

# ACTINOMYCETES: VERSATILE MICROBES FOR BIOREMEDIATION AND SUSTAINABLE BIOTECHNOLOGICAL APPLICATIONS

## Abstract

Bioremediation uses advanced biotechnology instruments to create a clean environment without contaminants, thereby improving people's lives. For the purpose of biotransformation, degradation and various metabolic processes Actinomycetes are used by a diverse collection of filamentous bacteria. Their diversity of properties enables them to flourish in a variety of environmental conditions and produce primary and secondary metabolites, which are used for practical purposes. Actinomycetes, which include a number of genera, have the potential to biodegrade cities and agricultural waste for useful chemical substances. Actinomycetes in nature perform a number of important environmental actions, which include the breaking up and recyclisation of complex polymer structures or the production of bioactive chemicals. As a consequence, the prospect of cleaning contamination with actinomycetes is fascinating to biotechnologists. This will be accomplished by using the Green Bioremediation method, in which some of the bacteria are brought into contaminated areas with a view to increasing their degradability. It is therefore important to note that Actinomycetes are a very good bioremediation target due to the release of more contaminants into the environment. In order to reduce the detrimental effects of pesticides and metals on biological ecosystems for agriculture, the article discusses how actinomycetes can be used as a bioremediation agent.

**Keywords :** Actinobacteria, Bioremediation, Agricultural waste, Sustainable environment

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## I. INTRODUCTION

Actinomycetes are a prokaryotic organism belongs to subdivision of the gram-positive bacterium phylum. Most of these belong to the Actinobacteridae, a taxonomic family and order Actinomycetes. A high concentration of G+C in this category, i.e. 55mol %+) helps all group members to differentiate from one another. They are filamentous like bacteria and produce two types of branching plant structures: aerial and substrate(R. S. Gupta et al., 2015). It is vital that the plant structure be aerial because its home to a part of the organism capable of making spores. Therefore, they must be considered to be fungi, which are reflected in their name: akitino means ray and mykes means mushroomfungus, so actinomycetes has been called rayfungus. The actinomycetes are the most diverse group of organisms that live in soil, commonly referred to as saprophytes. Geosmin, a stinky substance produced by soil actinomycetes, literally meaning "earth odour". When rain falls, that chemical molecule is contributing to an odor in the air which comes from a period of drought(Lee et al., 2011; Zaitlin & Watson, 2006). The actinomycetes, which help plants develop by decomposing organic soil materials or nitrogen fixing in the atmosphere, thrive on plant rhizosphere soils. Antibiotics, considered to be effective in the fight against plant diseases, are produced. The genus Streptomyces contains a large proportion of soil dwelling actinomycetes(Long et al., 2022). They can make a large number of primary metabolites and extracellular enzymes, which are both cost effective and useful to human beings. The Actinomycetes sp. family, with other species such as *SaccharaPolysporum*, *Amycolatopsis*, *Micromonospora* and *Actinoplanesia*, has produced more than 60% of the bioactive substances intended for agricultural use. A diverse range of bioactive chemicals such as macrolides, benzoxazols, aminoglycosides, polyenes and glycoside antibiotics are produced by Actinomycetes sp. Through the production of enzymes which destroy plant cytomembrane or antifungal substances, Actinomycetes protects roots against rootinfecting fungus. In soil and waste they are also suitable for the degradation of plant, animal or microbe polymers. In order to protect plant roots, the pathway of action by actinomycetes is associated with association, parasitosis, production of ex vivo hydrolytic enzymes and iron competition. They are able to produce a range of extracellular hydrolases such as cellulase, chitinase and other enzymes. These hydrolytic enzymes start the process of physical disintegration of plant cell walls (FCW). It is considered that siderophores caused by soil actinomycetes, particularly those of genus Streptomyces, have an inhibitory effect on the dispersal of phytopathogens in plant rhizosphere soils because they compete for iron(Al-Fadhli et al., 2022; Shi et al., 2019; Tiwari & Gupta, 2014).

