Kartlägga biohydrometallurgi

Vill du låta dina uppsatser komma till användning istället för att dom landar i byrån? EU-projektet BioMinE (Biotechnology for Metal Bearing Materials in Europe) handlar om hur man kan dra nytta av mikroorganismer för att utvinna och avlägsna metaller på ett mer ekonomiskt, energisnålt och miljövänligt sätt. Som en del av projektet skall en hyperlänkad tankekarta (mindmap) om biohydrometallurgi publiceras på Internet. För att bättre förstå biohydrometallurgin kommer de relaterade ämnena mikrobiologi och hydrometallurgi också att ingå i tankekartan. Och där kommer du in. En del av de uppsatser eller kortare uppgifter som du skriver på någon av dina kurser eller som eget arbete kan passa som innehåll till mikrobiologi- eller biohydrometallurgi-noderna. En sådan text skall vara enkelt och pedagogiskt formulerad på engelska, faktamässigt granskad och godkänd av en lärare. Dessutom skall texten åtföljas av någon slags illustration eller schematisk skiss.

Mer information …

- EU-projektet: BioMinE har 36 partners i 14 länder – bland annat universitet, gruvbolag och vattenreningsföretag. Svenska partners är Luleå tekniska universitet och Umeå Universitet. Läs mer på hemsidan http://biomine.brgm.fr/
- Biohydrometallurgi:
  - http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=14566432&dopt=Abstract
  - http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=14566430&dopt=Abstract
  - http://www.microbialcellfactories.com/content/4/1/13
  - http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-47426V5-2&_coverDate=01%2F31%2F2003&_alid=369714765&_rdoc=1&_fmt=&_orig=search&_qd=1&_cdi=5181&_sort=d&view=c&_acct=C000035038&_version=1&_urlVersion=0&_userid=650452&md5=4f494318bd0b3100d112aeca798f6972
- Hyperlänkad tankekarta:
  - För att få en idé hur en sådan skulle kunna fungera, kolla in http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
  - Se bifogade instruktioner: Mapping down Biohydrometallurgy

- Anmäl intresse till:Anna.H.Bauer@gmail.com
  Anna Bauer
  Skeria Utveckling (BioMinE)
  Work: +46-(0)910-58 54 18
  Cell: 073-847 92 64

Noder

Noder som behöver fyllas är listade nedan. Dessa kan ses som förslag till uppsatsämnen. Frågeställningar och innehåll till noderna får **mycket gärna** kommenteras av dig! Innehållet i detta dokument är nämligen preliminärt och skall förbättras - gärna med hjälp av din kritik.

- Verkar frågorna relevanta?
- Är frågorna rätt formulerade?
- Finns det fler frågor som bör besvaras?

Environments relevant for biohydrometallurgy microorganisms: Mines and treatment plants for metal-rich wastewater, other sulphur and/or metal-rich environments? Discuss pH, oxygen- and nutrition-access, temperature, salinity and light.

Microorganisms: Derive from all domains, though two domains are dominating. What is characterising microorganisms in general? How big are they? Can you compare the size of microorganisms with something or in another way make their small size understandable. What is the amount of microorganism biomass on earth? Most microorganisms are prokaryotes. Are there any advantages of prokaryotic over eukaryotic cells? How does a short generation time affect ability to adaptation? Give some examples of rapid colonization by microorganisms?

Biohydrometallurgy microorganisms: What is the origin of bioleaching microorganisms? How are the microorganisms in mining environments and treatment plants for metal-rich wastewater differing from each other? Similarities? What adaptation do they need to survive in mining environments? What adaptation do they need to survive in treatment plants for metal-rich wastewater?

