Technique & Basic Knowledge of Fermenter

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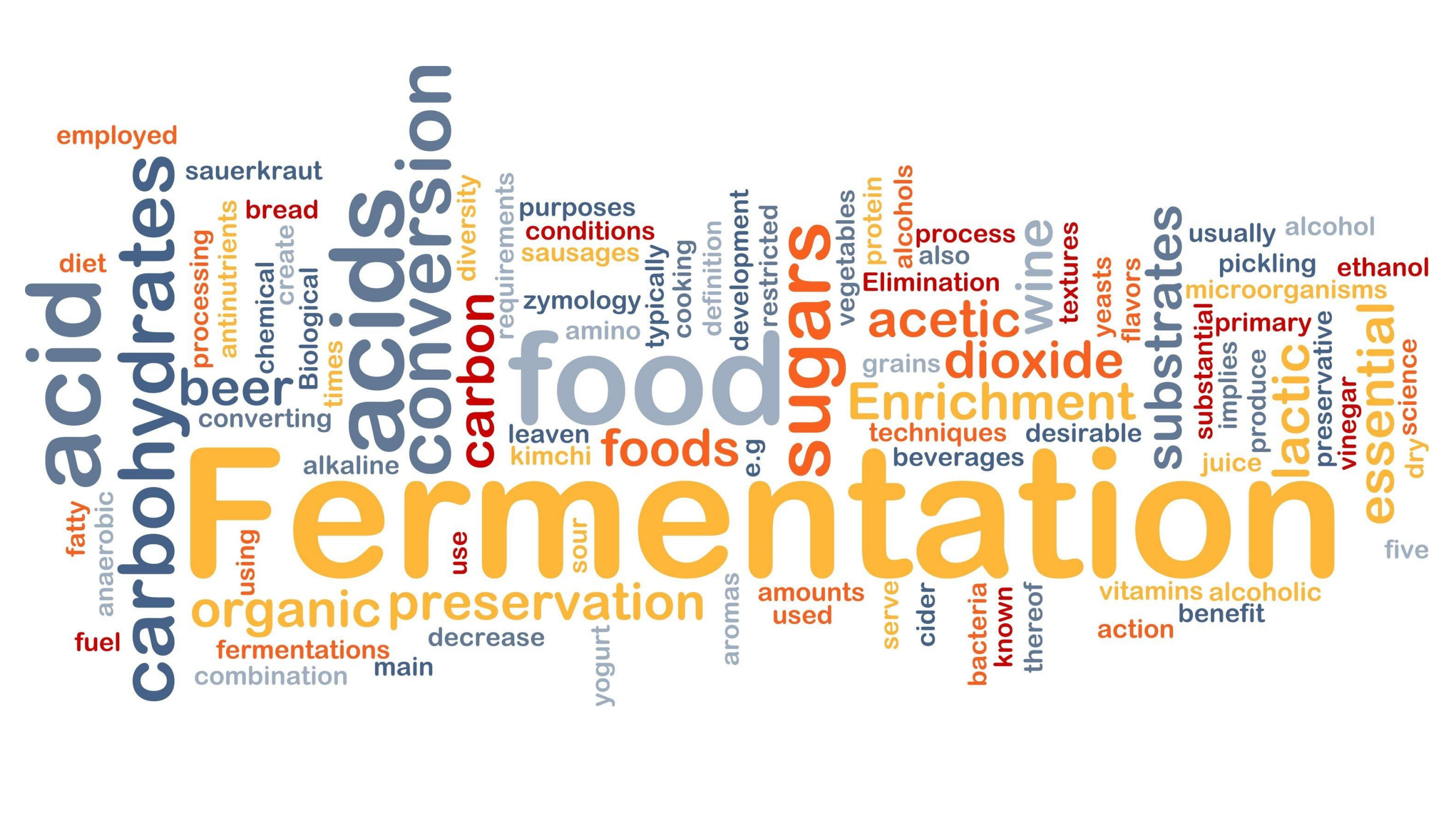