## II. STRUCTURE OF ACTINOMYCETES

During the growth of the actinomycetes spp., its spectrum line is monitored by the genus actinomycetes. The endospores of these species arise from a new wall layer formed in the cortex of the reproductive structure, extending to create germtube walls, as opposed to eubacteria (Dhaneesha et al., 2021). The actinomycete spores studied had a two-layered wall, with the inner layer spreading to create the germ-tube wall. It is unclear if this layer was newly created during the germination or how it has been formed by a reconfiguring of latent spore wall. Structural changes that occur as a result of the germination of plant seed are extensively investigated. The majority of fungal species are either part of the two groups 1. Those in which a layer of wall already existing in the latent reproductive structure is expanded to form the germ tube wall 2. Those in which the germ-tube wall is formed by

extending a wall layer already present within the dormant reproductive structure wall(Sharma et al., 2014). Some results are conflicting, because close relatives have been reported to be entirely separate teams. The use of other fixatives may have played a part in this, as permanganate produces lower results than metal elements tetro-oxide or aldehyde. Associations may cause significant alterations in reproductive structure wall layers even during the preparation of specimens. Actinomycetes, if cultivated on the agar surface, branch out to form networks of hyphae which grow both at ground level and beneath it. Horizontal hyphae are those found in the surface, whereas substrate hyphae belong to the bottom of the soil. Septa split hyphae into long cells (20 metric linear unit and longer) with several microbe chromosomes, which are not unusual (nucleoids). They're asexually reproducing aerial hyphae that extend higher than the stratum. Once the motility has been achieved, actinomycetes are predominantly nonmotile; they can only be confined to limbic sporulates(Challa & Neelapu, 2021; Dijksterhuis et al., 2021; Guillaume-Gentil et al., 2022).

### III. NATURE AND HABITAT

Large numbers of Actinomycetes have been discovered in soil, water sediment, air and plants. Actinomycete is an organism living in the soil which makes threadlike strands. In the natural world they can be seen in a lot of different places(Delgado-Baquerizo et al., 2018; Gibbons & Gilbert, 2015). They're a global collection of bacteria that have been discovered in nature around the world. They are mostly soil dwellers, but they can also be discovered in a wide range of aquatic systems and sediment from deep ocean depths such as the Mariana Trench. In harsh conditions, such as Antarctica's cryophilic zone, or even desert soil, they can be found(Solanki et al., 2016).

- 1. Terrestrial Environment:** The population of actinomycetes is highest in the soil's surface layer, and decreases with depth; its strains are present all over the ground. The most extensive and widespread soil organisms are actinomycetes. They spread over the soil, compost and so on with levels from  $10^4$  to  $10^8$  per gram of soil(Ezzariai et al., 2018; Wéry et al., 2017). They are susceptible to acidity/low pH (the ideal pH range is between 6.5 and 8.0) and damp soil conditions(Borhannuddin Bhuyan et al., 2019). They are mesophilic (25-30°C) creatures, and only a few species commonly found in compost and manure are thermophilic (55-65°C) organisms(Bhatti et al., 2017).
- 2. Fresh Water Environment:** The actinomycetes are plentiful at water lakes. They grow very well at 60°C and are usually found in the trash. A representative species of the genera Actinoplanes, Micromonospora, Rhodactin, actinomycetes and therefore endosporeforming thermomyces was identified from fresh environments(Bui, 2014; Zaitlin & Watson, 2006). Most of these actinomycetes are likely to have been washed from the land and have settled in a new habitat. The actinoplanes were found in allochthonous leaf litter washed up on the shores of the lake, and in branches that had been submerged in the streams. The members of the micromonospora species residing in inner lakes and bottom deposits form a real native microbial community. In streams, rivers and lakes the micromonospora fungus will survive as latent propagules(Anandan et al., 2016; Barka et al., 2016).
- 3. Marine Environment:** Due to soil pollution or the presence of algal debris on the surface of the ocean, it is believed that actinomycetes are present in coastal environments(Jacquin

et al., 2019). As there are no clear morphological or chemical differences between terrestrial isolates and marine isolates, it is possible that actinomyces evolved on shore but were adapted to the salt content of ocean waters. Rain or river water may carry the actinomyces spores from land to sea. On the other hand, we find bound native actinomyces in deep sediments. Moreover, a bimodal distribution in the applicable depth has been identified for almost all quantities of actinomyces collected from sediments offshore at shallow or deeper sampling sites (Mitra et al., 2008). It is therefore assumed that actinomyces deriving from the marine environment came into existence in Terrestrial habitats.

