Project Title	**Mobilization of metals from metal-containing solids using cyanogenic microorganisms**
Supervisor	Marion Stagars, Institut für Umweltwissenschaften, Universität Zürich, Winterthurerstrasse 190, 8057 Zürich marion.stagars@access.unizh.ch, phone 635 52 03
Textbook Chapters	Rehm H.J., Reed G. (Eds.) Biotechnology. Volume 10: Special processes. Wiley-VCH, Weinheim, 2001, Chapter 8, pp. 192-224 (ETH 847021:10) Madigan, M.T., J.M. Martinko and J. BROCK, BIOLOGY OF MICROORGANISMS, 9th ed. 1999, Prentice Hall. Chapter 16.19 deals with microbial metal mobilization
Objectives and Research Questions	Cultivation and growth optimization of commercially available cyanogenic (HCN-forming) bacteria, e.g. *Chromobacterium violaceum* and *Pseudomonas fluorescens,* and fungi, e.g. *Pleurotus ostreatus* and *Boletus satanas)* Biological treatment of metal-containing solids (e.g. automobile catalytic converter) to solubilize platinum, palladium, and rhodium as cyanide complexes Development of an analytical protocol to separate and identify metal cyanides using high pressure liquid chromatography (HPLC)
Background	The goal is the characterization of HCN-forming microorganisms with the ability to solubilize metals from solid materials as cyanide complexes. Hydrocyanic acid (HCN) is formed by a variety of bacteria, e.g. *Chromobacterium violaceum*, *Pseudomonas aeruginosa*, *Pseudomonas fluorescens*, and fungi, e.g. *Marasmius oreades*, *Clitocybe* sp., *Polysporus* sp. In addition, some cyanobacteria and algae are also able to form cyanide. Although cyanide formation by microorganisms is known for many years, quantitative data on the ability of HCN formation of many species are still missing. Mainly fungi are poorly investigated and only qualitative data are available for most of the strains. Cyanide is formed as secondary metabolite. It is assumed that its formation has an advantage for the organism by inhibiting competing microorganisms. Glycine is a precursor of cyanide which is formed by an oxidative decarboxylation. Typically, cyanide is formed during growth only during a short time period (early stationary phase). A significant cyanide formation can be obtained only in certain growth media under specific conditions. Generally, cyanide can interact with a series of metals. It is known that nearly all transition metals (except lanthanides and actinides) form well-defined cyanide complexes which show often a very good water solubility and a very high chemical stability. Some of these (e.g. complexes of iron, silver, or gold) have been recognized as stable substances for more than a century. However, until today a combination of this chemical knowledge with microbiological principles regarding metal solubilization from metal-containing solids and the formation of water-soluble cyanide complexes has not been considered yet!
Selected Literature	Knowles, C.J., Bunch A.W. (1986) Microbial cyanide metabolism. Advances in Microbial Physiology 27: 73-111 Lawson, E. N., Barkhuizen M., Dew, D.W. (1999) Gold solubilisation by cyanide-producing bacteria Chromobacterium violaceum. In: R. Amils and A. Ballester (eds.) Biohydrometallurgy and the Environment toward the Mining of the 21st Century, Vol. 9A. Elsevier, Amsterdam, , pp. 239-246

	Campbell, S.C., Olson G.J., Clark, T.R., McFeters, G. (2001) Biogenic production of cyanide and its application to gold recovery. Journal of Industrial Microbiology & Biotechnology 26(3): 134-139.
www. Links	
Practical Work	Standard microbiological techniques will be used for the cultivation of HCN forming microorganisms from commercial sources (or natural sources such as sewage sludge or soil). Organisms will be exposed to platinum-, palladium- and rhodium-containing solid waste materials (automobile catalytic converter). Cyanide will be determined using a colorimetric test. Analyses of metal cyanides will be performed using high pressure liquid chromatography.
Materials and experimental Protocols	Cell cultivation. Optical and gravimetric growth determination. Spectrophotometric techniques. High pressure liquid chromatography.
Goals and Experience gained	Familiarity with literature regarding microbial metal mobilization. Understanding metal-microbe-interactions. Familiarity with specific analytical techniques.
Timing	Cultivation of cyanogenic microorganisms and chemical analyses can be performed during the duration of the course.
Reporting	Oral presentation, written report
Questions to be answered	Can platinum be mobilized and separated from automobile catalytic converter using a biological process?
Laboratory Rules and Precautions	Cyanogenic microorganisms belong to the biosafety group 2. Biohazard precautions (e.g. gloves, safety working bench) are strictly required! Be aware of the toxicity of HCN and of metal cyanides and dispose of the wastes properly.