(SENIOR PRODUCT APPLICATION SPECIALIST)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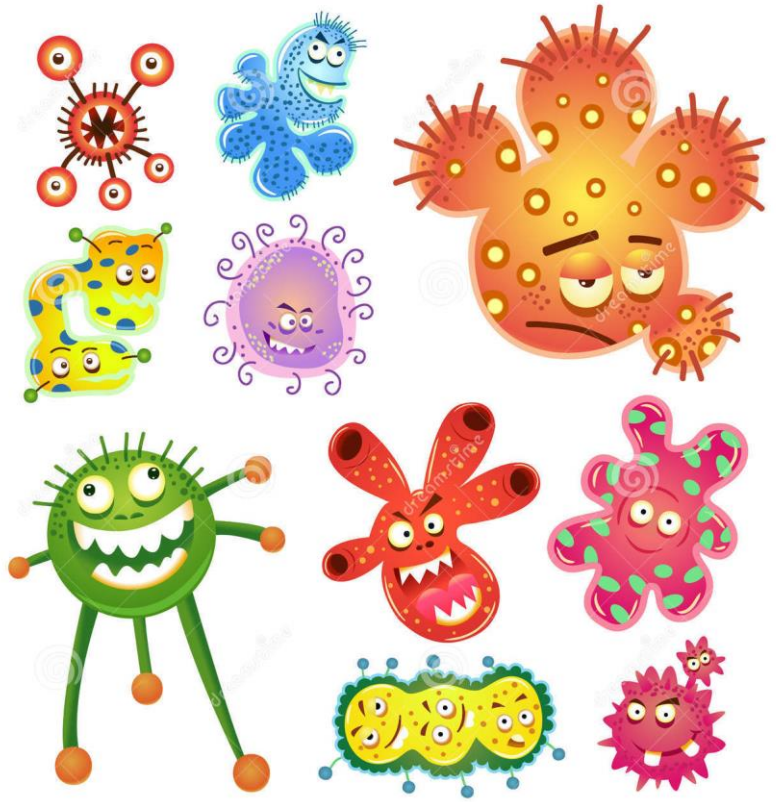
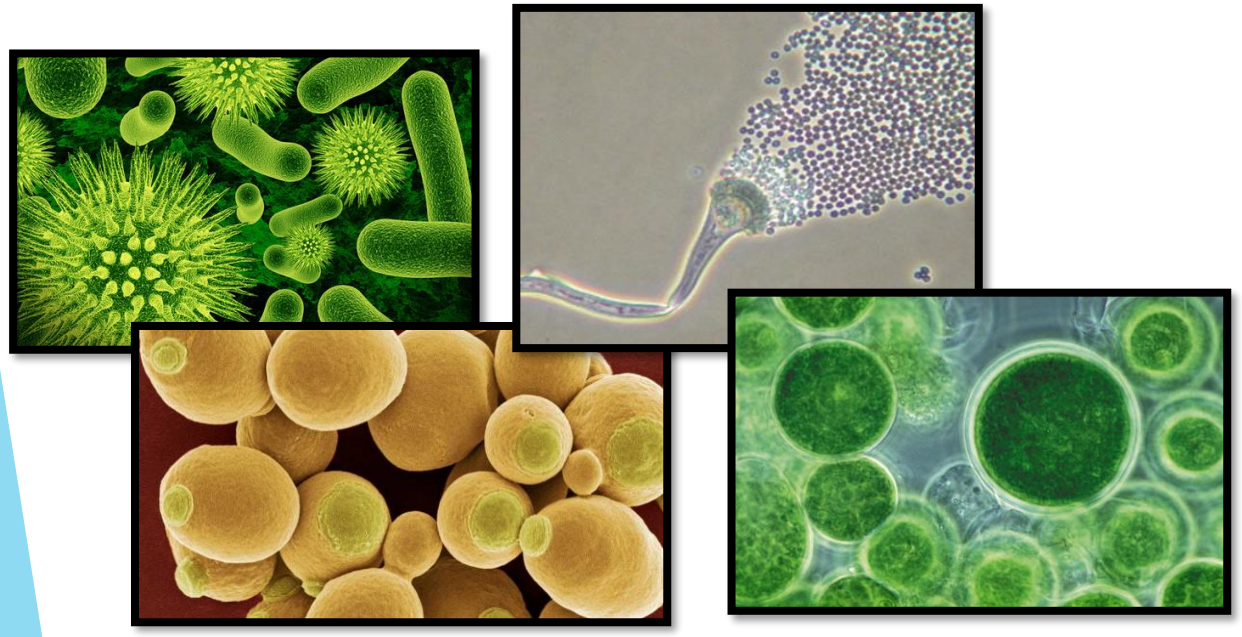
OUTLINE