- 4. Extreme Environments:** In harsh environments, actinomyces can be identified. Alkalophilic actinomyces The main species are *Streptomyces* and *Nocardia* residing on basic soils with a pH between 10 and 12 near mineral springs (Hussein et al., 2018). Acidophilic actinomyces isolated from acidic forest and humate soils, in particular actinomyces and micromonospora, obligatory psychrophilic actinomyces isolated from acidic forest and humate soils, In the same way that meteorite crater water samples were extracted from silt, thermophilic actinomyces spp. had been grown with an optimal growth temperature 9 to 12 C and did not grow at temperatures above 18° C (Davids et al., 2017). Among the few temperature tolerant actinomyces found in dry soils of the Mojave Desert are *microbispha*, *Nocardia*, *Microtetraspha*, *Amyclaptosis*, *Actinomadura* and *Saccharothrix* (Kaveri & Aluva, 2018; Nithya et al., 2020).

#### IV. ACTINOMYCETES CLASSIFICATION

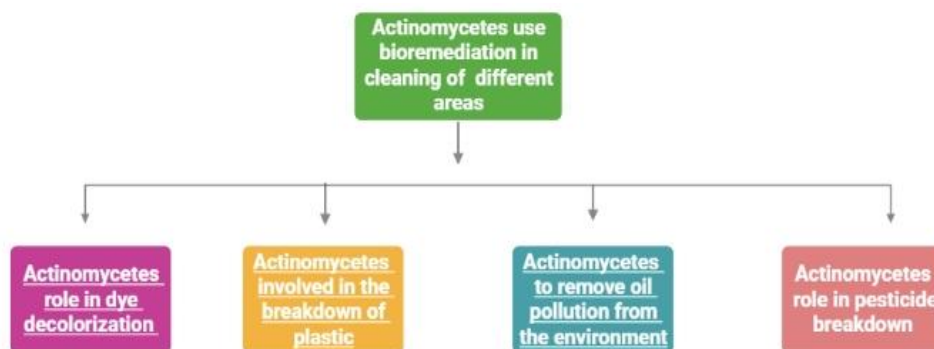
There are five volumes in a book entitled The Bergey's Guide to Systematic Bacteriology 2nd Edition for the classification of Actinobacteria, which include internationally recognised names and bacterial descriptions. There has been a change in the classification of Actinobacteria. Six categories of phylum actinobacteria, namely Actinobacteria, Acidimicrobia, Coriobacterium, Nitrospirae, Rubrobacteria and Thermoterrae are broken down in volume 5 (Guerrero et al., 2001). Kingdom: They're unicellular organisms with a single cellular structure, which is what makes them kingdom bacteria. They belong to this realm, and are present in various habitats all over the world where some of these species can cause a low or very high level of sickness for humans. Since they are gram positive bacteria, peptidoglycan layer is likely to be present in the cell wall. Phylum: They belong to the phylum Actinobacteria, as a member of this phylum Actinomyces are said to be Gram-positive with having the highest content of "G + C" in the DNA structure. It can be found in the aquatic and terrestrial areas, which allows it to exhibit nutritional versatility at a higher level. Mycelium is also being produced by them. Subclass: they belong to a class of Actinobacteria, which is extremely diverse and contains many types of organisms that are present in most habitats. Actinomyces belong to the order Actinomycetales; these are diverse, and may be found in both terrestrial and aquatic habitats. They're aerobic organisms and gram positive organisms. As they grow in the form of filamentous structures, there are various characteristics associated with their growth. This is made up of various suborders, e.g. Actinomycineae, Corynebacterineae, Catenispora, and Micrococcieneae. As they are capable of showing a wide range of nutritional characteristics, they can be distributed throughout the world. It is therefore possible to live in any environment and become a competitor for the organisms that are existing within it (Sharma et al., 2014; rani et al., 2022., Alkhajari, et al., 2019).