Metabolism: Microorganisms are much more metabolically flexible than humans. They only need a small number of nutrients and energy sources. Why is that so? Describe their flexible biodegradation mechanism. Make a sketch/picture of the electron-tower with electron-donors and electron-acceptors relevant for a mining environment. Make a sketch/picture of the electron-tower with electron-donors and electron-acceptors relevant for a waste-water treatment plant? In both pictures, give some examples of reactions that are catalyzed by microorganisms. Why are many iron-oxidisers acidophiles? Why are many sulphur-oxidisers acidophiles? Why are not all iron-oxidisers and sulphur-oxidisers acidophiles? (Possible answer: Metabolic flexibility makes it possible to use other sources of energy) Write something about iron-reducers. How and why does pH sometimes affect the redox-potential? Define autotrophy, heterotrophy, chemolithotrophy, acidophile, thermophile.

Metal-resistance: There are different ways for microorganisms to handle high concentrations of metal. Describe different mechanisms. What metals have the highest toxicity? Why?

Communities: Heap-bioleaching and wastewater treatment plants are non-sterile environments. Therefore microorganisms will grow together in a community.

Microbial consortium: Microorganisms interact with each other in different ways. Bioleaching is more effective when certain heterotrophs and chemolithotrophs are living together in a consortium. Why? Are there other examples of consortia within Biohydrometallurgy? Closely related to a microbial consortium is the phenomenon of microbial succession. The initial microorganisms change the environment so that other microorganisms can thrive. Describe the succession of mesophiles, termophiles and even hyperthermophiles in a bioleaching heap. (bacteria versus archaea) Describe the succession to more and more acidophilic species in a heap or during acid mine drainage.

Elemental cycles: Bioleaching is almost exclusively performed on sulphur ores (except for uranium which is leached from oxides). Treatment of metal-rich wastewater often includes precipitation as metal sulfides. Describe the sulphur cycle.

Biokinetics: Very briefly intro about kinetics in general: What is chemistry control and diffusion control? What factors decide how rapidly reactants will be converted into products? Biological catalysts (enzymes) in general. An example of an enzyme relevant for a bioleaching reaction. Transportation processes (of reactants and products) outside (independent of) and inside the organism affect the rate of reaction. Explain why the small size of a microorganism may be a competitive advantage in diffusion limited reactions.

Mixed culture: A diagram showing the growth of two or more microorganisms that are co-varying in one culture. Description of the diagram. Examples of mixed cultures. Is it known how the microorganisms are interacting? Should one think of something special when cultivating several species together?

Free/attached: Living attached to a surface may serve several functions for microorganisms:
- The microorganisms may be protected from predators.
- The microorganisms may be attached directly to a nutrition and energy-source. In heap-leaching attached microorganisms avoid being flushed away by the percolation through the heap. The contact mechanism requires attachment to the sulfide surface.
- The fixation may serve as an anchor so that the microorganisms can be flushed with nutrition or an energy-source and not be surrounded by the same particles. Biobarrier.
- Other reasons?

Free-living microorganisms, on the other hand, can more easily colonize new environments. Are there other advantages for free-living microorganisms? Often microorganisms are living free or attached during different phases of colonisation of a population. Describe.

Biofilm: What is a biofilm? From the view of the microorganism, what is the function of a biofilm? When are biofilms causing problems for humanity? Describe how the microenvironment created by a biofilm enhance corrosion. When are biofilms helpful? Especially, describe biofilms relevant for bioleaching, metal removal in wastewater treatment plants or other examples from the Biohydrometallurgy area.

Genetic drift/gene transfer/mutations: What is the difference of these notions? Illustrate difference with picture. How often do these events occur? Is it possible to initiate and drive these events? Metal resistance (for example resistance to arsenic) and salt-tolerance are two characteristics important for bioleaching microorganisms. Are any of the genetic processes (genetic drift/gene transfer/mutations) more likely to have established such modifications (metal resistance, salt tolerance) within a bioleaching population?