- INTRODUCTION
- MICROBIAL GROWTH
- TYPES OF FERMENTATION
- FERMENTER DESIGN



INTRODUCTION

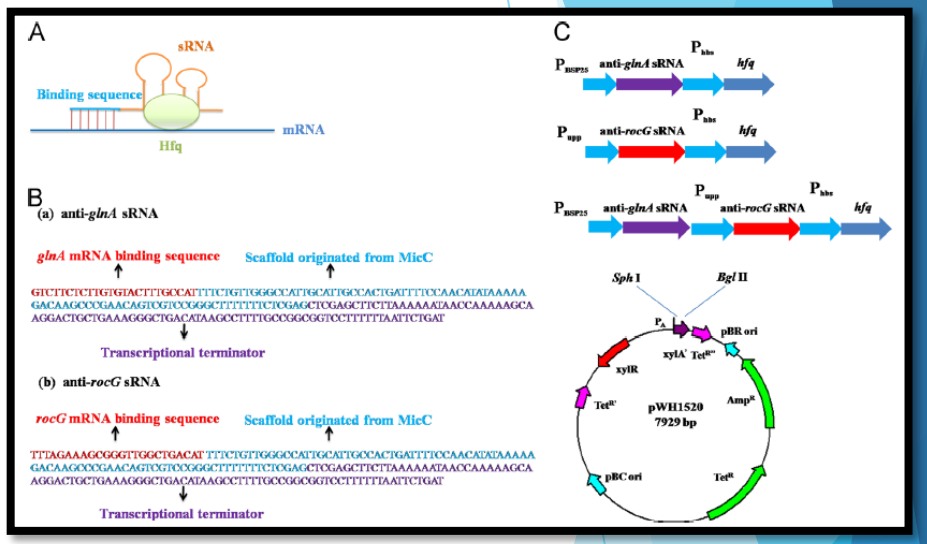
- FERMENTATION IS THE TERM USED BY MICROBIOLOGISTS TO DESCRIBE ANY PROCESS FOR THE PRODUCTION OF A PRODUCT BY MEANS OF THE MASS CULTURE OF A MICROORGANISM.



INTRODUCTION

The cell itself: referred to as biomass production.

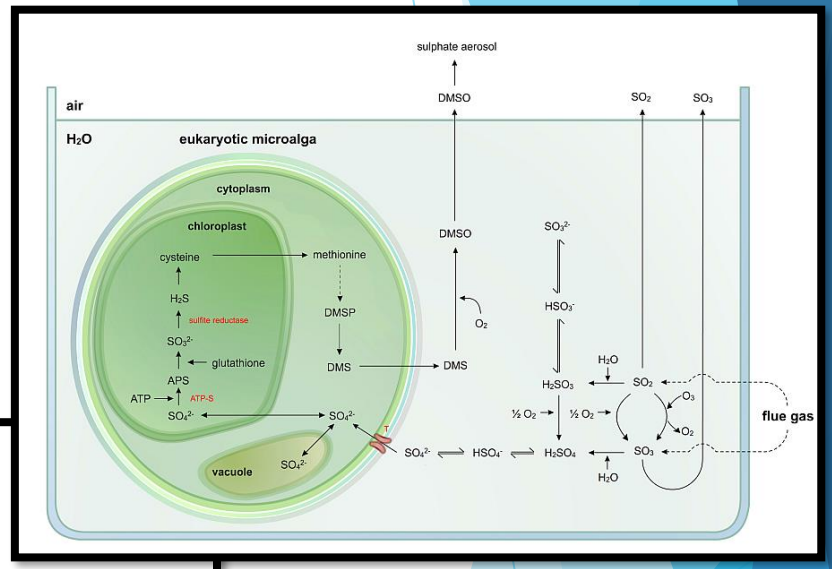
- **A microorganisms own metabolite:**
  - referred to as a product from a natural strain.
- **A microorganisms foreign product:**
  - referred to as a product from recombinant DNA technology or genetically engineered strain, i.e. recombinant strain.

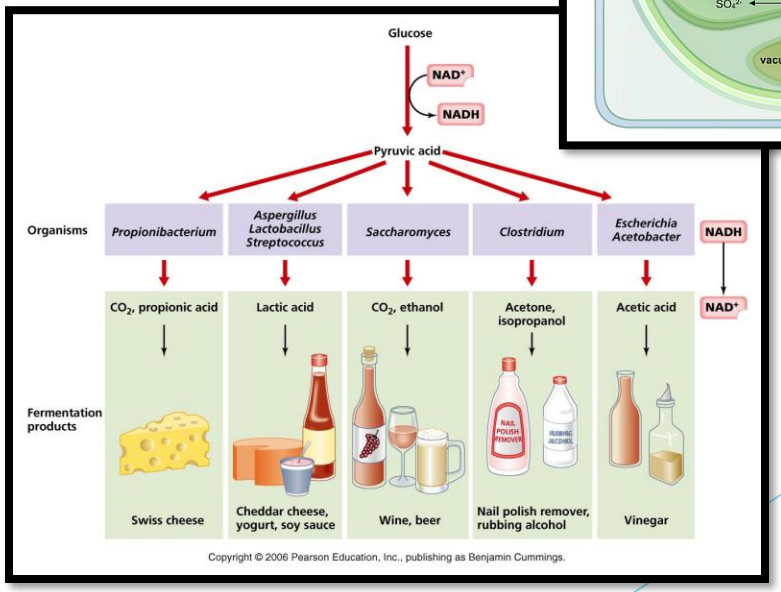


Synthetic sRNAs design and expression (Feng *et al.*, 2015).

