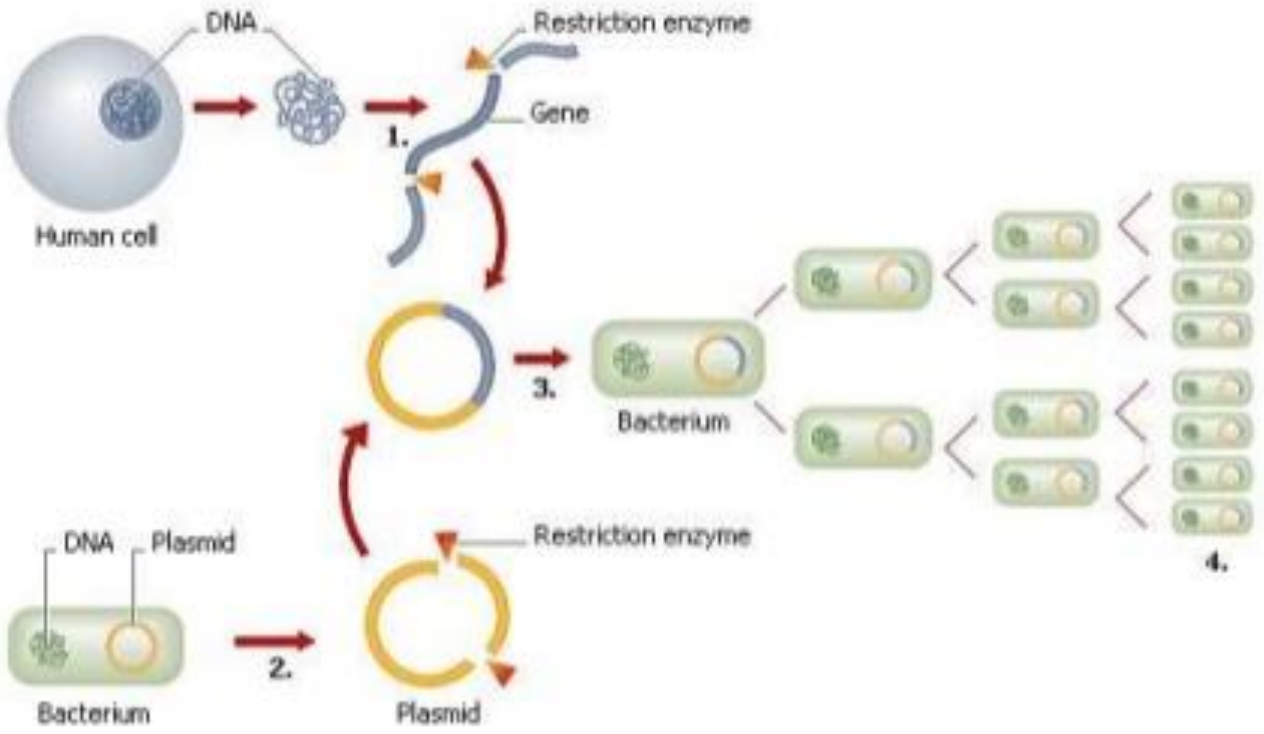
APPLICATION OF GENETICALLY ENGINEERED MICROBES IN BIOREMEDIATION

FROM

SOS IN ENVIRONMENTAL CHEMISTRY

What is genetically Engineered Microorganism?

These are the **microorganisms** which genetic makeup has been changed through biotechnology process and use for betterment of human life.



