

## Introduction

>30% of proteins in PDB contain a metal

• Metals are essential enzymatic cofactors and structural elements in

Hydrolyses, redox chemistry, signaling

Photosynthesis, aerobic respiration, N-fixation, global chemical turnover

• Evolution of life is governed by interactions between organic life forms and essential inorganic resources





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## Hard & soft acids and bases

Hard-soft acid/base classification of metal ions and ligands important to bioinorganic chemistry:

## Metals:

Ligands

Hard:  $H^+$ ,  $Na^+$ ,  $K^+$ ,  $Mg^+$ ,  $Mn^{2+}$ ,  $H_2O$ ,  $OH^-$ ,  $MeCO_2^-$ ,  $PO_4^{3-}$ , Al<sup>3+</sup>, Ga<sup>3+</sup>, Ca<sup>2+</sup>, Cr<sup>3+</sup>, Co<sup>3+</sup>, Fe<sup>3+</sup>. Tl<sup>3+</sup>

Borderline: Fe<sup>2+</sup>, Co<sup>2+</sup>, Ni<sup>2+</sup>, Cu<sup>2+</sup>, Zn<sup>2+</sup>

**Soft**: Cu<sup>+</sup>, Au<sup>+</sup>, Cd<sup>2+</sup>, Pt<sup>2+</sup>, Tl<sup>+</sup>, Pb<sup>2+</sup>, Pt<sup>4+</sup>, Hg<sup>2+</sup>

 $CO_3^{2-}$ ,  $NO_3^{-}$ , ROH,  $R_2O$ ,  $NH_3$ , RNH<sub>2</sub>, N<sub>2</sub>H<sub>4</sub>, RO<sup>-,</sup>, Cl<sup>-</sup>

> NO<sub>2</sub><sup>-</sup>, N<sub>2</sub>, SO<sub>3</sub><sup>2-</sup>, Br<sup>-</sup>, N<sub>3</sub>, aniline, imidazole

 $R_2S$ ,  $RS^-$ , RSH,  $SCH^-$ ,  $H^-$ ,  $R_3P$ , CN<sup>-</sup>, RNC, CO, R<sup>-</sup>



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## Cytochromes, Peroxidases, and Catalases

- Cytochrome P-450
  - Oxidation catalyst
- Peroxidases/Catalases
  - Decomposition of organic peroxides.







- ACE
- digestive enzymes, carboxypeptidases
- matrix metalloproteases (MMPs), secreted by cells
- one lysosomal protease.

Some MMPs (e.g., collagenase) are involved in **degradation of extracellular matrix** during tissue remodeling.

Some MMPs have roles in cell **signaling** relating to their ability to release cytokines or growth factors from the cell surface by cleavage of membrane-bound pre-proteins.