INTRODUCTION

- THE FERMENTATION IS COMPOSED OF FIVE MAJOR :
  - CHEMICAL
  - PHARMACEUTICAL
  - ENERGY AND ENVIRONMENTAL
  - FOOD
  - AGRICULTURAL



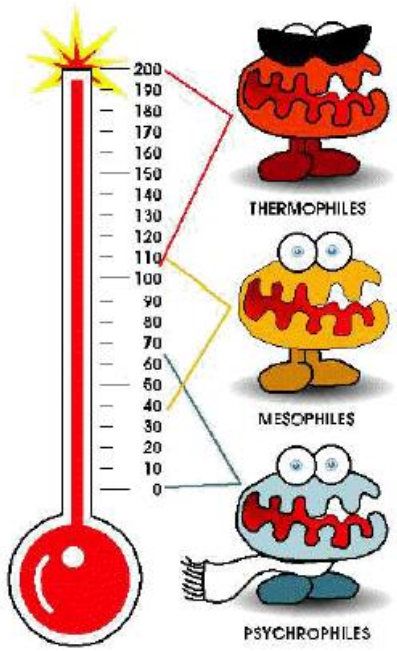


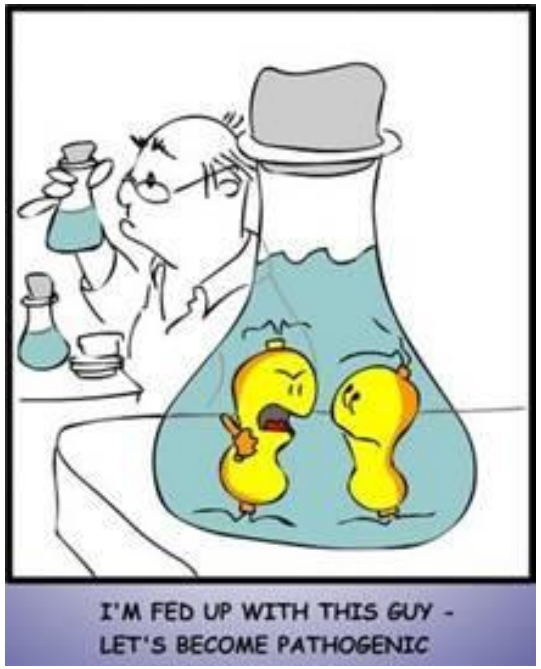
Environmental technology with microalgal bacterial flocs (MaB-flocs) (Vervaeren, 2013)

http://www.edo-ergo-sum.com/2010/10/fermentation-is-your-friend.html

MICROBIAL GROWTH

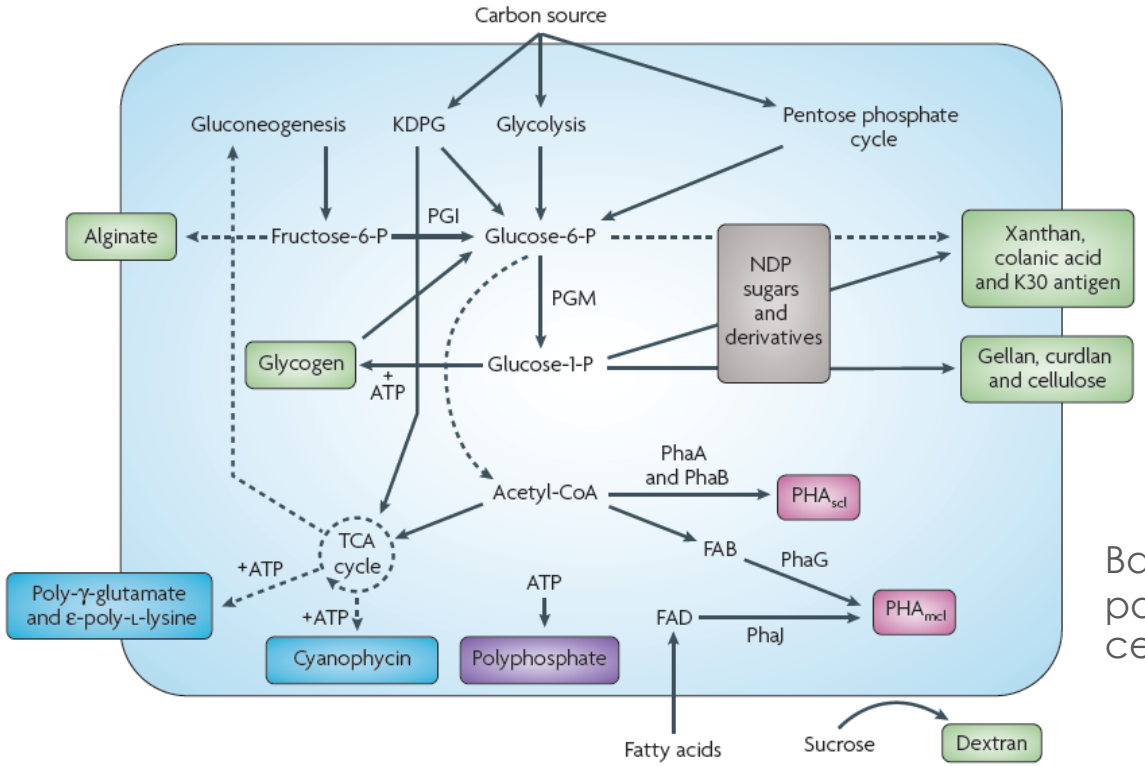
- Microbial growth can be divided:
  - Physical
    - Temperature
    - pH
    - Osmotic pressure
  - Chemical
    - Medium
    - Oxygen





