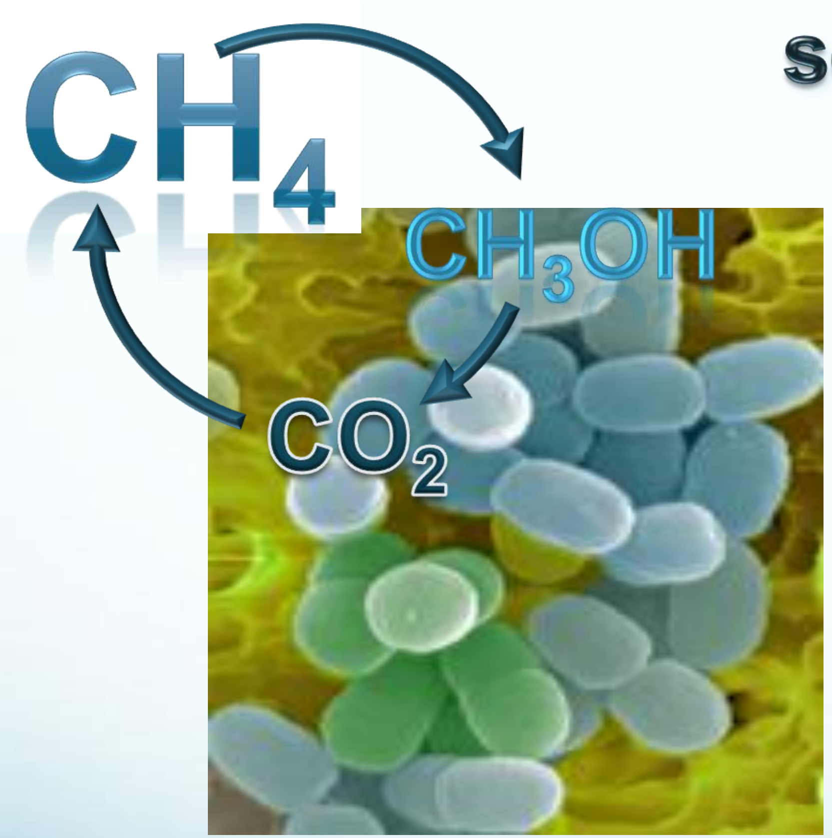
Biological methane sensing



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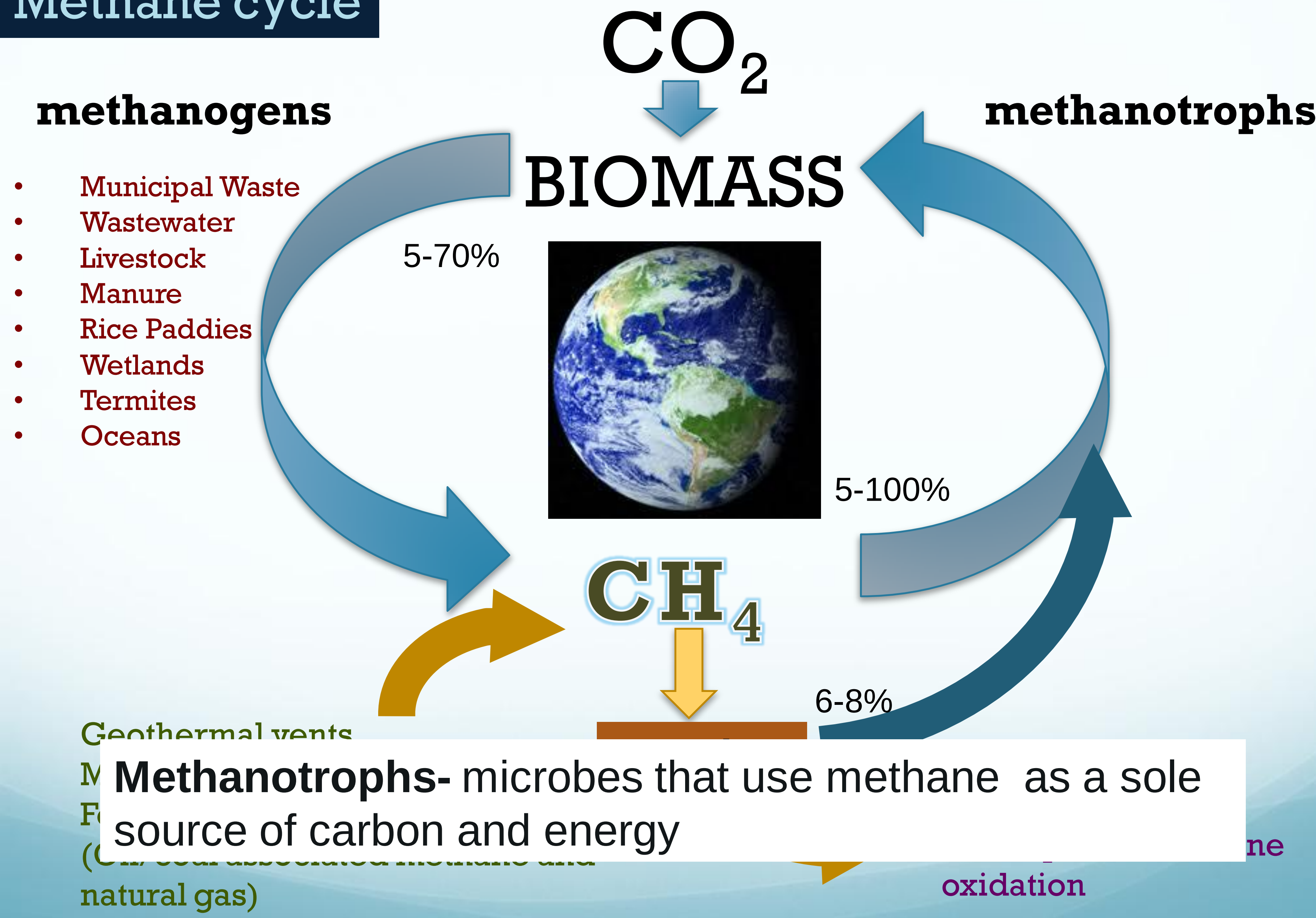
ARPA-E workshop 2013

