Joint Graduate Seminar
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Magnetotacitic bacteria: Bacteria with compasses

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Magnetotacitic bacteria: Bacteria with compasses

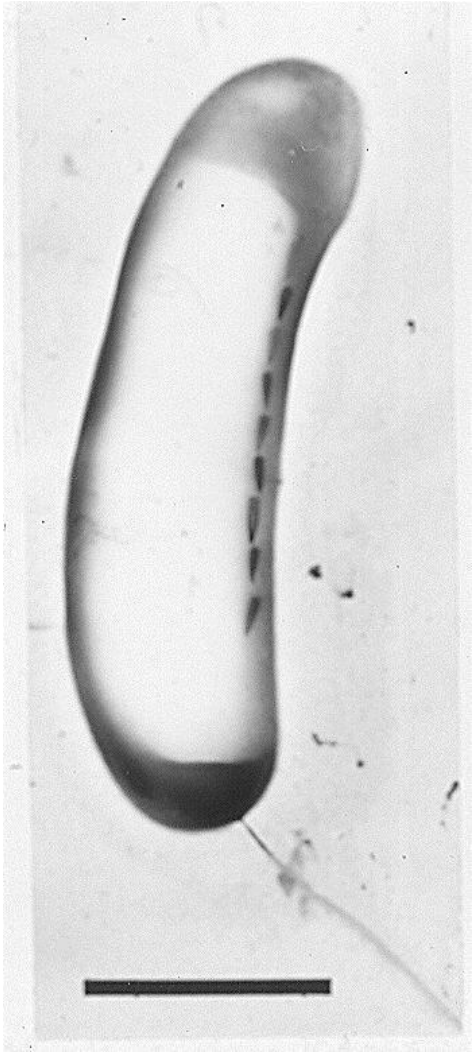
Introduction

Magnetism

- Response to magnetic field
- Magnetoception
  - Animal perceive direction and location
- Magnetotaxis
  - Bacteria coordinate movement

What is Magnetotactic bacteria?

- 1970s by Richard Blakemore
- Align along the magnetic field
- Heterogeneous group
- No taxonomic meaning