## V. ACTINOMYCETES IN BIOREMEDIATION

Actinobacteria are being researched for their potential in bioremediation due to the growing concern of industrial contamination of soil and water systems. Current methods for removing pesticides and toxic chemicals are not always effective, especially for organic compounds. Actinobacteria are widely dispersed in soil and water, fulfilling the function of environmental balance by degrading their environment with both biological and inorganic compounds. Some Actinobacteria species use pesticides as carbon sources, degrading and returning anoxic base elements and compounds. Additionally, researchers have discovered *Streptomyces* strains capable of producing tyrosinase enzymes that help remove phenols from various pesticides polluting water sources (Naghdi et al., 2023).

Environmental pollution is a significant concern due to urban growth and industrial development. Textile effluents contain synthetic and complex aromatic molecules that are harmful to the environment. These dyes are carcinogenic and mutagenic, posing a problem for aesthetics and causing carcinogenic effects on biotic components. Physicochemical treatment has decolorized textile dye effluents, but it does not completely remove them (Hassaan et al., 2017). Actinomycetes have been shown to degrade textile dyes, but a systematic study on their use in MB remediation is lacking. Polycyclic aromatic hydrocarbons (PAHs) are the main source of marine pollution, originating from the petrochemical industry and spillage of petroleum products from ships. PAHs are persistent environmental recalcitrant compounds and resist degradation due to their thermodynamic stability (Kucuksezgin et al., 2012). Despite their high cost, physicochemical methods are expensive, and phenanthrene toxins in contaminated water are not eliminated. Microbial degradation is an acceptable way to mitigate phenanthrene in water. Actinomycetes are a dominant group of degraders, with various reports on the degradation of individual pollutants like pesticides and PAHs. The potential degradation of phenanthrene and alachor is known to be caused by isolated strains of *Streptomyces* sp. (Shekhar et al., 2014).

Actinomycetes have potential applications in the removal of toxic metals from the environment, such as pesticides. Many Actinobacteria species, particularly *Streptomyces*, are tolerant to heavy metals, making them ideal for metal bioremediation. *Streptomyces* species are particularly interesting due to their ability to tolerate large concentrations of toxic metals and their unique ability to precipitate, bioaccumulate, and adsorb these metals (Mani et al., 2014). Studies have shown that *Streptomyces* species can absorb metals like Cu (II) and Cd (II), and both *Streptomyces* and *Amycolatopsis* species can bioaccumulate Pb, Cd, Cr, and Zn (El Baz et al., 2015).. The order Actinomycetales has a strong capacity to metabolically process heavy metals, making it a vital and underexplored area that warrants further research and application (Jagannathan et al., 2021). Actinomycetes are used for the treatment of a contaminated site as an environmental scrubber. The widespread use of Actinomycetes has been demonstrated figure 1