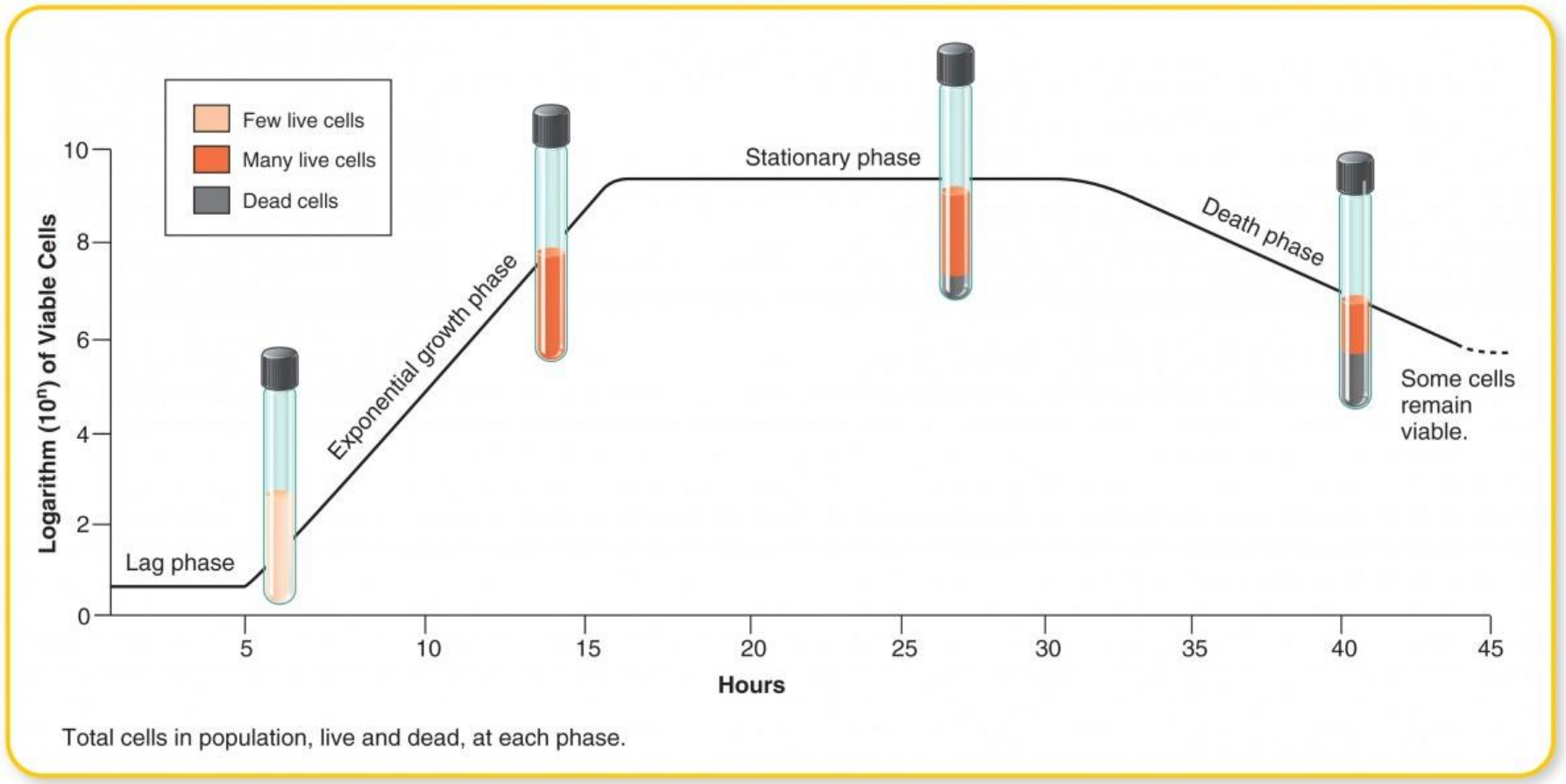
MICROBIAL GROWTH (Medium)

