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Biochemical and Molecular Responses of Plants to Heavy Metal stress: Uptake, Compartmentalization, Detoxification and Tolerance

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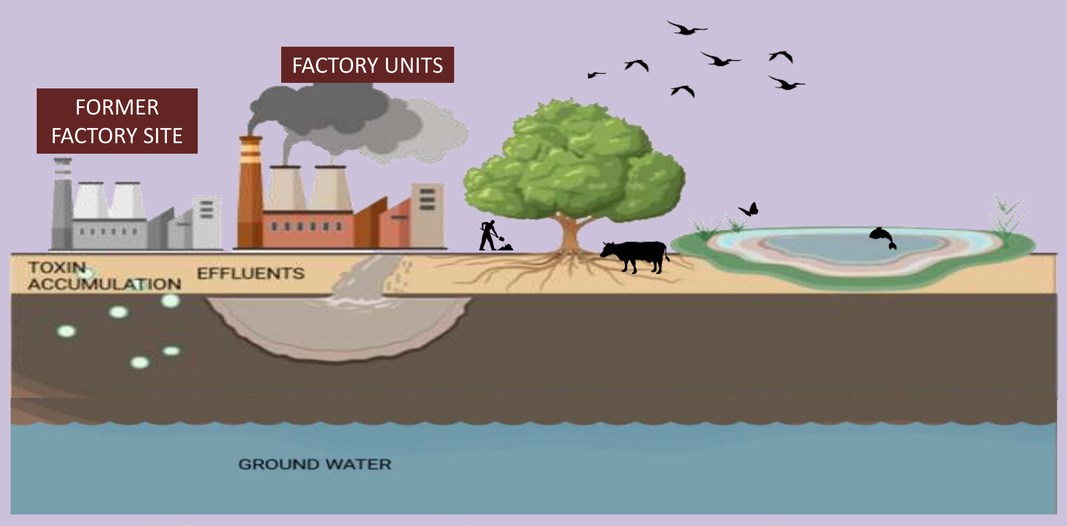
Introduction



Effluents containing metal → Plant uptake → Deterioration in plant health → Defense mechanism

(Shahid et al., 2017)

Sources of metal and its uptake	• Majorly industrial effluents and mining. • Plants mostly take up through roots, sometime via foliar uptake.
How plants adapt to this?	• Primary defence – cell wall and exudates. • Protects itself majorly through expression of antioxidant and transporter genes • Hyperaccumulator plants have the ability to store excessive amounts of metal .
Compartmentalisation and sequestration	• Through carriers like phytochelatins (PC) and metallothioneins (MT), metals are sequestered into vacuoles. • Metals are even accumulated in leaf petioles, sheathes, trichomes.

Aim and Objectives

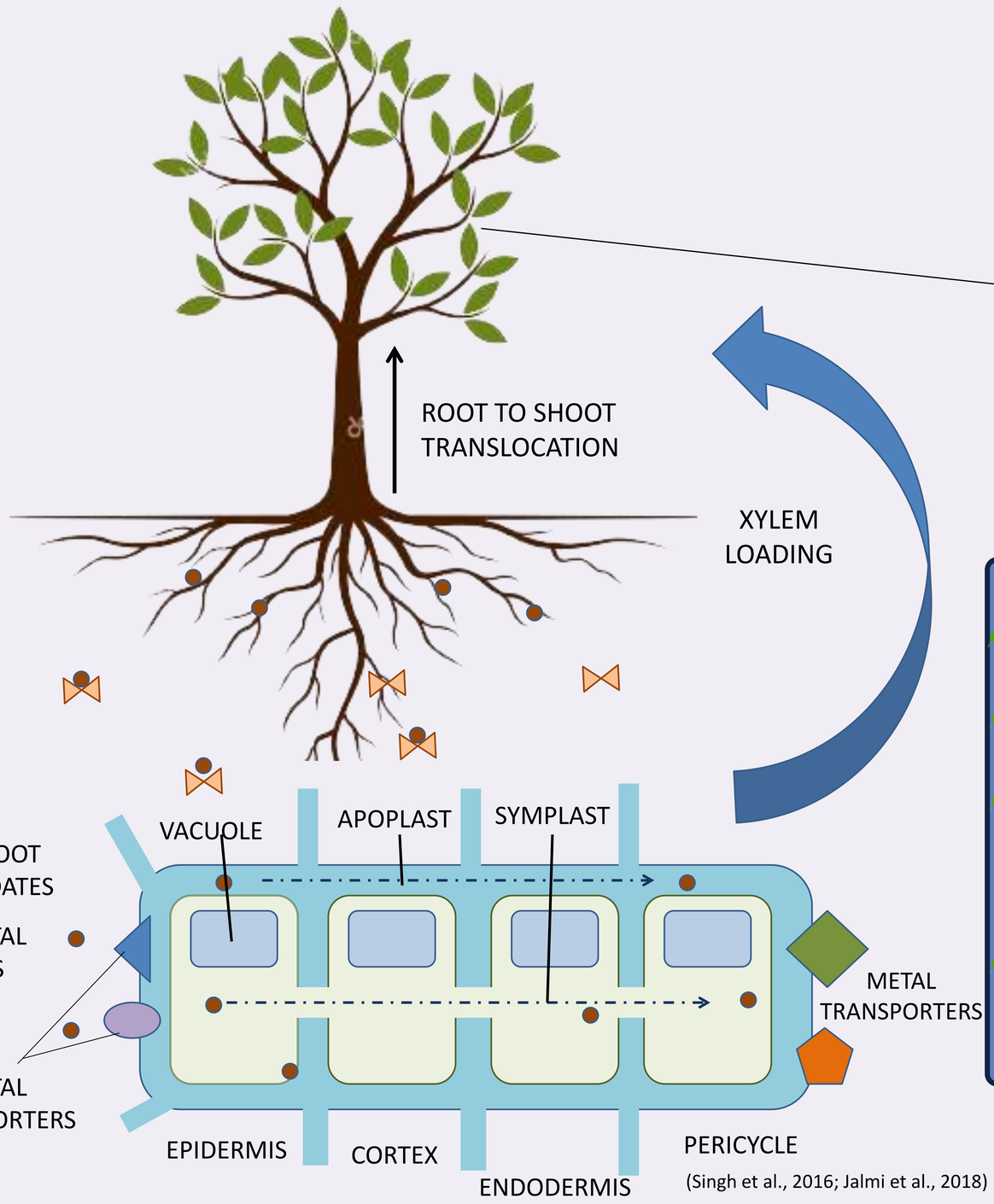
- Sources of metal pollution and basic mechanism of metal uptake by plants
- Various plant responses to metal stress and effects/ changes observed in plants
- Plant defence mechanisms and metal compartmentalisation and sequestration

