PETROLEUM MICROBIOLOGY

(MCB 410)

BIOGENESIS OF FOSSIL FUELS WITH EMPHASIS ON THE ROLE OF MICRO-ORGANISMS.

What is Fossil Fuel ?

Examples: coal, crude oil, natural gas.

Importance of fossil fuels in various industries including transportation, industrial activities, and petrochemical production.

Theories of Origin of Fossil Fuel

- Biogenic theory
- Abiogenic theory

Biogenic theory

Process of Formation

- Diagenesis
- Catagenesis
- Metanogenesis

Abiogenic Theory

- An overview of the theory
- Inorganic hydrocarbon formation
- Mantle-derived hydrocarbon

Role of Microorganisms

- Importance of microorganisms in the biogenic theory of fossil fuel formation.
- Anaerobic microorganisms involved in the decomposition of organic matter.
- Production of biogenic methane gas during decomposition processes.

PETROLEUM PROSPECTING AND SECONDARY RECOVERY

- Definition of petroleum prospecting and secondary recovery.

- Importance of these techniques in maximizing oil extraction from reservoirs.

Traditional petroleum prospecting

vs

Microbial petroleum prospecting

Secondary Recovery Techniques

- Definition of secondary recovery: methods used to increase oil production from existing reservoirs.

- Common secondary recovery techniques:

- Water flooding

- Gas injection (carbon dioxide, nitrogen)

- Enhanced oil recovery (EOR) methods (thermal, chemical, microbial)

METHANOGENESIS AND METHANOTROPHY

Methanogenesis

- Definition: the biological production of methane by microorganisms known as methanogens.
- Overview of methanogen metabolism:
- Anaerobic process
- Production of methane from organic compounds such as acetate, hydrogen, and carbon dioxide
- Occurrence in environments lacking oxygen, such as wetlands, rice paddies, and the digestive systems of animals

Methanogenesis Pathways

Description of the three main pathways of methanogenesis

Hydrogenotrophic methanogenesis:

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

Acetoclastic methanogenesis:

$$CH_3COOH \rightarrow CH_4 + CO_2$$

Methylotrophic methanogenesis:

$$CH_3OH \rightarrow CH_4 + H_2O$$

Environmental Implications of Methanogenesis

- Role of methanogenesis in carbon cycling and greenhouse gas emissions.

- Contribution of methanogens to methane production in anaerobic environments.

Methanotrophy

Definition: the biological consumption of methane by microorganisms known as methanotrophs.

- Overview of methanotroph metabolism:
- Aerobic process
- Utilization of methane as a carbon and energy source
- Occurrence in environments with sufficient oxygen, such as soils, sediments, and aquatic systems

Methanotrophy Pathways

Description of the main pathways of methanotrophy:

Aerobic methane oxidation: $CH_4 + O_2 \rightarrow CH_3OH \rightarrow$ formaldehyde $\rightarrow$ formate $\rightarrow CO_2$

Anaerobic methane oxidation: $CH_4 + SO_4^{2-} \rightarrow HCO_3^- + HS^- + H_2O$

Environmental Implications of Methanotrophy

- Role of methanotrophy in mitigating methane emissions and reducing greenhouse gas concentrations.

- Contribution of methanotrophs to methane oxidation in various ecosystems.

- Potential applications of methanotrophy in bioremediation and methane bioconversion processes.

EFFECT OF OIL SPILLAGE ON MICROBIAL ACTIVITIES IN AQUATIC AND TERRESTRIAL ECOSYSTEM

- Oil contamination as a global menace
- The Nigerian oil spillage situation
- Adverse effect on the well being of the environment
- Importance of studying microbial activities in oil contaminated environment

Impact on microbes in aquatic ecosystems

- Alteration of microbial community
- Change in metabolic pathway and pattern
- Impact on the biogeochemical cycle
- Alteration of microbial community interaction

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Implications on the aquatic life in the water and soil health and fertility in the terrestrial environment.

BIODETERIORATION AND BIOTRANSFORMATION OF HYDROCARBON

- What is biodeterioration of hydrocarbon?
- Mechanisms of biodeterioration
- Identity of spoilage organisms
- Economic implication of biodeterioration in the petroleum industry
- Preventive measures

Biotransformation

- What is biotransformation of hydrocarbon?
- Relevance in environmental clean up and bioremediation
- Mechanisms of biotransformation
- Factors influencing biotransformation
- Applications and implication in the industry