Energy and the environment are two important concerns of modern society. Rapid industrialization has resulted in cumulative hazardous effects on the environment. The industries produce a variety of highly toxic organic wastes. Such toxic wastes are often resistant to natural biodegradation and therefore persist in the environment. Aromatic compounds are common organic toxicants present in industrial effluents. Phenol represents the major organic pollutant in the waste-waters emanated from the industries. Phenol and phenolic compounds come to the natural water resources from the effluents of a variety of chemical industrial such as coal refineries, phenol manufacturing, pharmaceuticals and industries of resin paint, dying, textile wood, petrochemical and pulp mill (Fleeger et al., 2003; Mukherjee et al. 1990; Mukherjee et al., 1991). The concentration of phenol in industrial effluents varies; the lower permissible limit of phenol in the discharged effluent is set as one milligram/liter (Satsangee and Ghosh, 1990). Phenol and its derivatives are the cause of growing concern as water pollutants, particularly because of its toxic effects on the aquatic flora and fauna of the water bodies into which the effluent has been discharged and hence can ultimately affect the ecological balance (Ghadi and Sangodkhar, 1995).

The increasing awareness of the environmental problems caused by industrial and agricultural pollution has created a demand for progressively more sophisticated detection methods. A potentially inexpensive and simple way to reduce the cost of contaminant detection is to use biosensors derived from the genetic systems of bacteria that use organic contaminants as growth substrates. Whole-cell bacterial biosensors have the potential to provide inexpensive, easy-to-use methods for detecting industrial pollution. A whole-cell bacterial biosensor capable of detecting a wide range of pollutants can be created by placing a reporter gene under the control of
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an inducible promoter. Expression of the reporter gene provides a measurable response when the appropriate transcription activator protein interacts with a pollutant molecule to signal a particular environmental condition. Operons are the machinery that has helped certain microorganisms to survive in polluted environments. The operon in turn consists of genes that code for proteins that help bacteria in extruding the toxins out of the cell. The expression of the genes of the operon is tightly regulated by the presence or absence of specific chemical compounds in the cells. This chemical induced expression can be utilized in developing biosensing systems for the specific chemical compound (which is known as analyte). The biosensing strategy employed is based on the genetic fusion of the reporter gene to the regulatory gene of the operon induced by its respective analyte. Thus, when the induction takes place in the presence of the target analyte, the reporter gene is co-expressed along with the other genes of the operon. Consequently, the concentration of the inducer can be quantified by measuring the signal generated by the reporter protein. Operons carrying genes required for metabolism of pollutants (such as phenol) in some bacterial species (*Pseudomonas* sp. and *Acinetobacter* sp.) are controlled through inducible promoters recognized by σ-associated RNA polymerase. Transcription directed by these promoters occurs when a regulatory protein detects the presence of the pollutant for the catabolic enzymes.

The use of whole cells as reporter sensors has been used in a wide range of applications including toxicity testing, drug evaluation, bio-prospecting, testing biocompatible materials and environmental monitoring. Each application detects the response and signal transduction of cell to external signals. The thriving field of synthetic biology makes use of such signalling networks and regulatory elements of living cells to
engineer and reprogram organisms to achieve novel beneficial properties. Whole cell biosensors have sparked an intense research activity around the globe with a great promise of delivering a step change towards a bio-economy.

The present work is aimed to generate the novel regulatory proteins from the operon system (of selected pollutants) through mutagenesis in pollutant-sensing domain without disturbing the DNA binding or transcription activating functions. Modifications in the sensor domain can allow the creation of novel proteins that may respond to a range of pollutants, which remain undetected by the wild-type protein. Such proteins have the potential to extend the pollutant target range of biosensors beyond that based on natural systems.