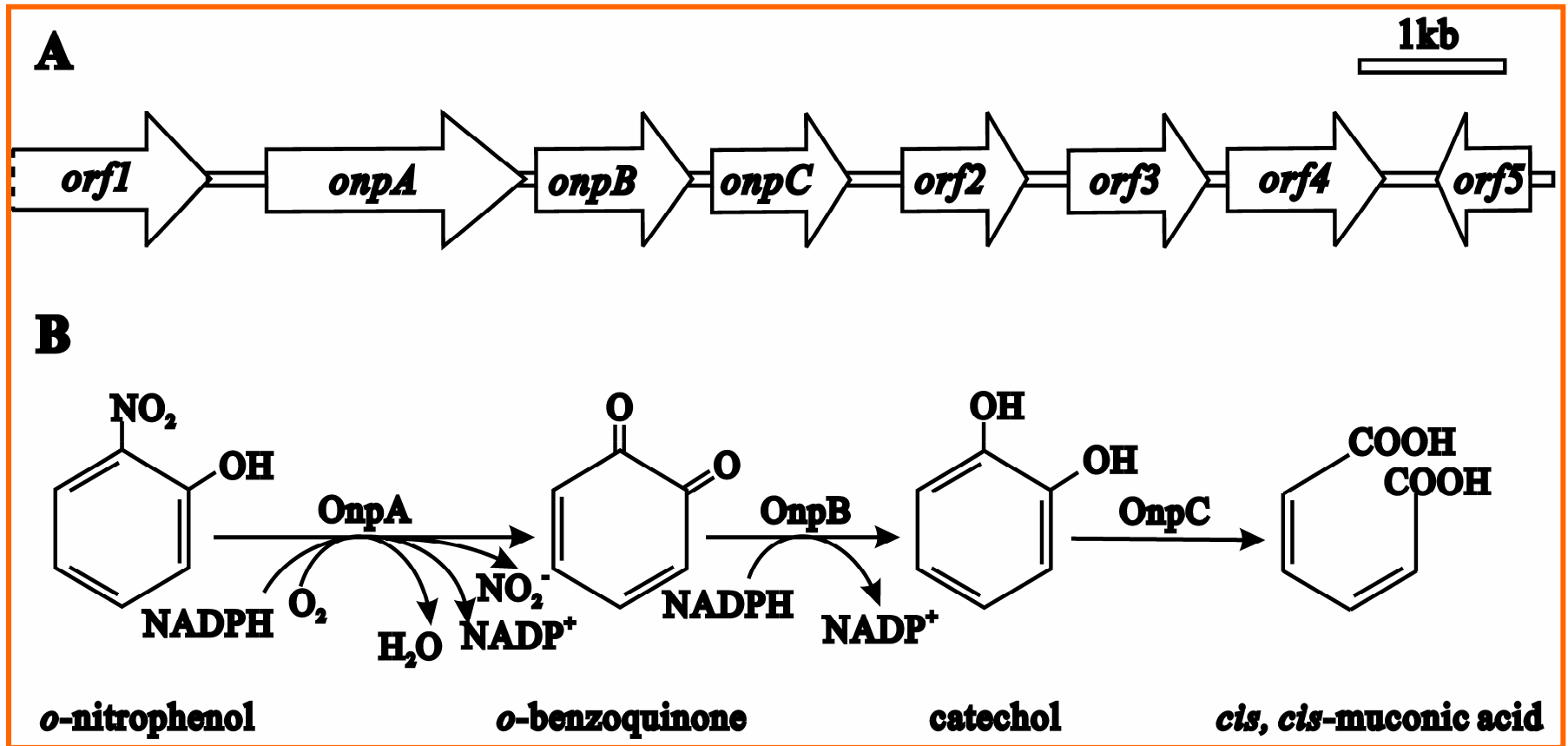
■ Genes encoding mutant cytochrome P-450 enzyme and the physiological electron transfer co-factor proteins were introduced into PCP-degrader ATCC39723 to investigate the possibility of degradation of HCB via PCP.

*S. Chlorophenolicum* ATCC39723






# Catabolic cluster and proposed pathway for the initial reactions of ONP catabolism in *Alcaligenes* sp. strain NyZ215



Xiao et al 2007. J. Bacteriol.189: 6587-6593.



# Diversity for the Xenobiotic Degradation Pathways and Enzymes.

Address  <http://umbbd.msi.umn.edu/index.html>

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Publications



171 pathways; 1185 reactions; 1106 compounds; 758 enzymes; 440 microorganism entries; 233 biotransformation rules; 50 organic functional groups; 76 reactions of naphthalene 1,2-dioxygenase; 109 reactions of toluene dioxygenase;

Ellis et al, 2006, *Nucleic Acids Research* **34**: D517-D521

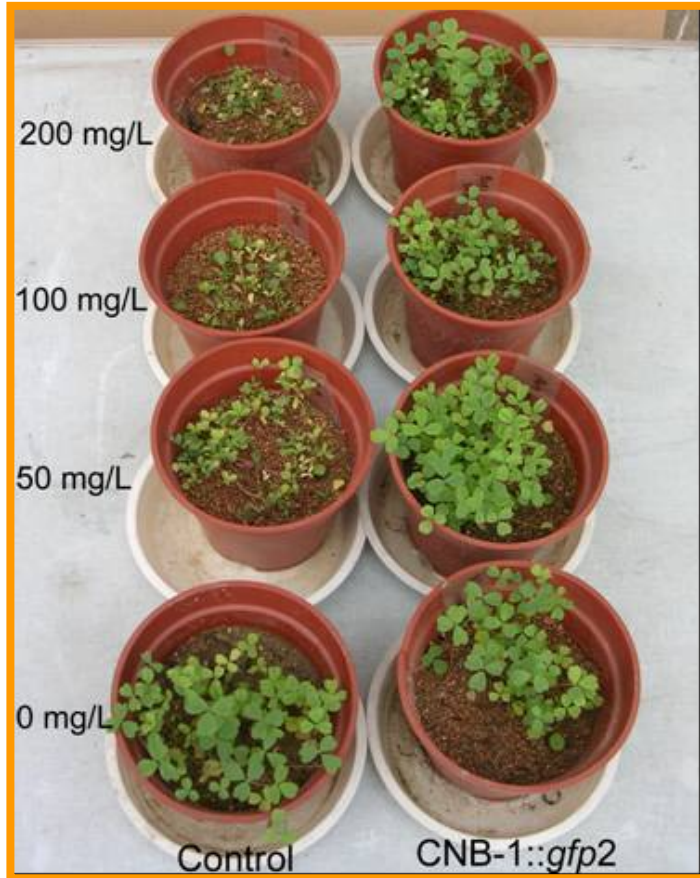


# Possible application

- ✓ **Bioremediation** is defined as the process whereby organic wastes are biologically degraded under controlled conditions to an innocuous state, or to levels below concentration limits established by regulatory authorities.



# Plant–microbe association for Rhizoremediation of Chloronitroaromatic Pollutants



- Liu et al (2007) *Environ Microbiol* **9**: 465.





# Possible application

## Biocatalysis and Biotransformation

- Enzymes found in the metabolic pathways with good region- and stereo-selectivity can be devolved for production of fine chemical intermediates.



# Acknowledgements



Financial supports from NSFC, MoST and CAS

*Thanks for your  
attention !*



Innovation China UK  
中英科技创新计划



南方医科大学

Southern Medical University

