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# Review Article on Cyanobacteria

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**Abstract**

Blue-greenalgae,ormoreexactly, photosynthetic prokaryotescyanobacteriaplaya pivotalroleinglobalecosystems;theyaretheancientmicrobiallifeamongthemost earlyoxygenating organisms onEarth and thus contributed highly toatmospheric evolutionary change.Their preferred conditions extend over freshwater versus marinesystems right through extremes of hotsprings and deserts.Theyshow enormous metabolic diversity whereby processes such as nitrogenfixation,carbon sequestration, and sequestration of secondary metabolites can be included. The aspectsinvolveagriculture,biofuelgeneration,orenvironmentalremediationapplied in biotechnology.However, onlysome percentages allow ecological issues sinceit brings harmfulalgalblooms(HABs)thatintroducetoxins.Discussedhere beloware thetaxonomy-structure-ecology-interventions thatsupportsustainabledevelopment and management intervention.

## Introduction

CyanobacteriaareGram negative, oxygenic photosynthetic microorganisms.They belongtothedomainBacteria.Theyareconsideredamongtheoldestlifeforms with fossilrecords traced tomorethan 3.5 billion years ago.It was these organisms that played a very instrumental role in the “Great Oxygenic Event” that transformed Earth’searlyanoxicatmosphereintoonesuitableforaerobiclifeforms.

Cyanobacteria shall bedefined as those organisms capable of carryingout photosynthesis using water as an electrondonor andreleasing oxygen-such atype of photosynthesis is found in higher plants.They have chlorophylla besides phycobiliproteins(phycocyanin,allophycynanin,andphycoerythrin)thatrenderthem blue-green, attractive.Theirhabitat diversityranges from marine tofreshwater lakes, soils, to hot springs; even theyform symbiotic associations with fungus (lichens), plants, and animals.

Beyond their ecological importance, cyanobacteria are gaining increasing importancefortheirapplicationsinsustainablebiotechnology-suchasbiofertilizers, biofuels,pharmaceuticals, andwastewatertreatment.However,theiruncontrolled growthcan lead toharmful algal blooms, posing ahealthrisk to aquatic organisms and humans.

EcologyRole:

Schirrmeister et al.(2013) notethat it was most likelycyanobacteria whowere responsible for the oxygenation of Earth's atmosphere during the Precambrian period.In aquatic ecosystems, they assume the role of primary producers-supportingvarioustrophiclevels.Photosyntheticoutputkeepscarbondioxidein check andsustains global carbon equilibrium.

**1. NitrogenFixation:**

Anabaena, Nostoc, andAulosira are among those cyanobacteria which develop heterocystsandfixnitrogeninaerobicconditions(Kumar etal.,2010).Thus,they have great value as natural biofertilizers for the fields of paddycrops.

**2. SymbioticAssociations:**

Cyanobacteria have symbiotic relationships with many different organisms.For example,Anabaenaazollaandparticipatesinnitrogenenrichmentofwetland(Singh et al.,2015).

**3. BiotechnologicalApplications:**

Cyanobacteriaproducesecondarymetabolitesincludingpeptides,alkaloidsand phenolic compounds with antimicrobial, antiviral and anticancer properties (Gademann & Portmann, 2008).

**4. EnvironmentalApplications:**

BioremediationStudieshaveindicatedthatcyanobacteriamaybeusefulorganisms forthebioremediationoftoxicmetalsandradionuclides.Theycanalsocatalysethe decomposition of contaminants in wastewater systems (Mishra et al., 2015).
Moreover,abilitytoformbiofilmaddsvalues ofmakingthemalsopromisingfor wastewater treatment.

**5. CyanotoxinsandAlgalBlooms:**

Although manyspecies of cyanobacteria are useful, theycan also be toxic, producing toxins such as cylindrospermopsin,anatoxins, and microcystins that threaten both aquatic lifeand human health(Carmichael 2008).Across theglobe, waterbloomsbycyanobacteriahavebeenestablishedasOneofthe causesforthis.

**Discussion**

Theduality of cyanobacteria as beneficial microorganisms and putative environmental hazards make them interesting items for research.They play an irreplaceable role in the global biogeochemical cycle, especially for carbon and nitrogencycles.Thenaturalnitrogen-fixingcapacityofcyanobacteriacontributesto soilfertilitynot onlydoes this reduces need for synthetic fertilizers, it alsomakes agriculture sustainable.

The biotechnological use of cyanobacteria has gained popularity due totheir renewableandenvironmentallyfriendlynature.Geneticengineeringhasenabled scientists toincreasetheir efficiencyin the production of biofuels, pigments (phycocyanins), and value-added biomolecules.

Excessivenutrientenrichment(especiallynitrogenandphosphorus)fromagricultural runoff, combined with rising temperatures, favours theformation of blooms.These bloomscanreleasepotenttoxinsthataffectthenervous,hepatic,anddermatological systems of animals and humans.Further researchshouldfocus on genetic manipulation toincreaseproductivity, development of biosensors todetect toxins, and sustainable management practices to reduce blooms while maximizing beneficial uses.

## Conclusion

Cyanobacteria are remarkable lifeforms that bridge old and new biospheres. They areanecologicallysignificantpartof oxygenicphotosynthesisinthattheyplayarole inoxygenproduction,nitrogenfixation,andglobalnutrientcycles.In additiontotheir physiologicalproperties,suchorganismsalsoofferpotentiallyvaluableopportunities forbiotechnological,agricultural,environmentalandenergy-relatedapplicationsdue totheir arrayof metabolic activities. Yetthedanger of cyanotoxins andtoxic blooms demandscontinuedstudyandvigilance.Takingtheirfullpotentialintoaccount,while reducing the risks they generate, cyanobacteria can also contribute strongly in achieving ecosystem sustainability and stability.

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