Microbiology Day 1

① Bacterial Memory and Bet-hedging

- What is bet-hedging?

A strategy to diversify phenotypes—resulting in selective advantage for survival under fluctuations in the environment.

- In order to respond quickly, bacterial memory helps — triggering bet-hedging at the population level

> **Bacterial memory**
> enables bacterial cells to respond to current conditions based on prior experience.

For example, bacterial memory plays an important role in the development of antibiotic resistance.

- Interestingly, bacterial memory lasts from a few seconds to a few generations; bacterial adaptation has a much longer timescale.

More about bet-hedging

- In bet-hedging, isogenic populations randomly diversify their phenotypes, resulting in fitness tradeoff — maladapted individuals with lower reproductive success, but capable of surviving better in changed environments

- exploitation of gene-regulatory networks such as operon and regulon – to switch phenotypes
- phenotypic switching

  random
  (stochastic switching)
  ↳ random, hence faster and more advantageous in unpredictable environments (no adaptive lag)

  → response to environmental cues
  (responsive switching)

② Culturable Microbial Forms

- bacteria that can be grown in laboratory — only small fraction of total existing diversity in nature

- How do we know of these unculturable bacteria?

Molecular phylogeny — analysis of biomolecules like DNA sequences or proteins → prediction of phylogenetic trees through analysis of housekeeping genes like 16SrRNA (1600 nucleotides) → similarity search of unidentified organisms

How do we characterise mixed bacterial communities?

DNA extracted from biomass of original sample
↓
16S rDNA amplified by PCR using primers (conserved reg)

↓

cloned in a plasmid vector to create library

↓
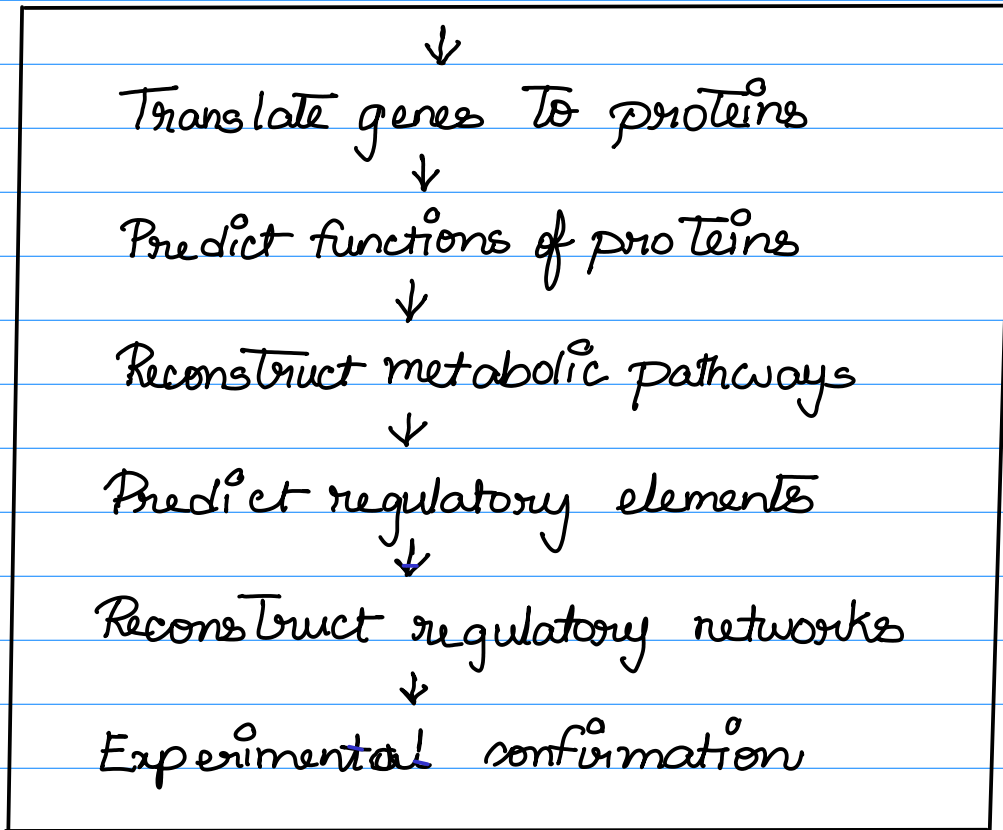
checked with database to reveal uncharacterised portions