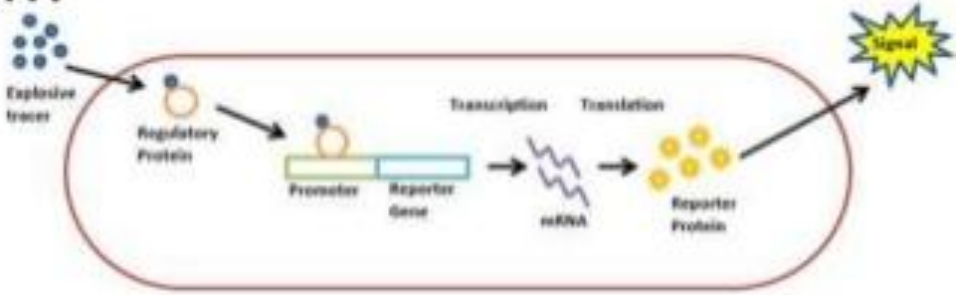
Way of genetically engineered microorganism for pollution control

Involves the use of microorganisms genetically modified by recombinant DNA technology.

GEM is a powerful tool in creating environment friendly alternatives for products and processes

For e.g. :

- Production of enzymes
- Amylose free potato
- Indigo producing bacterium

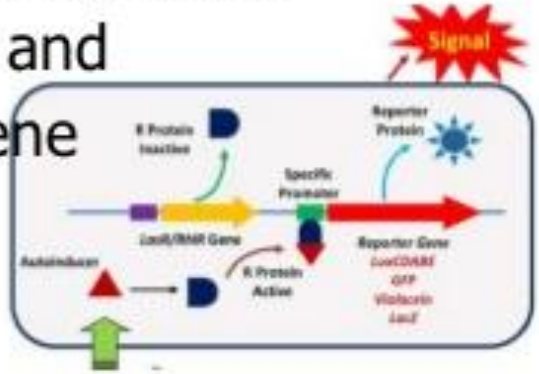


Genes responsible for control of environmental pollutants

Genes responsible for control of environmental pollutants, for example, toluene, chlorobenzene acids, and other halogenated pesticides and toxic wastes have been identified. For every compound, one separate plasmid is required. It is not like that one plasmid can degrade all the toxic compounds of different groups.

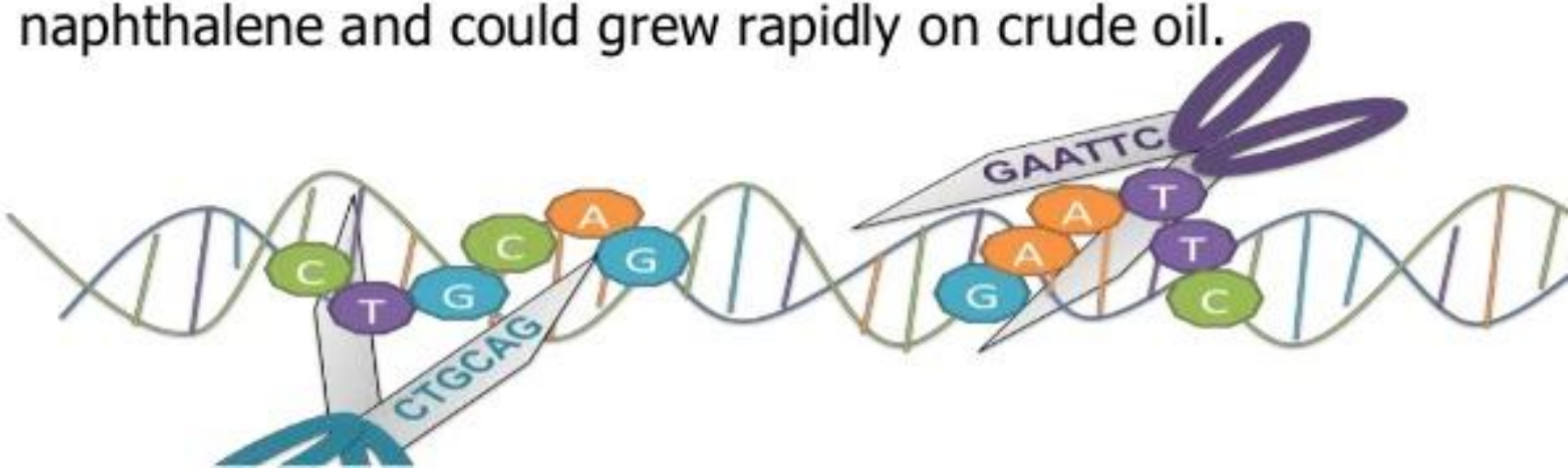
The plasmids are grouped into four categories:

1) OCT plasmid which degrades, octane, hexane and decane;
2) 2) XYL plasmid which degrades xylene and toluenes,
3) 3) CAM plasmid that decompose camphor and
4) 4) NAH plasmid which degrades naphthalene



Use of genetically engineered microorganism for pollution control

- A multiplasmid-containing *Pseudomonas* strain capable of oxidizing aliphatic, aromatic, terpenic and polyaromatic hydrocarbons.
- *Pseudomonas putida* that contained the XYL and NAH plasmid as well as a hybrid plasmid derived by recombinating parts of CAM and OCT developed by conjugation could degrade camphor, octane, salicylate, and naphthalene and could grew rapidly on crude oil.



Super bug (Pseudomonas putida)

- Superbug“ is Genetically Engineered bacterium, Pseudomonas putida that can degrade hydrocarbons found in petroleum wastes.
- It is a multiplasmid strain developed by using genetic engineering technique.
- Super bug is used to treat oil spills as a measure to control oil pollution.
- Petroleum products contain cycloalkenes (octane), napthenes, xylene, tolune and aromatic hydrocarbons.
- The mass culture of superbug is sprinkled over paddy straw and the straw is dried in shade.
- The bacteria inoculated straw can be stored for more than an year to treat oil spill.

Use of genetically engineered microorganism for pollution control

Control of environmental pollutants by genetically engineered microorganisms are focused on genetically engineered bacteria using different genetic engineering technologies:

Pathway modification, modification of substrate specificity by *Comamonas testosteroni* VP44 .

- The application of genetic engineering for heavy metals removal has aroused great interest. *Alcaligenes eutrophus* AE104 (pEBZ141) was used for chromium removal from industrial wastewater.
- The recombinant photosynthetic bacterium, *Rhodopseudomonas palustris*, was constructed to simultaneously express mercury transport system and metallothionein for Hg^{2+} removal from heavy metal wastewater

Use of genetically engineered microorganism for pollution control

- For polychlorinated biphenyls degradation, chromosomally located PCB catabolic genes of *R. eutrpha A5, Achromobacter* sp. LBS1C1, and *A. denitrificans* JB1 were transferred into a heavy metal resistant strain *R. eutropha* CH34 through natural conjugation.
- Genetic engineering of endophytic and rhizospheric bacteria for use in plant associated degradation of toxic compounds in soil is considered one of the most promising new technologies for remediation of contaminated environmental sites.
- Many bacteria in the rhizosphere show only limited ability in control of organic pollutants.

Obstacles associated with the use of GEM in bioremediation applications

- The major problem encountered in successful bioremediation technology pertains to hostile field conditions for the engineered microbes.
- The molecular applications are mainly confined to only few well characterized bacteria such as *E. coli*, *P. putida*, *B. subtilis*, etc.
- Other bacterial strains need to be tried for developing the engineered microbes.
- The specific characteristic of open biotechnological applications has clearly necessitated the development of engineered bacterial strains to meet the new challenges.

Obstacles associated with the use of GEM in bioremediation applications

- The main concern is to construct GE bacteria for field release in bioremediation with an adequate degree of environmental certainty.
- Efforts should be made to examine the performance of engineered bacteria in terms of their survival, potential of horizontal gene transfer, which may affect the indigenous microflora within a complex environmental situation.
- Pollution control by GEM processes have been designed for specific purpose under the laboratory conditions, ignoring the field requirement and other complex situations.

Conclusion

- GEM is used to improve the pollution control capabilities of environment.
- Nevertheless, there are many risks associated to the use of GEM in the field.
- Whether or not such approaches are ultimately successful in bioremediation of pollutants may make a difference in our ability to reduce wastes, eliminate industrial pollution, and enjoy a more sustainable future.