

Biomagnification

- The phenomenon of progressive increase in the concentration of the Xenobiotic compd, as the substance is passed through the food chain is referred to as **biomagnification** or **bioaccumulation**
- Example- insecticides (DDT) → plants & m.o. → birds and fish → animals & man

Types of Bioremediation

1. *In situ* Bioremediation- microbial degradation occurs at the site of contamination. Done to clean up oil spillages, beaches, soil, ground water.
 - May be an inherent property/engineered
 - 😊 cost- effective. Minimal exposure to public
 - 😊 Sites remain minimally interrupted

 - 😞 Time consuming process
 - 😞 Progress depends on environmental and seasonal conditions

2. *Ex situ* Bioremediation- waste or toxic material collected from the polluted site and bioremediation carried out in designed places

😊 Better controlled and efficient

😊 completed in a short period

😞 Costly process

😞 Site of pollution highly disturbed

😞 Maybe a disposal problem when process is complete

Metabolic Effects of microorganisms on xenobiotics

1. Detoxification- toxic → non-toxic
2. Activation → non toxic → toxic
3. Degradation → complex → simpler
4. Conjugation → forming complexes with other compds. Simple → complex. Very rare

Types of reactions in biodegradation

1. Aerobic Biodegradation- monooxygenases act on aromatic and aliphatic hydrocarbons. Dioxygenases hydrolyse only aliphatic compds
2. Anaerobic Biodegradation-degradation process very slow. Cost effective since it doesn't involve continuous supply of O_2 .
3. Sequential Biodegradation:In this, both aerobic and anaerobic processes take place sequentially

Biodegradation of Hydrocarbons

- HC are usually pollutants from oil refineries and oil spills.
- Slow process due to their insolubility
- Requires a consortium of microorganisms to complete degradation
- Organisms involved: *Pseudomonas*, *Corynebacterium*, *Arthrobacter*, *Mycobacterium*