- Optimum balance of the media is mandatory for cells propagation and for the maximum production of target metabolite (end-product).
- Media compositions:
  - Carbon source
  - Nitrogen source
  - Minerals
  - Growth factors
  - Precursors (mutants)



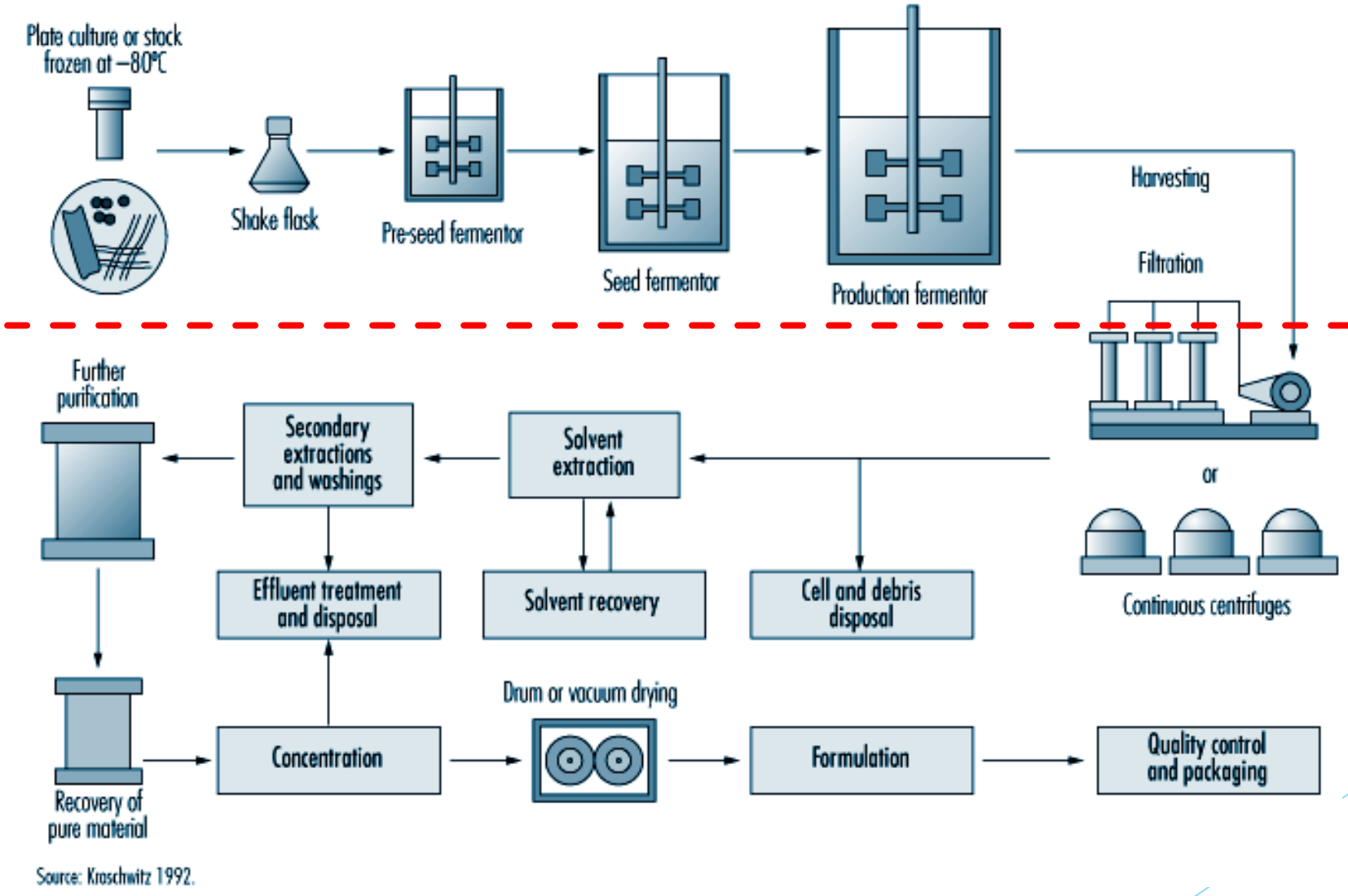
Bacterial polymer biosynthesis pathways from intermediates of central metabolism. (Rehm, 2010.)

MICROBIAL GROWTH



Total cells in population, live and dead, at each phase.

