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

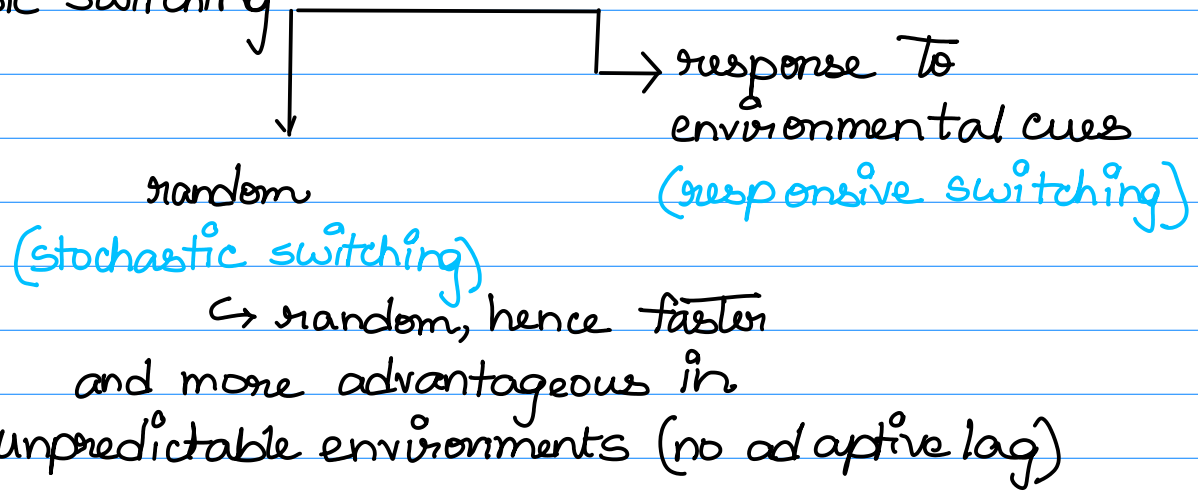
For example, bacterial memory plays an important role in the development of antibiotic resistance.

- 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



(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 16S rRNA (1600 nucleotides) → similarity search of unidentified organisms

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How do we characterise mixed bacterial communities?

DNA extracted from biomass of original sample

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16S rDNA amplified by PCR using primers (conserved reg)

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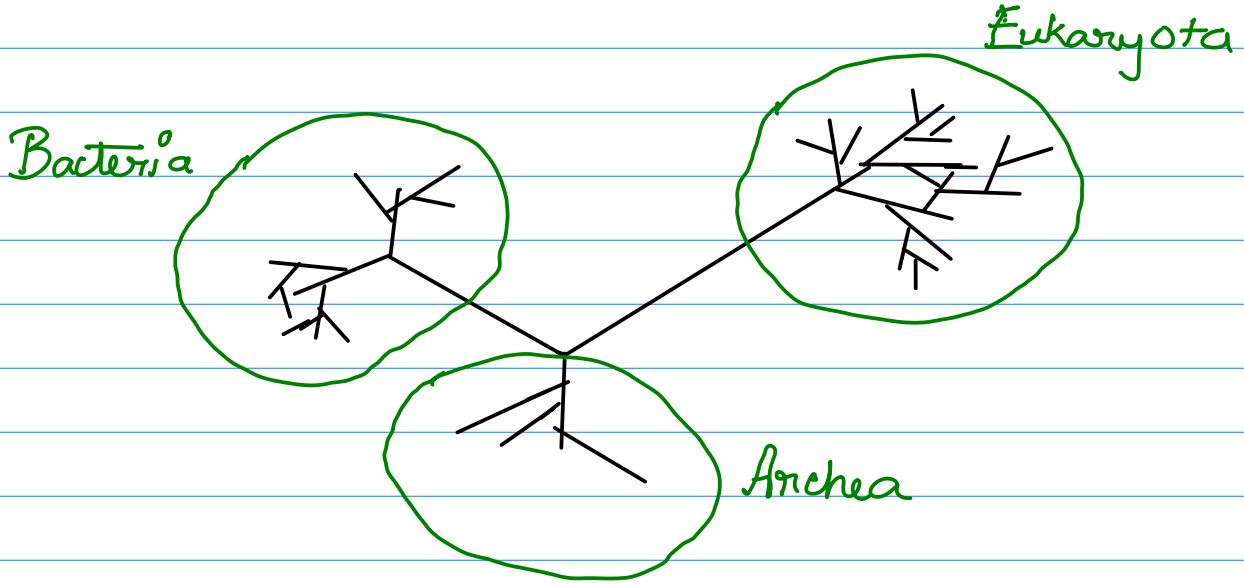
cloned in a plasmid vector to create library

↓

checked with database to reveal uncharacterised portions

Characteristics of 16S rRNA that make it useful:

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



(3) Reading the prokaryotic genome map

Determine complete DNA sequence

↓

Predict genes

↓

Translate genes to proteins

↓

Predict functions of proteins

↓

Reconstruct metabolic pathways

↓

Predict regulatory elements

↓

Reconstruct regulatory networks

↓

Experimental confirmation

(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

⑥ Selective forces controlling cell shape:

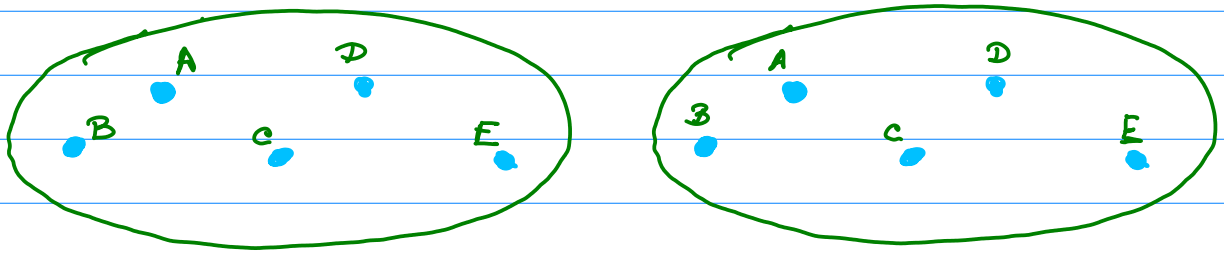
1. Optimisation for nutrient uptake
2. Swimming motility in viscous environments
3. gliding motility

Morphology is genetically directed and selected by evolution to maximise fitness for the species in a particular habitat.

This is bet-hedging.

Would this be stochastic or responsive switching?

Possible experiment:



Replica plate experiment: I have two sets of plates — replicas of each other.
I expose both plates to the same amount of stress.
If adaptive, both the replica colonies will survive. If responsive, the results might not match in the replica plates
Over time, the no. of colonies showing responsive switching will increase.