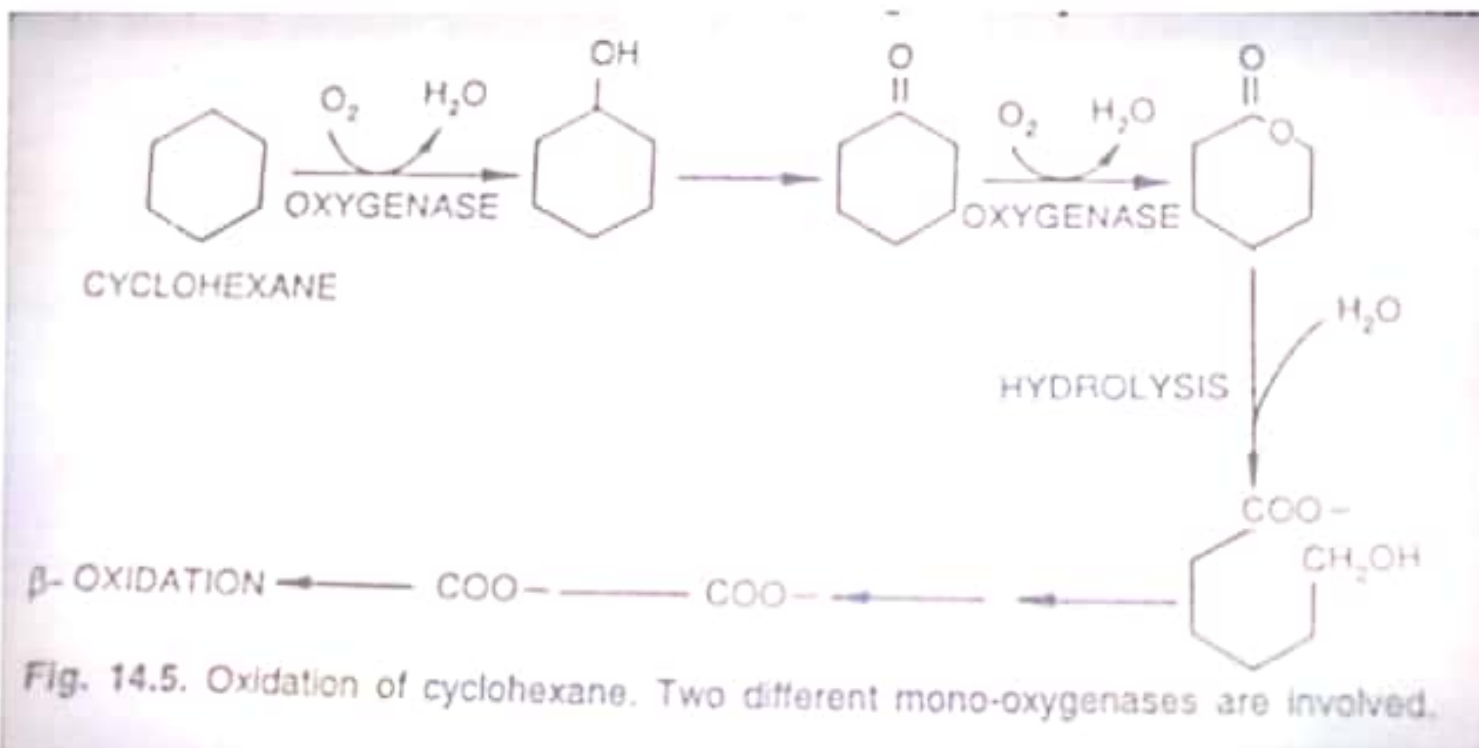


Fig. 14.5. Oxidation of cyclohexane. Two different mono-oxygenases are involved.

Biodegradation of pesticides and herbicides

- Used regularly to contain various plant diseases
- Contributed to green revolution
- Examples: propanil, prothiopham, atrazine, picloram, dichlorodiphenyltrichloroethane (DDT), monochloroacetate (MCA), glyphosate (oragnophosphate)
- Most pesticides are toxic and recalcitrant in nature

- Most commonly used herbicides and pesticides are aromatic halogenated compounds(usually chlorinated)
- The rate of degradation of halogenated compounds is inversely related to the number of halogen atoms.
- Dehalogenation is the first step for detoxification. It is catalysed by the enzyme dioxygenase

Biodegradation of PCBs

- Used in pesticides, in electrical conductivity of transformers, in paints and adhesives
- Inert, very stable and resistant to corrosion
- They have been implicated in cancer, damage to various organs and impaired reproductive function