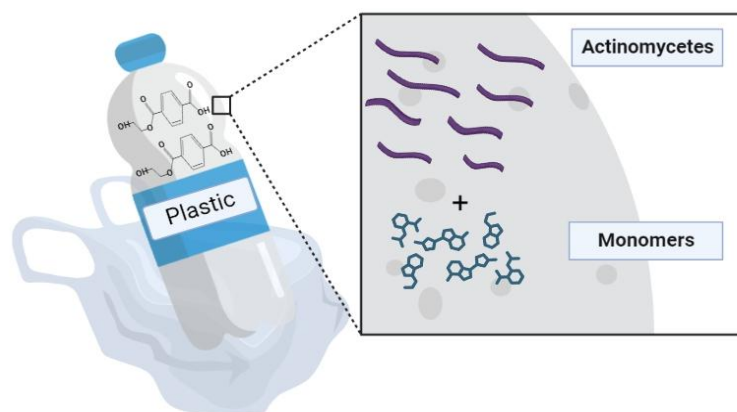


**Figure 1:** The effect of actinomycetes in different areas

- 1. Actinomycetes Role in Dye Decolorization:** Textile industries heavily use synthetic dyes and colorants, leading to significant wastewater production, reducing dissolved oxygen concentration and causing anoxic effects on aquatic ecosystems and toxic effects on flora and fauna. The release of colored effluents into rivers and lakes further contributes to this issue. Additionally, photosynthesis is reduced due to the hindered diffusion of light in water bodies. The most significant concern for the environment is the color of textile wastewater, which is difficult to remove in waste water treatment plants (kant et al., 2011 , Uddin et al., 2021 ).Azo dyes, watersoluble reactive dyes, are widely used in various industries, including textile, pharmaceutical, paper, food, and cosmetics. However, their environmental pollution is toxic, carcinogenic, and mutagenic. The degradation of dyes depends on dye concentration and growth, with enzymes responsible for steady degradation activity being lupin peroxidase, laccase, and tyrosinase (El-Batal et al., 2017). Azo dyes, consisting of various reactive groups, are the most commonly used type. Chemical oxygen demand and biological oxygen demand are increased by reactive dyes originating in dyeing industries, affecting the pH of water bodies, causing severe problems for plants, animals, and humans. The presence of dyes in water is visible and affects the transparency, beauty, and appearance of water. Actinomycete strains colorize effluents containing reactive chemicals, such as anthraquinone, phthalocyanine, and azo dyes, and reaction dyes are absorbed by the strains cells during decolorization (Dutta et al., 2022).
- 2. Actinomycetes involved in the Breakdown of Plastic:** It is possible to generate large-molecule weight organic polymers with different hydrocarbons and petroleum derivatives. Plastic is a term given to these polymers. The Greek term "Plastikos" is the place where the English word "plastic" derives (Painter & Coleman 2009). Plastics can be defined as polymers that move when heated and may be sculpted into molds. Except for biodegradable bioplastic, the vast majority of plastic items are produced from petrochemicals (Tolinski et al., 2011).Chloride, oxygen, hydrogen, carbon, silicon, and nitrogen constituents of plastic. 64% of all commercial plastic is polyethylene, having the general formula  $C_nH_2$ . Plastics are used for packaging and also for lots of other things, which include the manufacturing of agricultural films, nappy packaging and fishing nets. Throughout the world, plastics are crucial to all sectors of the economy. Plastics use ensures that they are in high demand in areas that are noticing significant development, like agriculture, building and construction, health, and consumer goods. Without plastics, no one would do their jobs. Plastics, the cornerstone for multiple businesses, are utilized

in the manufacture of many items we use on a daily basis, like military items, sanitary items, tiles, plastic bottles, faux leather, and other local items. Food products, medicines, detergents, and cosmetics are all wrapped using plastics (Bell et al., 2018).

Long chain polymers are produced by synthesis from petrochemicals and chemical processes to produce plastics, corrosion inhibiting materials, strong, reliable and cheap polymers (Hayes et al., 2022). Plastics polymer are not considered poisonous at room temperature, but when heat is emitted from plastics it has an adverse effect on the environment and humans' health. Plastics are also available in a number of forms such as nylon, polycarbonate, polyethyleneterephthalate, polyvinylidene chloride, Urea, polyamides, polyethylene, propionate, polystyrene, polytetrafluoroethylene, polyurethane and polyvinyl chloride (Saviello et al., 2016). Naturally occurring microorganism contributes to degradation of organic materials such as plastics and plastic waste. Styrene is possibly carcinogenic to humans that cause mammary gland tumors in animals (Rudel et al., 2007). The bacteria that depolymerize plastic are found in a variety of materials, namely landfill leachate, organic matter, sewage solids, forest soil, soil from agriculture, crop soil, weed field soil, roadside sand and pond sediment. Biodegradation is the term for any physical and chemical alteration of a material brought on by the activity of microorganisms (Warscheid & Braams, J. 2000). Degradation of natural and manmade plastics via actinomycetes bacteria is mentioned in Figure 2.