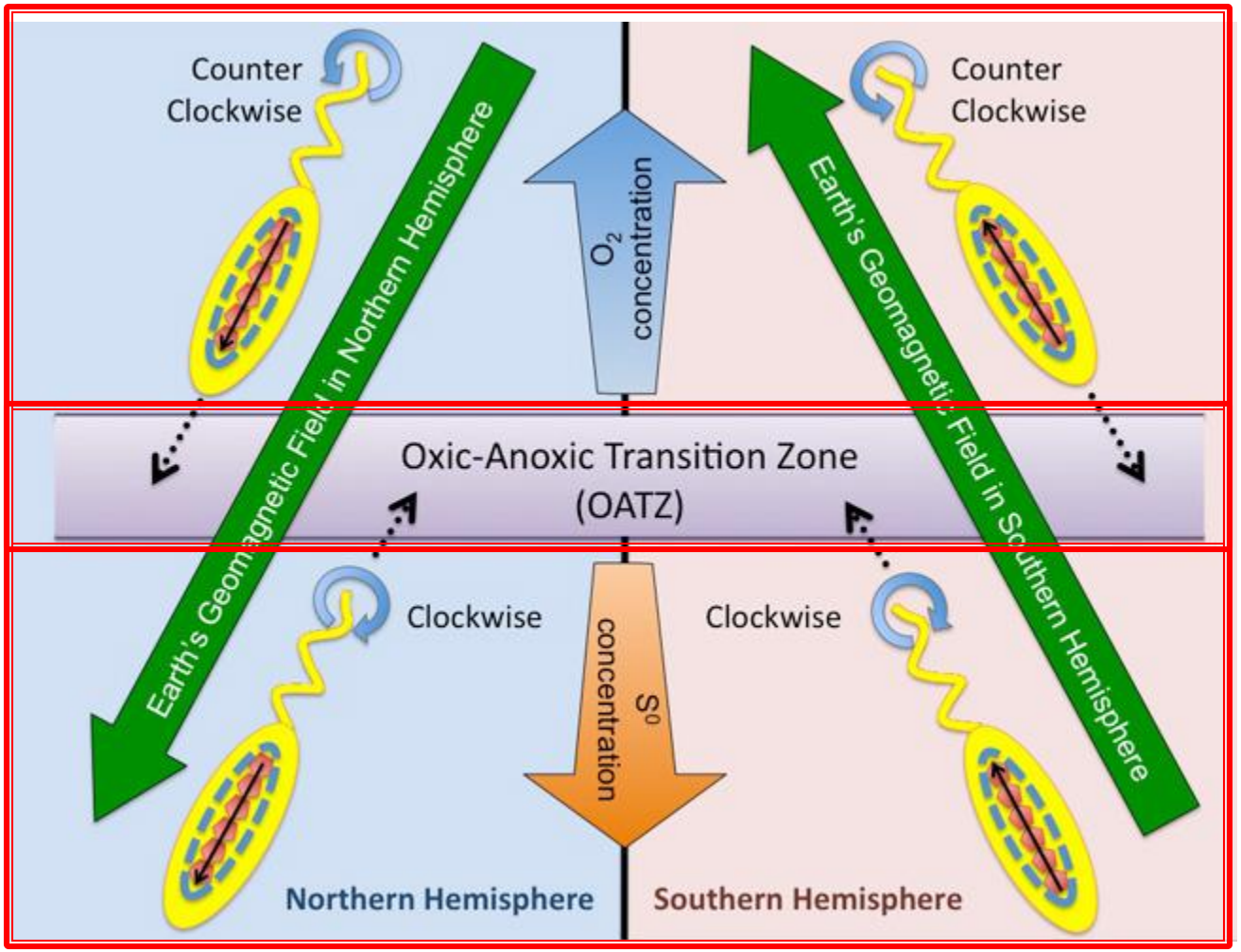


Magnetotactic bacteria

- Gram –ve with flagella
- Anaerobes/ microaerophiles
- Only in oxic-anoxic interface
  - Hard to culture at lab
- *Magnetospirillum magnetotacticum*

Magnetotaxis???

- Alignment
- **North pole** : North seeking
- **South pole** : South seeking
- Swim downward (Inclined geomagnetic field)
- **Magnetoaerotaxis**



Why Magnetotaxis?

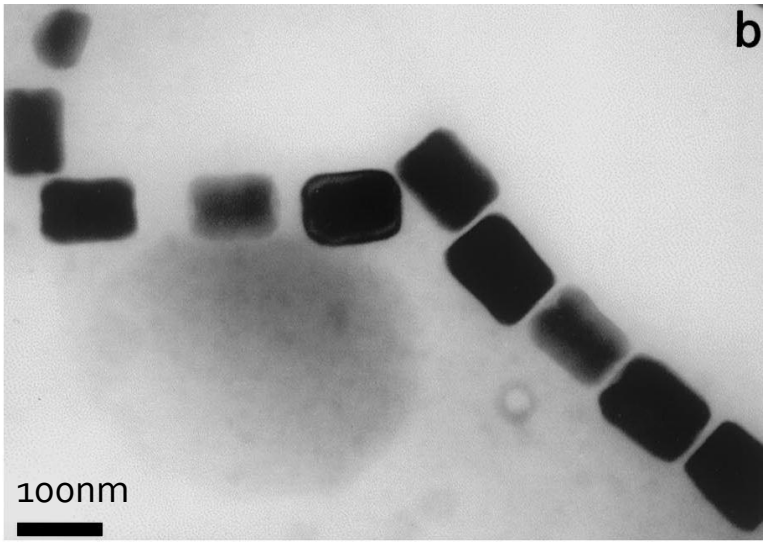
- Search for optimal conditions
- Compare to chemotaxis
  - 3D search → 1D search problem?

What makes magnetotaxis?

Biology of MTB

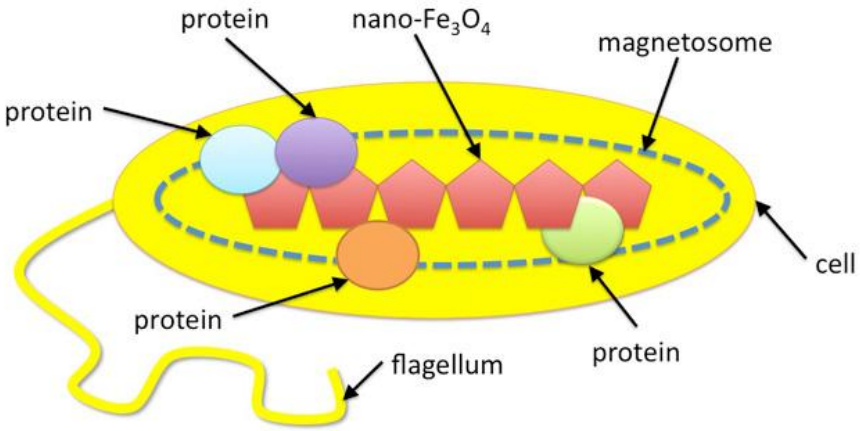
Magnetic Crystal in MTB

- Magnetite (Fe_3O_4)
- Extremophilic bacteria:
  - Gregite (Fe_3S_4)
- Different in species
- Regular shape
- Nano-sized: (35-150nm)
  - Single domain ~> Single magnet



