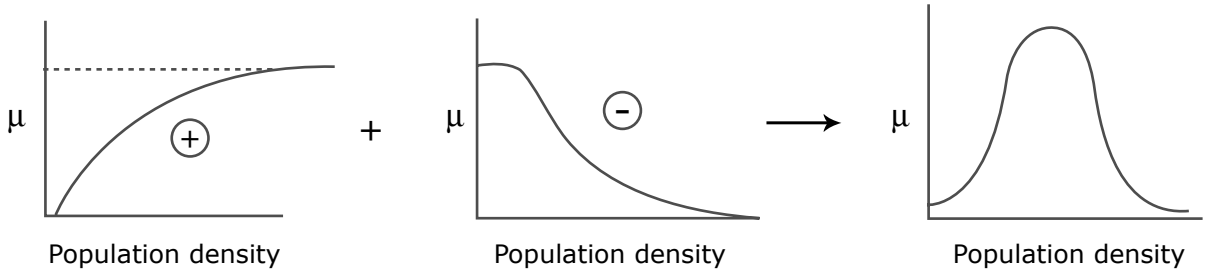
1.89, Environmental Microbiology
Prof. Martin Polz
Lecture 18

Microbial Population Interactions

- Definition of population: coexisting individuals of the same species.
- Interactions within populations
  Alle e⁻'s principle → at any given time both ⊕ and ⊖ interactions play a role in structuring populations.



- ⊕ interactions:
  Example:
  - exoenzymes (break down polymers)
  - infectious dose
  - local adjustment of pH or Redox

  ↓
  Adaptation:
  - colony formation
  - quorum sensing (density triggers specific traits)

- ⊖ interactions:
  - competition for resources
  - accumulation of toxic substances

Interactions with other populations

- Commensalism: vitamins, co-factors, etc. are often required by bacteria isolated from the environment. eg: D. ethenogens need Vitamin B_{12} (which is produced by methanogens)

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  "Cometabolism" = transformation of a substrate without gain of energy. Product can then be utilized by other bacteria.

- Synergism: both organisms benefit (eg: anaerobic environment)

  → "cross-feeding"

Compound A $\xrightarrow[\text{(utilizes A)}]{\text{population 1}}$ Compound B $\xrightarrow{\text{population 2}}$ Mineralization

→ detoxification

- Symbiosis (mutualism): 2 types of organisms interacting in a mutually dependent way; they need each other to survive; symbionts are <u>obligate</u>

  Example:

  a) <u>lichens</u> (very drought resistant; primary colonizers) = algae or cyanobacteria + fungi
  b) protozoa (termite gut, cow stomachs): bacterial endo and ecto symbionts (Bacteria grow on/in protozoa)

  Types of metabolisms: photosynthetic bacteria, methanogens, S-oxidizers

- Competition: 2 organisms share/have the same limiting resource
  - → can lead to competitive exclusion
  - → difficult to assess in environment
    - → for bacteria, competition is studied using chemostats.

  In a chemostat, the rate of supply of medium (or limiting nutrients) determines the growth rate:

  $$D = \frac{f}{V}$$

  D - dilution rate
  f - flow rate
  V - volume

  $$\frac{dB}{dt} = \mu B - \frac{f}{V}B = \mu B - DB$$

  at SS, $\frac{dB}{dt} = 0$ and $\mu = D$

  ↓

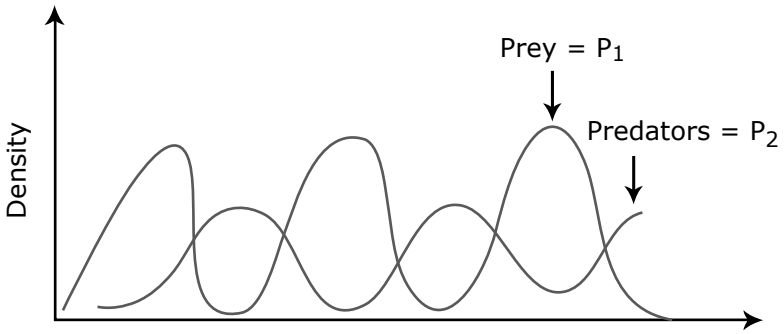
  growth rate = dilution rate!

  } shows who will win the competition

- Predation: death Rates are equally important to growth rates

  Predators of bacteria: viruses, protozoa

  Theory: Latka-Volterra



$$\frac{dP_1}{dt} = \mu_1 P_1 - r P_1 P_2 \qquad \frac{dP_2}{dt} = \mu_2 r P_1 P_2 - d P_2$$

constant death rate