**Figure 2:** Plastic bioremediation by actinomycetes

Actinomycete strains from the *Streptomyces* and *Micromonospora* genera have been identified and evaluated for their capacity to degrade poly (ethylene succinate) (PES), poly(-caprolactone) (PCL), and poly(-hydroxybutyrate) (PHB) from the Touchien River in Taiwan (Hoang et al., 2007). The natural polymer poly (3-hydroxybutyrate-co-3-hydroxyvalerate, or PHBV) has been extracted from municipal sewage sludge by the soil burial techniques and has been breakdown by *Streptoverticilliumkashmirensis* AF1. Purified PHBV depolymerases extracellular enzymes released by *Streptoverticilliumkashmirensis* AF1 decompose PHBV film (Shah et al., 2007). The thermophilic actinomycetes strains *Actinomadura*, *Microbispora*, *Streptomyces*, *Thermoactinomyces*, and *Saccharomonospora* reported for degrading poly (ethylene succinate), poly (-caprolactone), and poly (-hydroxybutyrate) (Tseng et al., 2007). With relevance to environmental challenges in solid-waste management, polylactic acid (PLA),

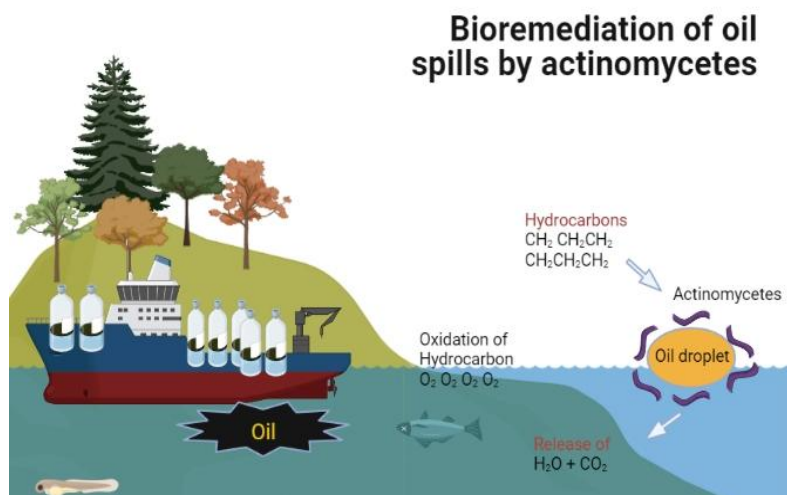
a biodegradable plastic, is seeing extensive use in food packaging. *Streptomyces sp.* KKU215 is a novel actinomycete that decomposes polylactic acid packaging, and it was used for the manufacture of biomass as a sole source of carbon (Devanshi et al., 2021). The potent strain has been used to stimulate PLA packaging biodegradation. Poly(L-lactide) degrader strain from *Amycolatopsis* strains has a tendency to consume degradation intermediates like poly lactic acids (Shah et al., 2008). Actinomycete *Amycolatopsis sp.* strain HT-6 has been found to disintegrate poly(tetramethylene succinate) (PTMS) and poly(tetramethylene carbonate) (PTMC) (Pranamuda et al., 1999). Actinomycetes strain thoroughly quickly and efficiently decompose 150 mg of polycarbonate PTMC film in a liquid culture, which leads to a significant yield of growth of cells.

- 3. Actinomycetes to Remove Oil Pollution from the Environment:** Because of the adverse event or deliberate release of toxic substances into the environment, industrial activity contributes to environmental contamination. Without an effective regulatory framework to control the environmental pollution, in developing countries there is a rapid proliferation of anthropogenic activity and industrial development (Panayotou et al., 2016). There are significant numbers of contaminated areas worldwide, and these represent a potential threat to human health. Chemicals solvents, paints, pharmaceutical residues and waste products, industrial byproducts from petroleum hydrocarbons, the release of other pollutants which have a negative effect on the environment are among the major pollutants. In today's environment, petroleum hydrocarbons are common, such as chemical compounds and fuel. The uncontrolled release of these compounds has a negative impact on water resources and soil. Petroleum hydrocarbons can be released into the soil from leaking storage tanks, disposal ponds of waste petroleum products in refineries, pipeline ruptures, drilling operations, and transportation processes (Aisien et al., 2015). Pollution from oil can contaminate the environment, posing a grave threat to it.