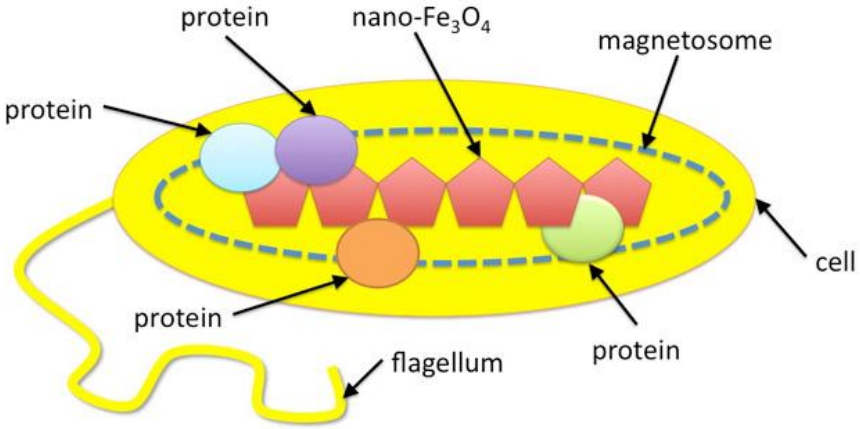
Magnetosome

- Membranous prokaryotic organelles
- Specific proteins
- Contains magnetite
- Species specific



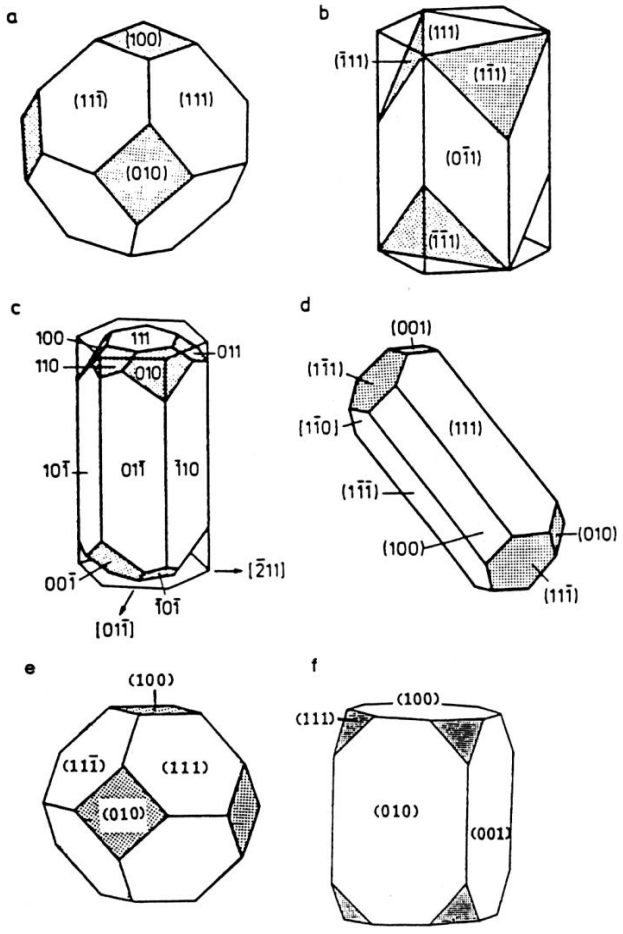
Magnetosome

- Chains to form a long magnet
  - Maximize the magnetic dipole moment
- Passively orient the bacteria and facilitate movement



Biomineralization

- Well controlled
- Formation, Iron uptake
- Compartmentation
  - Regulate biochemical pathways
  - Gradient
  - Proteins



A small magnetism, Big attraction?

Applications

Applications of Magnetism

- Different areas:
  - Geological, Biomedical, Commercial
- Convenient
  - Non-laborious, cheap and highly scalable
- Less adverse effect
- Still proof-of-theory stage

Magnetic Separations

- Metals from waste water

- MTB:
- Bioaccumulation
- Low intensity magnetic
- Quick and Easy

Magnetic Separations

- Biomolecules

- Isolated magnetosome:
- Coat specific antibodies
- Large S/A ratio
- Less mechanical stress

Biomedical

- Regular drug administration
  - Non-specific distribution
- Nano-scale drug carrier
  - Delivery vehicles
  - Passive, Physiological, Specific ligands, Magnetic
  - Achieve high local concentration

Magnetic-targeted Drug Carrier

- Fe_3O_4 as a core
- Magnetic-targeted
- Hyperthermia

- Propensity of congregating
- Difficult to control shape and size

Magnetosome vs Synthetic

- High chemical purity
  - Less defects
- Narrow size range and shape
  - Better control of particles
- Membrane bounded
- Multifunctional
- Less toxicity effect

Adverse effect?

- Low toxicity
- Impurity
- Membrane from bacterial origins
- Immunotoxcity

Summary

- Bacteria that align along the magnetic field
- Biomineralization to form magnetite
- Membrane bounded magnetosome
- Superiority of magnetosome

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Thank you!

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