Fermentation Process Diagram



TYPES OF FERMENTATION

- Solid State fermentation (SSF)
- Liquid State fermentation (LSF)

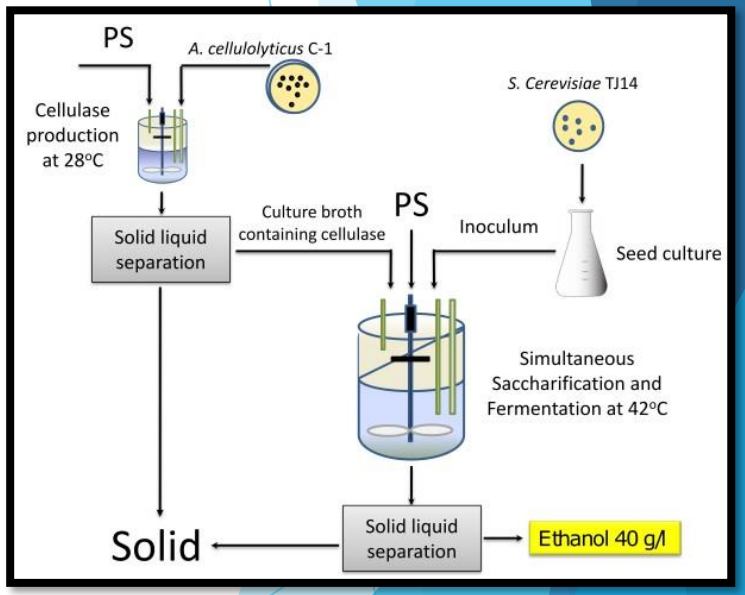
  Surface culture & submerged culture

Solid State fermentation (SSF)

- SSF process can be defined as microbial growth on particles without presence of free water.
- Particles are a solid culture substrate such as rice or wheat bran saturated with water and inoculated with (mold, yeast, bacteria) in controlled room temperature.
- It is ideal for growing filamentous fungi.
- It has been used in Asia and developing nations.
- It is more cost effective (smaller vessels lower water consumption, reduced waste water treatment costs, lower energy consumption, and less contamination problems).

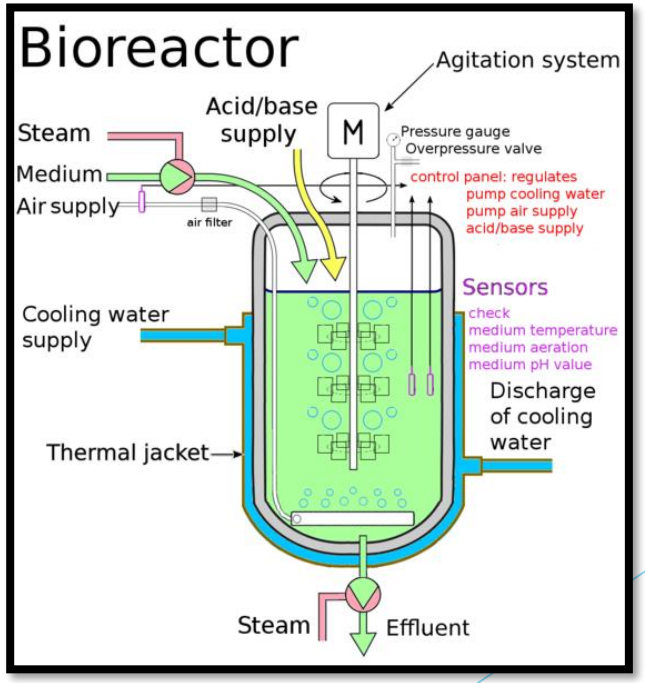
Solid State fermentation (SSF) APPLICATION:

- Potentially many high value products such as extra-cellular enzymes, primary metabolites, and antibiotics could be produced in SSF.
- It is estimated that nearly a third of industrial enzyme produced in Japan is made by SSF process.
- Production of organic and ethanol from starchy substrates.
- Digestibility of fibers and lignocelluloses materials for both human and animal consumption.



Liquid State fermentation (LSF)

- Submerged culture is performed in tanks which can reach in size for over 100,000 gallons.
- It is ideal for the growing unicellular organisms such as bacteria and yeast.
- LSF methods:
  - Batch fermentation
  - Fed-batch fermentation
  - Continuous fermentation
  - Semi-continuous fermentation

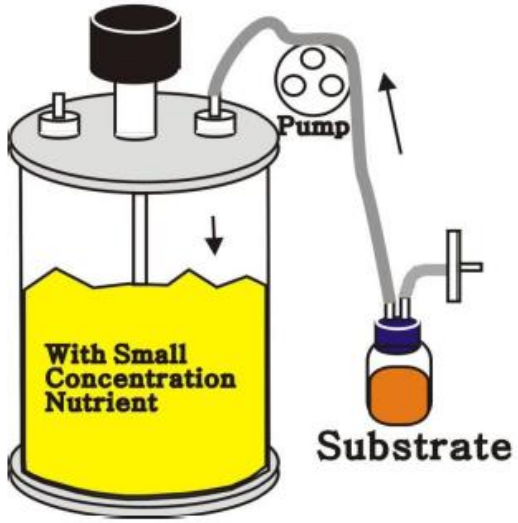


LSF: Batch fermentation

- Considered to be a closed system.
- The sterilized media in the fermenter is inoculated with the microorganism.
- Incubation is allowed under the optimum conditions (aeration, agitation, temperature).
- During entire fermentation nothing is added except air, antifoam and acid/base.