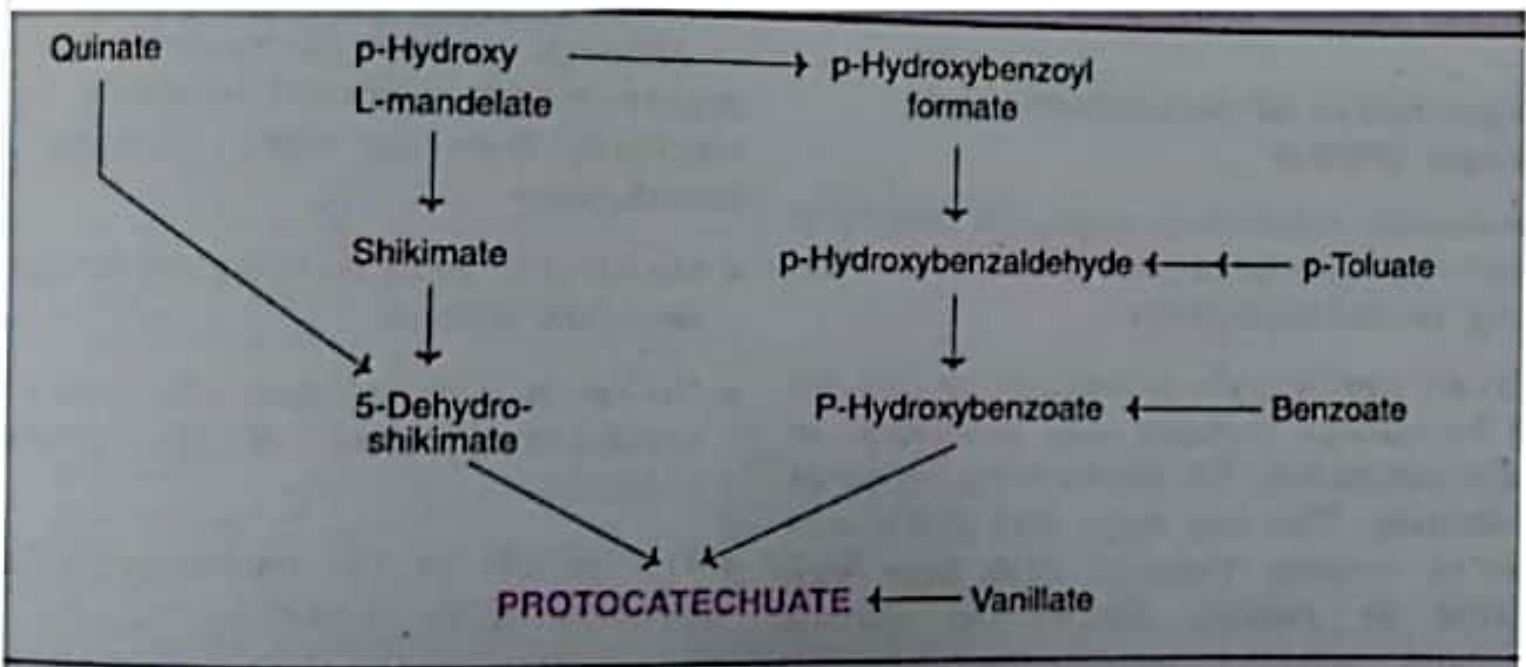


Fig. 59.2 : Bioremediation of certain organic compounds by bacteria to produce protocatechuate.

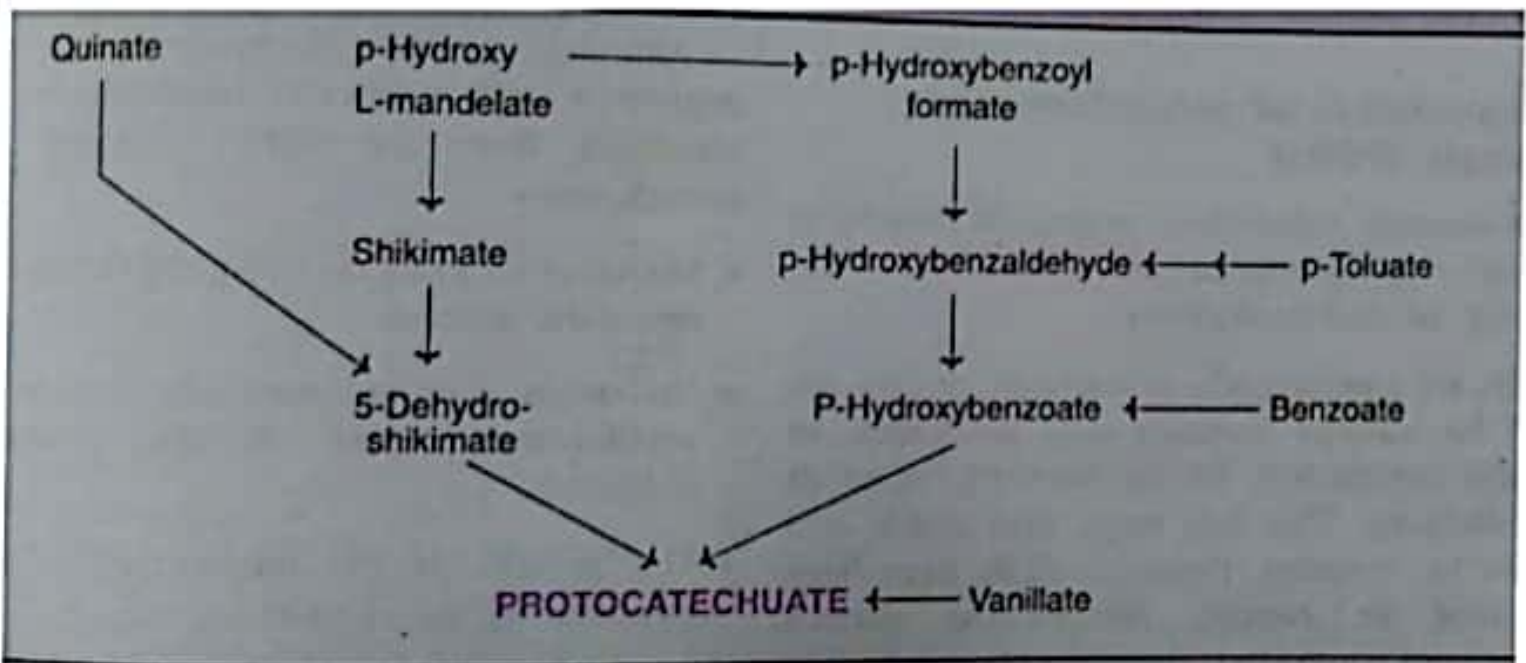


Fig. 59.2 : Bioremediation of certain organic compounds by bacteria to produce protocatechuate.