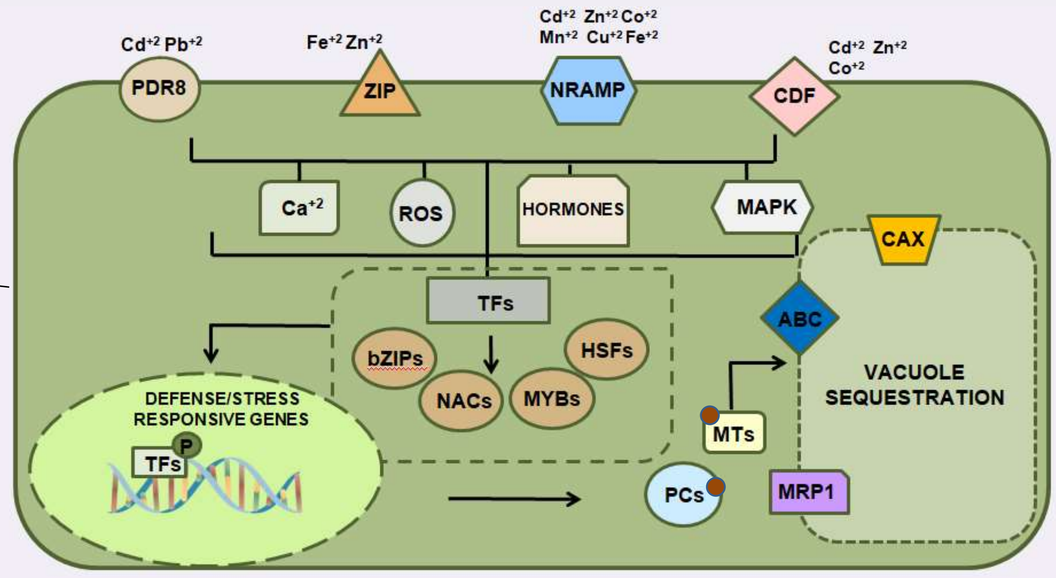
Plant effects and responses towards metal

- ↓ Photosynthetic and transpiration rate
- ↓ Root and shoot height
- Delayed germination and fruiting
- Deformities - chlorosis, necrosis, blight
- Genetic and cellular abberations
- ↑ ROS generation and Activation of defense genes
- Production of root exudates and phytohormones
- Activation of metal transporter genes
- Activation of signaling pathways
- Lipid peroxidation- MDA formation

(Patel et al., 2021)

Metal uptake and sequestration





(Singh et al., 2016; Jalmi et al., 2018)

Conclusion

- Plants take up metals mostly through root are sometimes via foliar means.
- They often secrete exudates like phytosiderophores and organic acids to either cope up with the stress or for uptake assistance.
- Metal transporters located on the membranes (for specific metals), the metallic ions then group with chelator molecules such as phytochelatins and metallothioneins, which in turn helps in vacuolar sequestration through transporters
- Ions are stored in neutral forms. Certain genes, in response to metal stress are upregulated, promoting the expression of transporters and for uptake, detoxification and sequestration.

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