In the areas of contamination, cleaning strategies should therefore be pursued. For the last few years, efforts to repair or redevelop these places have been explored as part of a range of International Efforts (Simone, et al., 2004). Crude oil is a substance that exists naturally, black, sticky liquid comprised of a complex group of polymers with a range of molecular weights and 30% polyaromatic hydrocarbons (PAHs). PAH compounds such as naphthalene, acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene and acenaphthylene are pollutants nominated by the United States Environmental Protection Agency as priority PAHs (Hong & Luthy et al., 2007). Environmental samples are evaluated for the most frequent biological contaminants with associated health risks. On the other hand, it can be found in environment that are teratogenic, mutagenic, and carcinogenic, that include cooked vegetables, oils, fats, and grains. Thereby, minimising PAHs is a topic of considerable interest (Giuliani et al., 2020). Focus has been put on metabolic pathways in crude oil which contains multiple PAHs. Currently, the most effective and sustainable bioremediation approach employs bacterial and fungal strains to target a specific PAH either aerobic or anaerobic conditions. Additionally, an innovative approach will be essential for achieving crude oil dearomatization for dispensing an alternative in many PAH inhabitants (Hidalgo et al., 2020). Introducing actinomycetes in soil bioremediation is a pleasant concept. They use a wide range of carbon sources, break down complex polymers such lignin, and have some of the beneficial characteristics of fungi, such as mycelial growth, development of spores, drought resistance, and



extracellular enzyme synthesis (Sankaran et al., 2010). Fig. 2 illustrates the general method by which actinomycetes participate in the bioremediation of oil spills.



**Figure 2:** Actinomycetes are involved in bioremediation of oil spills

The soil microflora that are capable of transforming PAH are the nocardioformactinomycetes of the genera *Mycobacterium*, *Rhodococcus*, and *Gordona*. These distinctive actinomycetes, *Sphingomonaspaucimobilis* BA2, *Gordona* sp. BP9, and *Mycobacterium* sp. VF1, were suited to mineralizing PAH with up to four rings and thriving on anthracene, pyrene, or fluoranthene as their sole carbon source. Actinomycetes were capable of converting phenanthrene isolated in two industrial sites with substantial amounts of polycyclic aromatic hydrocarbons (PAH) pollutants and roadside debris (Omoni et al., 2021; Nazari et al., 2022). Potentially appropriate actinomycetes for the remediation of polycyclic aromatic hydrocarbons in liquid culture and rising soil have been *Rhodococcus* and *Gordonia*. When phenanthrene can be produced on a medium including glucose, hexadecane, and rapeseed oil at 300°C, biosurfactant or phenanthrene is deteriorated. Although *Rhodococcus* sp. DSM44126 was capable of decompose phenanthrene as the sole source of carbon and anthracene, *Gordonia* sp. APB and *G. rubripertincta* developed emulsion from rapeseed oil. In a mechanical engineering workshop, an entirely novel anthracene-degrading actinomycete was identified in hydrocarbon-contaminated soil. *Kocuriarosea*, *Kocuriapalustris*, *Microbacteriumttestaceum*, and *Nocardiafarcinica* were all utilized in the investigation of the appropriate fluorescence process for evaluating the PAHs biodegrading capacity of actinobacteria (khalil Ibrahim et al., 2020). Haloalkalitolerantactinomycetes were also used. The stimulation and emission fluorescence has been used in the fluorescence methodology to evaluate the decomposition of PAHs and estimate the residual anthracene material (Sharma et al., 2022). A specialized and affordable examine to decreasing the mineral content of petroleum products was biodesulfurization (Mortezae et al., 2021). For microbial isolation and character development to determine the ability to modify organosulfur compounds common in various kinds of fossil fuels, scientists utilized DBT as a model polyaromaticsulphurheterocycle. However, biotransformation's occurred through metabolic degradative pathways or through employing it as a single source of