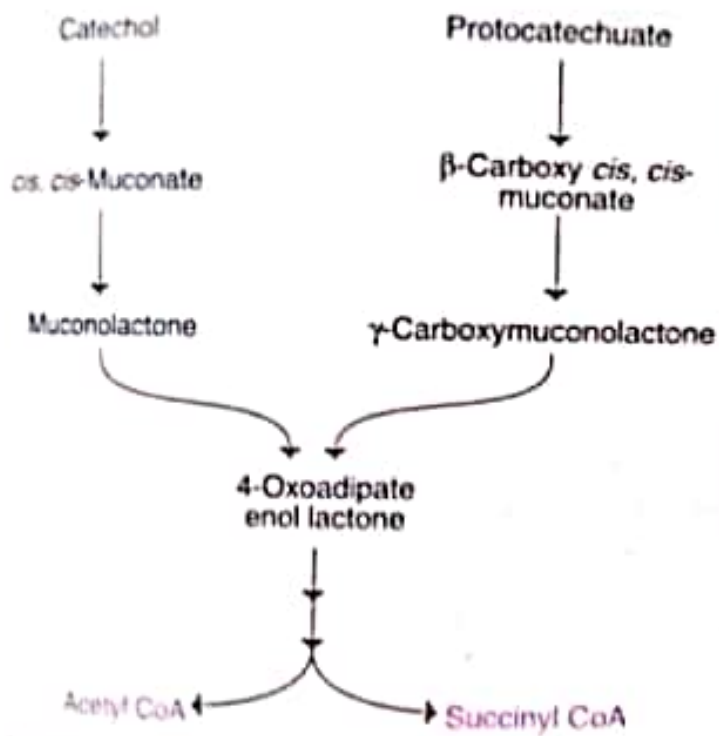


Fig. 59.3 : Conversion of catechol and protocatechuate to acetyl CoA and succinate by ortho-cleavage pathway.

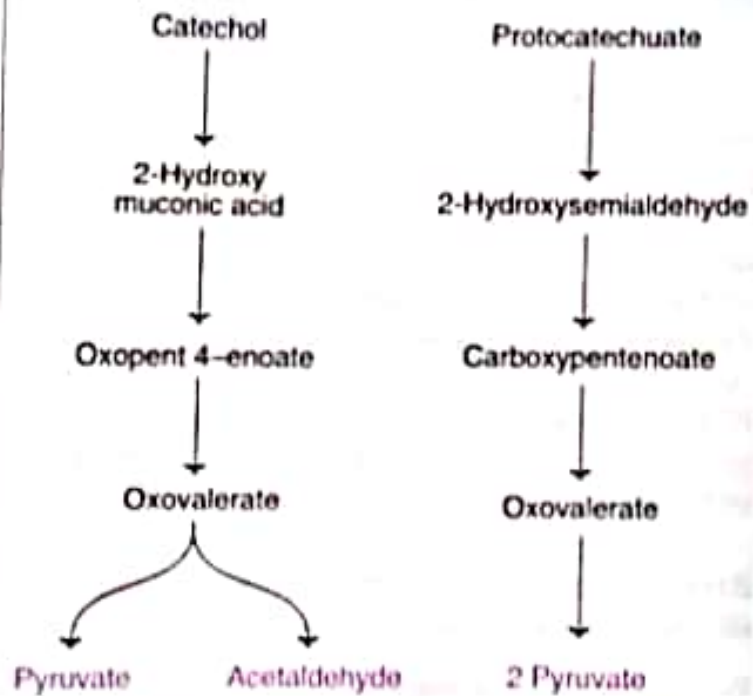


Fig. 59.4 : Conversion of catechol and protocatechuate to pyruvate and acetaldehyde by meta-cleavage pathway.

Biodegradation of PCBs

- Used in pesticides, in electrical conductivity of transformers, in paints and adhesives
- Inert, very stable and resistant to corrosion
- They have been implicated in cancer, damage to various organs and impaired reproductive function

- PCBs accumulate in soil sediments due to high hydrophobic nature and bioaccumulation potential
- Recently, methods have been developed for aerobic and anaerobic oxidation using *Pseudomonas*, *Alkaligenes*, *Corynebacterium*

Limitations of Bioremediation

- Slow
- One m.o. does not work for all xenobiotics
- Growth of m.o. may be inhibited by the xenobiotic compound
- Some xenobiotics get adsorbed on to the particulate matter of the soil and become unavailable for biodegradation