**Handout: Supplemental Information for Biotechnology**

**Mining with Microorganisms**  
-**Bioleaching:** Used to extract valuable metals from low-quality ores.  
-Oxidise sulfide 🡪 sulfate  
-Aerobic, exothermic reaction—released heat by early microorganisms in the chain enables more thermophilic bacteria to reproduce and oxidise  
-Used primarily with copper, but also with nickel, uranium, lead, and gold

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| **Pros** | **Cons** |
| Uses low quality ores that are otherwise economically not viable for production | Generates sulfuric acid (toxic environmentally) |
| Cheaper and more efficient for extracting maximum product | High tech—not available to all mining operations. |
| Can be done in situ—ore is piled or left in ground, live bacteria living on ore have water rained down on them which collects byproduct metal ions. |  |
| No SO2 production |  |

**Large Scale Production**-Microorganisms are produced in large scale via fermentation—used to make important microbes and to mass produce their byproducts  
 -Mycoprotein (food additive from fungi), antibiotics, enzymes for human use  
-Batch fermentation uses groups of microbes that are cleaned out after each “batch,” while continuous is…continually producing.

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| **Batch Culture** | **Continuous Culture** |
| If culture is contaminated or damaged, only that culture must be thrown away | Easy, contiunous, efficient process |
| Cleaned equipment can be reused for other organisms | Continuous nature means little time in between cultures |
| Regular cleaning keeps equipment operational and pipes empty | Microorganisms grown exponentially so product yield remains high |
| Easy, minimal attention needed once initial “ingredients” are added (fermentation continues and decreased nutrients can cause stress metabolites—sometimes the goal—to be formed) | Can use small containment and continually add more nutrients |

**Immobilising Enzymes**-used to decrease cost of enzyme reactions and prevent enzymes from being added to or washed away in various processes  
-(Enzyme + sodium alginate) is dropped into calcium chloride solution 🡪react into a solid jelly that contains the enzyme  
-substrates can be run over the enzyme beads—enzyme reacts the substrate but does not need to be filtered from it = the enzyme can be used again!