sulphur throughout growing, along with biocatalytic desulfurization for the selective removal of polyaromaticsulphurheterocycles (Ahmad,et al., 2023). With the assistance of several copies of essential dsz genes present in the cell, *Rhodococcuserythropolis* I-19 was utilised to desulfurize alkylated dibenzothiophenes (Cx-DBTs) from hydrodesulfurized middle-distillate petroleum (MD 1850) (Nassar et al., 2021). The most significant problem with the environment, sulphur oxide emissions from burning fossil fuels, lead to acid rain and air pollution. Microbes breakdown organosulfur compounds, such as dibenzothiophene (DBT) (Tahir et al., 2021). Three dsz genes, dszA, dszB, and dszC, have been identified in gene clusters of the dsz in *Rhodococcuserythropolis* IGTS8 (Keshav et al., 2022). *Rhodococcuserythropolis* IGTS8's dsz Promoter and related regulatory regions underwent genetic study. Dibenzothiophene (DBT) gets transformed by dsz gene clusters into 2-hydroxybiphenyl and sulfite in genetic studies. DBT can be the sole source of sulphur with *Rhodococcus*. as oil needs to be wiped up, use biosurfactants. *Arthrobacter* species strain MIS38 produced arthrofactin, an innovative biosurfactant. One of the most effective lipopeptidebiosurfactants, arthrofactin is useful in eliminating oil (Adetunji et al., 2021; Bjerck et al., 2021).

- 4. Actinomycetes Rolein Pesticide Breakdown:** Chemicals referred to as pesticides are used to regulate and eliminate bug populations at acceptable levels. Literally, the word "cide" means to kill. Pesticides are made up of numerous parts that have many different uses (Hill et al., 2008). However the designation is generated by merging the suffix with the pest names. A lot of pollutants have settled in the environment as a result of the rapid population growth. Due to this, new technologies have to be used to reduce or eliminate these xenobiotics from the environment. Landfills, recycling, pyrolysis, and other earlier technologies have been used to remove them from the environment, but these techniques also had adverse environmental effects and generated hazardous intermediates. These methods proved out to be expensive as well as hard to execute alongside pesticides (Nandanwar et al., 2016).

Over two million metric tons of pesticides have been utilized around the world, with Europe using 45%, the USA 24%, and the rest of the world using 25%. Most concerning is Asia, where China, subsequently followed by Korea, Japan, and India, utilizes the highest percentage. India consumes 0.5 kg/hectare, mainly because of the country's warm, humid weather (Yadav et al.,2015). The use of various insect repellents for high-yield crops has been made simpler owing to the green revolution. India ranks 12th worldwide and is the leading producer of Insecticides in Asia (Mozumdaret al.2014, Graham et al., 2001).

Pests brought about a 30% loss in yields from agriculture in the agricultural economy of India. As a result, there is an increasing demand for insecticides, fungicides, pesticides, and herbicides to protect crops (Popp et al., 2013., Cooper et al.,2007 ). Organophosphorus pesticide monocrotophos (MCP) is poisonous and frequently utilized in India to protect economically important crops. *Arthrobacteratrocyaneus* MCM B-425 and *Bacillus megaterium* MCM B-423 were able to metabolize MCP to an extent of 93% and 83%, respectively, by the biomineralization of Monocrotophos. MCP is decomposed by a process of metabolism which includes the enzymes phosphatase and esterase to generate carbon dioxide, ammonia, and phosphates. Metabolite, that is a not identifiable

molecule, is created as an intermediate metabolite alongside valeric or acetic acid and methylamine ( Dash et al., 2007, Mishra et al.,2013, Chaudhari et al., 2023).

From Saltpan Soil, a novel *Streptomyces* spp. VITDDK3, halo-tolerant Actinomycete has been identified and screened. The stain has been studied for its potential to synthesize bio surfactants which exhibit heavy metal resistance, and neutralize colors. *Streptomyces* spp. VITDDK3 had been predicted to annihilate 98% of the azo dye and Reactive red 5B. The lead compound will be developed on a large scale exploiting the new strain. Tetrachloro-para-hydroquinone was transformed by *Rhodococcus chlorophenicus* to 1, 2, 4-trihydroxybenzene through the employing of microbial enzymes in a reductive aromatic dechlorination process (Arul Jose et al., 2011).

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