Environmental changes/ Community interactions: may affect growth of microorganisms. Some bioleaching microorganisms are extremely restricted to certain substrates (*L. ferrooxidans*, *L. ferriphilum*, others?). The growth of such organisms is probably very sensitive to environmental changes affecting these substrates. Other bioleaching microorganisms are very metabolically versatile (*At. ferrooxidans*). If the environment is changed so as the original metabolism is no longer possible the microorganism might be able to utilize another energy-source. Such a behaviour might have big implications when it comes to the current treatment of acid mine drainage. Can you see a possible problem? Possibilities?

Give examples of environmental changes (relevant for Biohydrometallurgy) that will affect the growth of microorganisms. Comment whether these changes are created intentionally by mankind or are a result of microorganisms, weathering processes, etc. Especially consider

- Exposure to/Concealing from oxidising conditions (for example before, during and after exploitation)
- Additives used for metal extraction (in processes like flotation, agglomeration etc)
- Changes in metal ion concentration during leaching. Microorganisms can have different affinity for metal-ion substrate (for example Fe(II)) as well as different tolerance to metal-ions (for example Fe(III))
    - "Reasons why 'Leptospirillum'-like species rather than Thiobacillus ferrooxidans are the dominant iron-oxidizing bacteria in many commercial processes for the biooxidation of pyrite and related ores." http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10206710&dopt=Abstract
- Changes in pH. What may happen with sulfide tailings overtime?
- The microbial community in a multi-step, continuous tank-leaching process is not the same in all tanks. Why not? Describe the succession of microorganisms?

Cultivation: Continuous cultivation (already described), batch cultivation, enrichment, amenability testing.

Both bioleaching and wastewater treatment are processes that require cultivation of microorganisms. Compare bioleaching and wastewater treatment with a fermentation-process, with the goal to produce a recombinant protein. Do the processes include one microorganism species or a community of microorganism species? How does the goal of recombinant protein production differ from the goals of bioleaching and wastewater treatment? Think of biomass-production and consumption of substrates. Why are no bioleaching and wastewater treatment processes sterile? Why would the composition of the microbial community change during bioleaching and wastewater treatment? Is that change favourable for the results of the processes? What happens if the recombinant protein process would be non-sterile?

Identify/characterize: Describe culture-independent and culture-dependent methods. What are the advantages and disadvantages with such methods? What is the great plate-count anomaly? Explain and comment on prerequisites for the following techniques:

- **Gene library:**
- **T-RFLP, DGGE:**
- **FISH:**
- **Flow-cytometry:**
- **Enrichment cultures:**
- **Enumeration:**
- **Overlay-plate isolation:**
- **Micromanipulation**:

Bioleaching: What is the contact and non-contact mechanisms? What are the polysulfide and the thiosulfate mechanisms? How do the polysulfide and the thiosulfate mechanisms differ from each other? Biomining and acid mine drainage are two outcomes of bioleaching. Speculate: Are there other applications where bioleaching would be of use?

Biomining: Biomining is the general term to describe both bioleaching and biooxidation as a way to recover metals. Describe tank-leaching and heap-leaching. When is tank-leaching chosen over heap-leaching? When is biomining economically viable? What advantages do biomining have over other metal extraction methods? Disadvantages?

Acid mine drainage: already described by linking to external web-page.

Waste-management: What kind of waste might cause acid mine drainage? What are the characteristics of such waste? How is mining-waste handled?

Metal immobilisation processes: Very briefly – when are such processes happening naturally? Where are such processes used? Hypothesize: Where could they be of use in the future?

Treatment of process liquid and effluents: What methods? Flocculation, …

Bioreactor types: What are the basic principles when designing a reactor for aerobic microorganisms? The basic principles when designing a reactor for anaerobic microorganisms? Many more questions ...

Biological barrier walls = biobarriers:

Constructed wetlands:

Bioaccumulation: How? Applications today (and in future)?

Biosorption: How? Applications today (and in future)?

Bioprecipitation: How? Applications today (and in future)? Sulfate reducing bacteria.

Biocoagulation: How? Applications today (and in future)?

Biological transformation: How? Applications today (and in future)?