Characteristics of 16SrNA that make it useful:

1) conserved & variable regions with diff. degrees of variation
2) moderate length – easily sequenced
3) found in all bacteria

Bacteria

Eukaryota

Archea
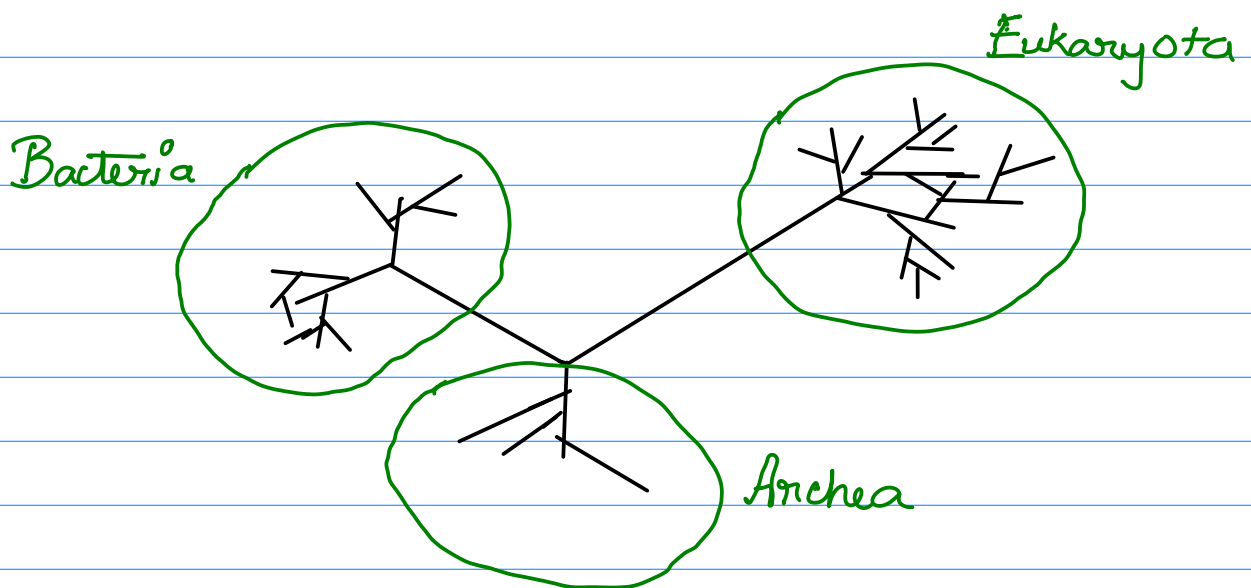
③ <u>Reading the prokaryotic genome map</u>

Determine complete DNA sequence

↓

Predict genes

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        ↓
Translate genes to proteins
        ↓
Predict functions of proteins
        ↓
Reconstruct metabolic pathways
        ↓
Predict regulatory elements
        ↓
Reconstruct regulatory networks
        ↓
Experimental confirmation
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④ Minimal bacterial cells

- contain genes only necessary and sufficient conditions to ensure continuous growth under ideal laboratory conditions
- helps to define minimal set of genetic functions essential for life
  ↳ modularise each process in the cell
        ↓
    design a cell from those molecules
            ↳ build complex cells by adding new functions

⑤ **Levels of Classification**

Taxon (operational Taxonomy Unit)

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species

What do we mean by a bacterial species?

↳ A collection of microbial strains that share many properties and differ significantly from other groups of strains