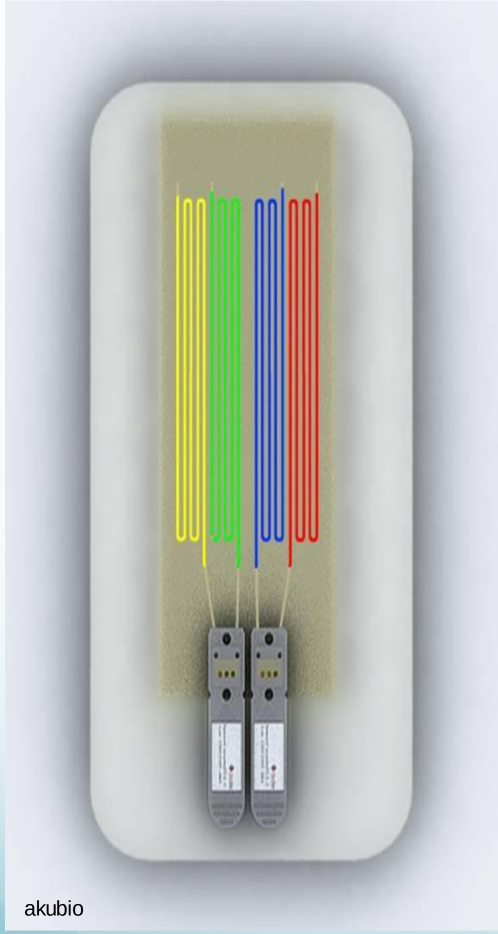
Methane cycle



Methanotrophs- microbes that use methane as a sole source of carbon and energy

Methane : Bio-sensing

Methane = cell growth/activity



1. Microchips: detection of microbial cells using molecular approaches (DNA, RNA, proteins, lipids, small molecules)

2. Whole cell biosensors:
   a. respiration (O_2-consumption);
   b. color change (carotenoids/melanin, fluorescent proteins)
   c. bioluminescence (luciferase)

