- Bioleaching is cheaper than chemical extraction, safer for the environment, and more efficient in extracting metals with low concentration in ores.
- It is performed by iron and sulfide oxidizing bacteria or acid producing fungus.
- Bacteria recycle the major leaching reagent, like ferric iron, and perform further oxidation steps while gaining energy from the electron transfer.

- **ore leaching**: The process of recovering metals from ores by using a number of different techniques.

Microbial ore leaching (bioleaching) is the process of extracting metals from ores with the use of microorganisms. This method is used to recover many different precious metals like copper, lead, zinc, gold, silver, and nickel. Microorganisms are used because they can:

- lower the production costs.
- cause less environmental pollution in comparison to the traditional leaching methods.
- very efficiently extract metals when their concentration in the ore is low.

The Leaching Process

Bacteria perform the key reaction of regenerating the major ore oxidizer which in most cases is ferric iron as well as further ore oxidation. The reaction is performed at the bacterial cell membrane. In the process, free electrons are generated and used for the reduction of oxygen to water which produces energy in the bacterial cell.

Ores, like pyrite (FeS_2), are first oxidized by ferric iron (Fe^{3+}) to thiosulfate ($S_2O_3^{2-}$) in the absence of bacteria.

In the first step, disulfide is spontaneously oxidized to thiosulfate by ferric iron (Fe^{3+}), which in turn is reduced to give ferrous iron (Fe^{2+}):

($S_2O_3^{2-}$) in the absence of bacteria.

In the first step, disulfide is spontaneously oxidized to thiosulfa by ferric iron (Fe^{3+}), which in turn is reduced to give ferrous iron (Fe^{2+}):

(1)

FeS2+6Fe3++3H2O⟶7Fe2++S2O2−3+6H+spontaneousFeS2+6Fe3++3H2O⟶7Fe2++S2O32−+6H+spontaneous

Bacteria are added in the second step and recover Fe^{3+} from ferrous iron (Fe^{2+}) which is then reused in the first step of leaching:

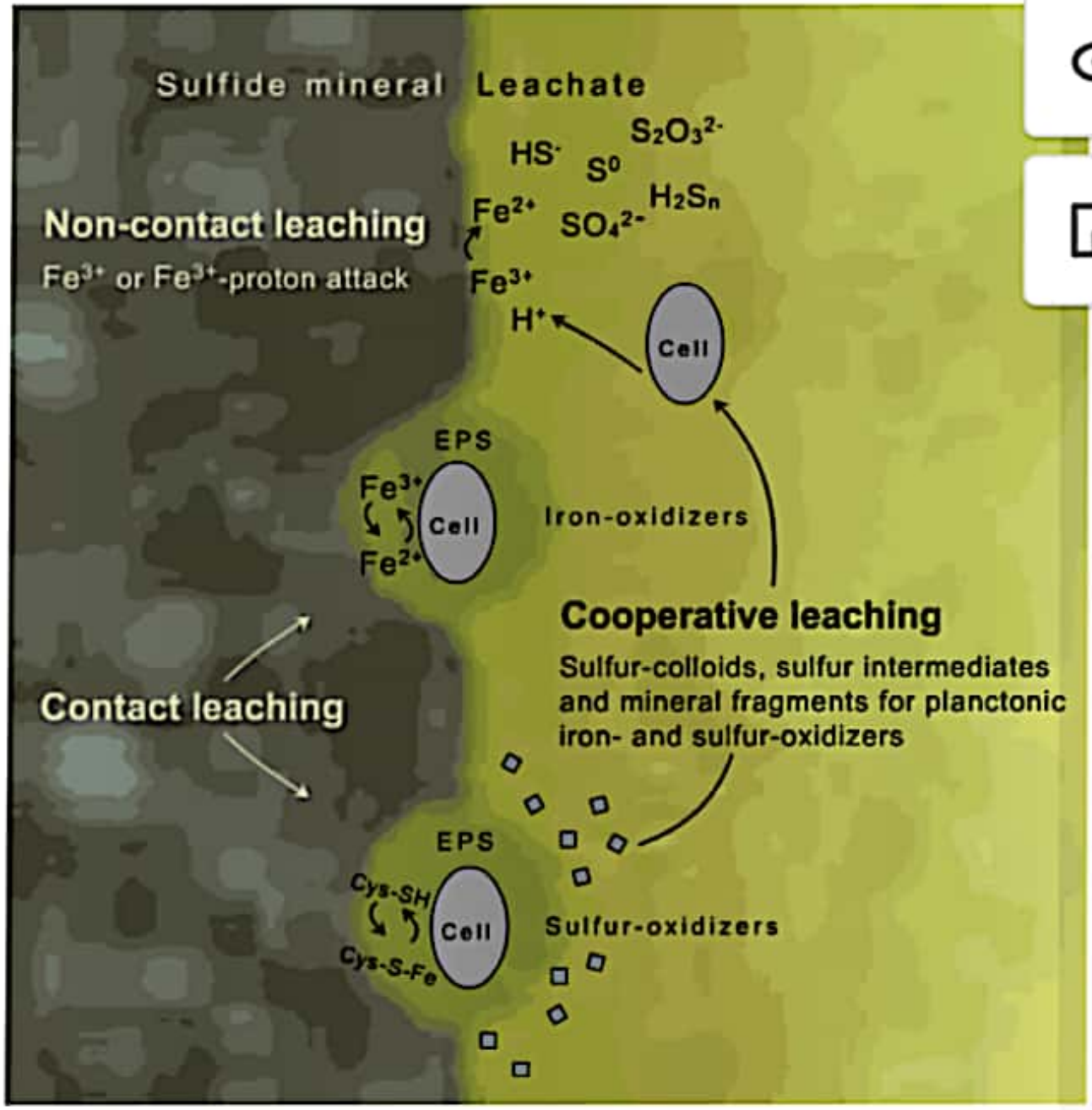

Figure: **Sulfide mineral bacterial leaching**: Bacterial cells oxidizing the ferrous iron back to ferric iron while using slightly different contact mechanisms with the metal.

(2) $4Fe2{+}{+}O2{+}4H{+}\longrightarrow 4Fe3{+}{+}2H2O$(iron oxidizers)$4Fe2{+}{+}O2{+}4H{+}\longrightarrow 4Fe3{+}{+}2H2O$(iron oxidizers)