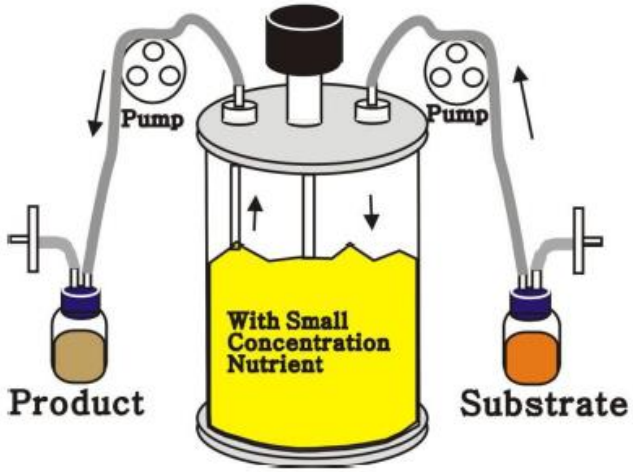
LSF: Fed-batch fermentation

- It is enhancement of batch fermentation.
- Continue adding the nutrients (feeding) in a small doses during the fermentation.
- The method in controlling nutrients feeding process is by measuring methods.
- The main advantage of fed-batch fermentation is the elimination of catabolite repression (feed-back inhibition).



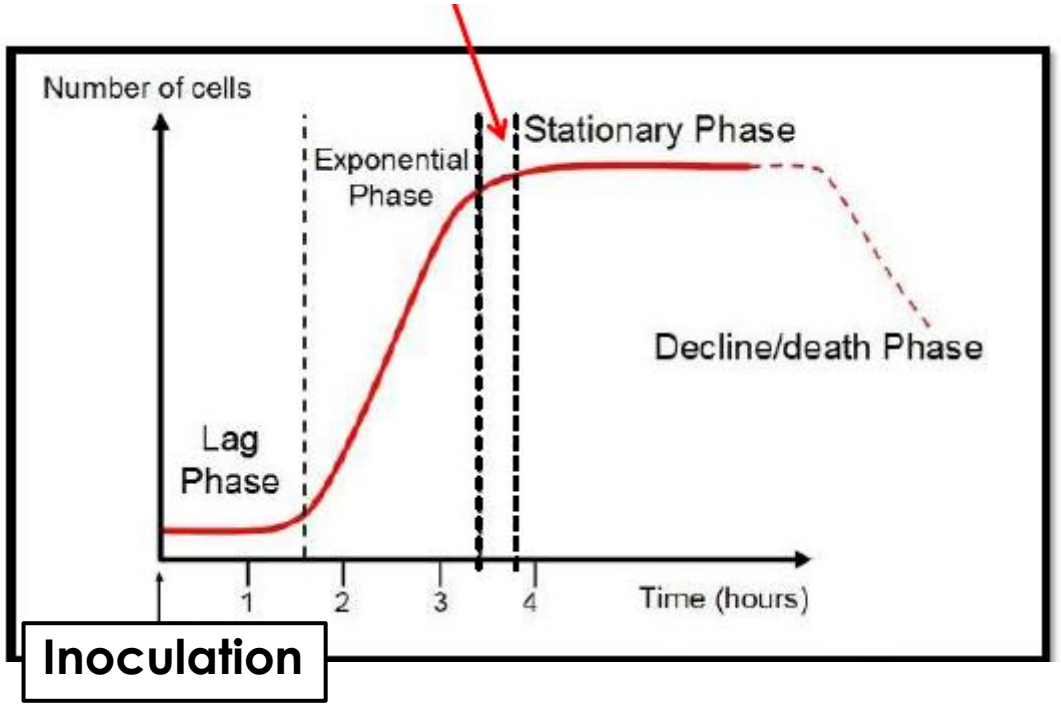
LSF: Continuous fermentation

- It is an open system.
- Continuously sterile nutrient is added, and the converted nutrient is taken out from the fermenter.
- In continuous process cell loss as a result of outflow must be balanced by growth of the microorganism.



LSF: Semi-continuous fermentation

- Semi-continuous fermentations, in which a fraction of a fermentation is replaced with fresh media at regular intervals.



THANK YOU

FOR YOUR ATTENTION