Among well as the production of metal chelators.

Environment

Among allthe environmental stresses, the effect of metal accumulation has beenconsidered one of the most disturbing factors arising in the late 19th andearly 20th centuries.

Some metals, such as zinc (Zn), mercury (Hg), copper (Cu), arsenic (As), lead (Pb), and cadmium (Cd), can bepersistentand bioaccumulative elements, thus being potentially toxic to living organisms, from microorganisms to animals. These elements may be introduced into theenvironment by many anthropogenic activities, such as mining, fertilizer use, metal-based pesticides, and a wide range of industrial activities, whichrelease metals into the environment. In the case of plants, metals in the soilcan enter the roots through symplastic or apoplastic pathways before enteringthe xylem and being translocated to the shoot, although transport through thephloem may also play a key role in delivering metals. Plants have a range ofstructural and biochemical barriers that can control the loading and unloadingof elements, and these include the exodermis and endodermis, as well as theproduction of metal chelators. Metals can also trigger a series of changes thatcan lead to phytotoxicity.

Cd is a toxic metal because of its relatively highmobility in the soil–plant. Cd can affect cell biochemical mechanisms and structuralaspects, for example, by lowering the control of the cell redox state, soinducing oxidative stress and disruption of membrane composition and function . Cdcan induce severe disturbances in the physiological processes of a plant, such asphotosynthesis, water relations, and mineral uptake. Hence, a complexbiochemical pathway within the cell can be triggered concomitantly withtranscription regulation of Cd-responsive genes, such as induction ofantioxidant systems and increase in expression of transcription factors. Moreover, a cross talk between many molecules involved in the modulation ofCd-induced signaling pathway has been explored, such as the interaction ofreactive oxygen species (ROS) or antioxidants with hormones. In fact, strongevidence has been presented to show that hormones are a major player in the signalingpathways of Cd-induced stress Introduction The presence of cadmium (Cd) in soils, sediments, and water is a major environmental concern.

Its release into theenvironment in large amounts as an industrial waste has led to its currentranking as a major anthropogenic pollutant. Cd, with its low affinity for soil, usually remains in the mobile bioavailable form. It is transported intomicroorganisms by the energy-dependent manganese or magnesium transportsystems.

It competes with and replaces other functional metals inside cells . Italso brings about the denaturation of proteins, inhibits bacterial respirationand proton–solute cotransport, and causes single-stranded breaks in cellular DNA. Becauseof the bioaccumulation of Cd and its long-term toxicity in humans, the study ofCd sequestration by microorganisms to clean Cd-contaminated environmentsbecomes important. Many microorganisms have evolved mechanisms to tolerate andovercome Cd toxicity. A major mechanismfor heavy-metal resistance involves alterations in the membrane transportsystem of an organism, resulting in the reduction or denial of entry of Cd intothe organism Alternatively, theintracellular or extracellular sequestration of heavy metals by adsorption tocell walls or by binding to a specific biopolymer results in tolerance toheavy-metal toxicity.

Heavy metaltolerance can also be achieved by microbially mediated extracellularprecipitation of the metal ion into an insoluble form, using microbiallyproduced sulfides, carbonates, hydroxides, phosphates, or oxalates, thusreducing the bioavailable soluble concentration of the toxic form. Another mechanism involves the utilizationof energy-dependent ion efflux pumps, which capture and remove the cytoplasmic metalsthrough the cell membrane. Anotherinvolvesthe enzymatic oxidation orreduction of the metal ion, resultingin its detoxification orvolatilization. In itsreduced form, Cd is nonvolatile, therefore its removal by enzymatic reductionwould be unnecessary and thus energetically unfavorable. Cd resistancesometimes involves the secretion of a polymer, protein, or other component thatsequesters Cd from extracellular media.

This sequestration occurs by means of (i)cell surface interactions involving specific functional groups on the cell wallor (ii) intracellular sequestration.