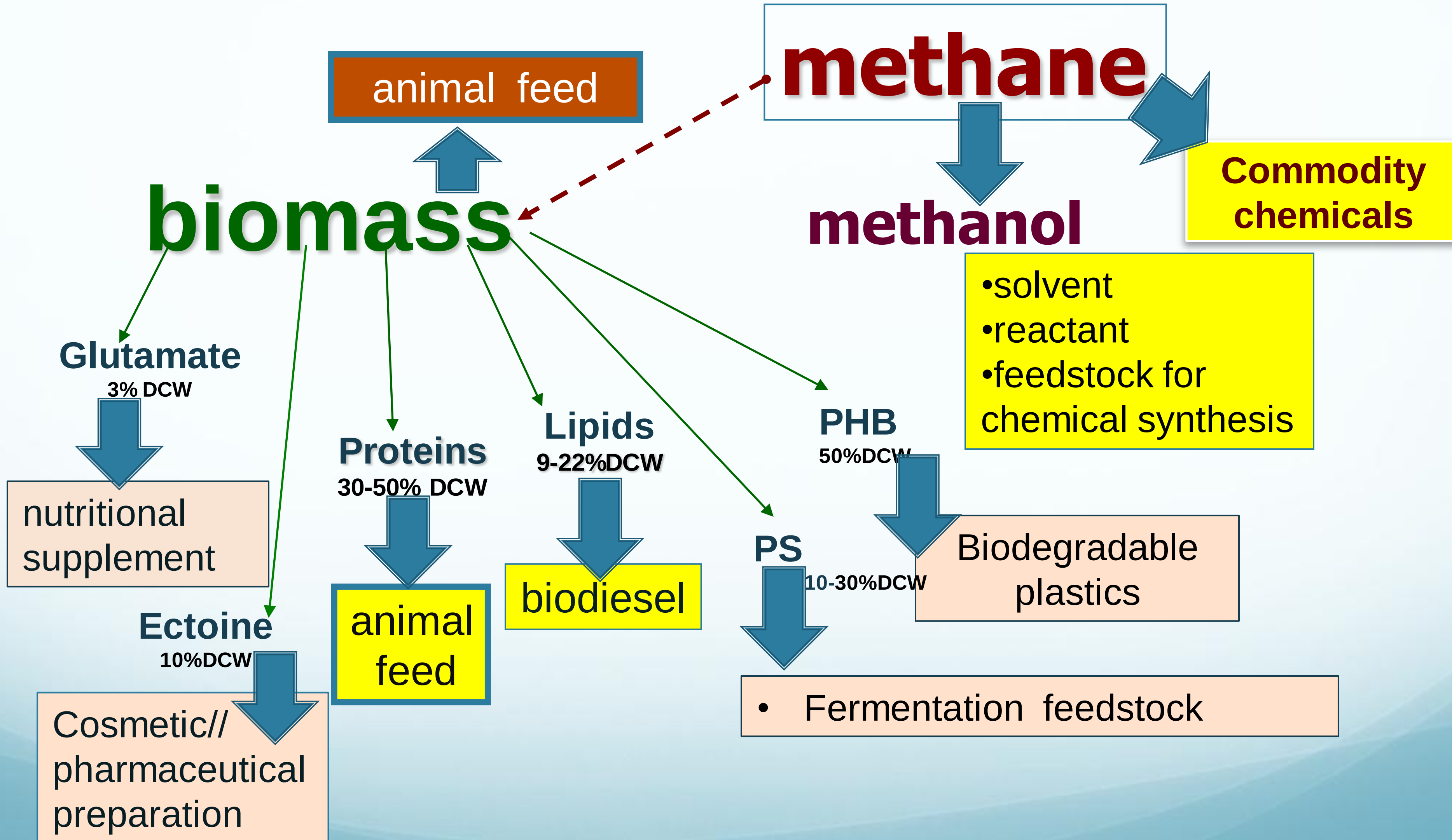
3. Enzymes-based sensors

Methane mitigation: Potential applications

Established technology

Early stage technology development/Small scale demonstration

Proposed/Potential applications



PHB, poly-hydroxybutyrate; PS polysaccharides

Methane: Biological Conversion

Advantages

- **Efficient** (CCE=62%)
- **Low T /Pressure**
- **Selective toward methane**
- **Scalable**
- **Low-complexity** (few modules, easy to assemble/disassemble)
- **Low environmental impact**
- **Biomass -** animal feed (SCP)

Limitations

- **Strains not robust**
  - ✓ Less studied
  - ✓ Unstable (spontaneous lysis/loss of viability)
  - ✓ Sensitivity to $C_{2\text{-}4}$ alkanes
  - ✓ Contamination (grow better in consortia)
- **Processes mass-transfer limited for methane**

Recent progress

Robust cultures/Microbial consortia:

- High rate of methane oxidation
- Low K_s for methane
- Simple cultivation requirements
- Stay active at a wide range of chemical parameters

Enabling new approaches

- ✓ Genomes/Genetic tools
- ✓ Metabolic/genetic alterations