

Chapter 7

Microbial Biotechnology and its Application



Structure of microbes

- Characteristics:
 - Consist of a single circular chromosome that lacks histone protein
 - May contain plasmid DNA
 - Lack membrane-bound organelles
 - Cell wall from peptidoglycan. This will protects the cell and determine their shape
 - Some bacteria contained outer layer of carbohydrates that form structure called capsule

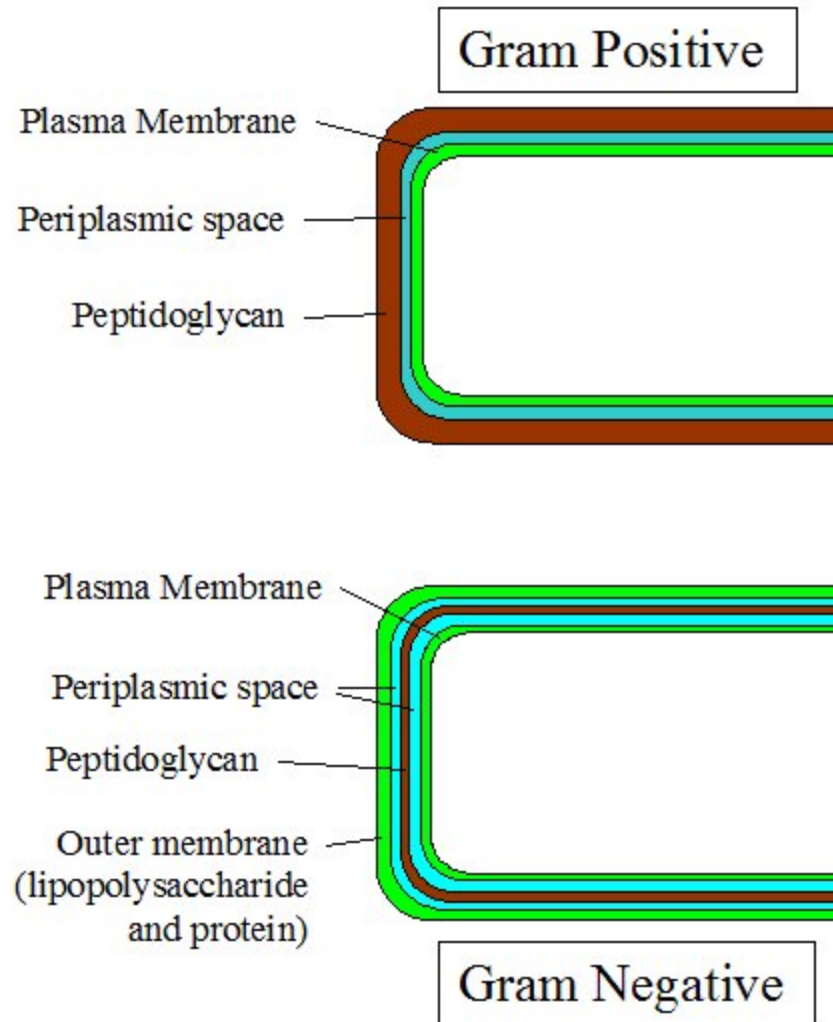
Type of bacterial cell wall

Gram positive

- Cell wall from peptidoglycans (mucopeptides, glycopeptides, mureins). This made up of a polysaccharide backbone consisting of alternating muramic acid (MA) and glucose amine (GA) residues
- Lysozyme enzyme will dissolved cell wall as this enzyme attacks the bonds between GA and MA in some bacteria but *Staphylococcus aureus*, the walls are resistant to the action of lysozyme

Gram negative cell wall

- Thin peptidoglycan layer adjacent to the cytoplasmic membrane
- Responsible for the cell wall's inability to retain the crystal violet stain upon decolourisation with ethanol during Gram staining
- Outer membrane composed of phospholipids and lipopolysaccharides
- They have unique lipopolysaccharides membranes that responsible for many of the antigenic properties

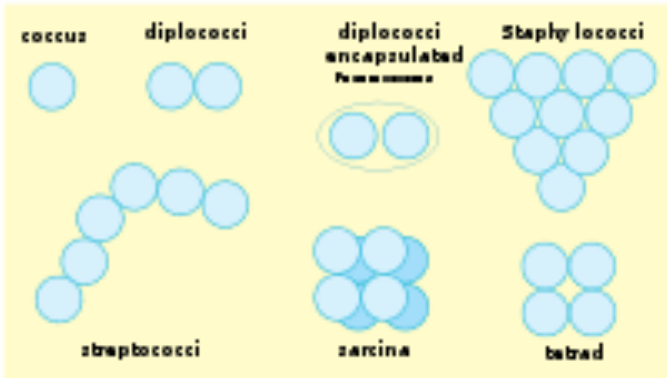


Cell morphology

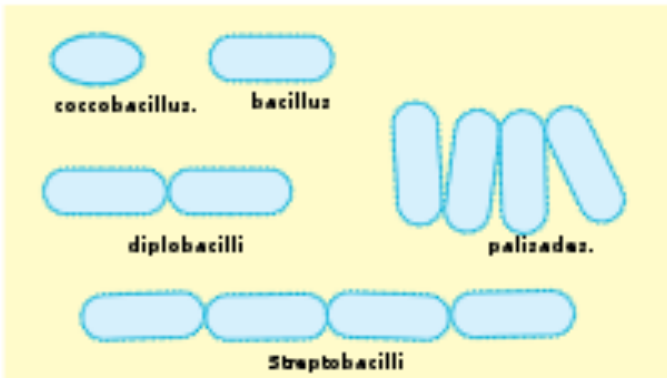
- Various morphology from coccus (spherical), bacillus (rod), spirillum (spiral) to filamentous
- Complex life cycles involving the production of stalks and appendages (e.g. *Caulobacter*)
- Elaborate structures bearing reproductive spores (e.g. *Myococcus*, *Streptomyces*)
- Their morphology was observed under light microscope
- Distinct colony were observed on the plate

Bacterial shape

Cocci



Bacilli



Budding and appendaged bacteria



Others



Yeast

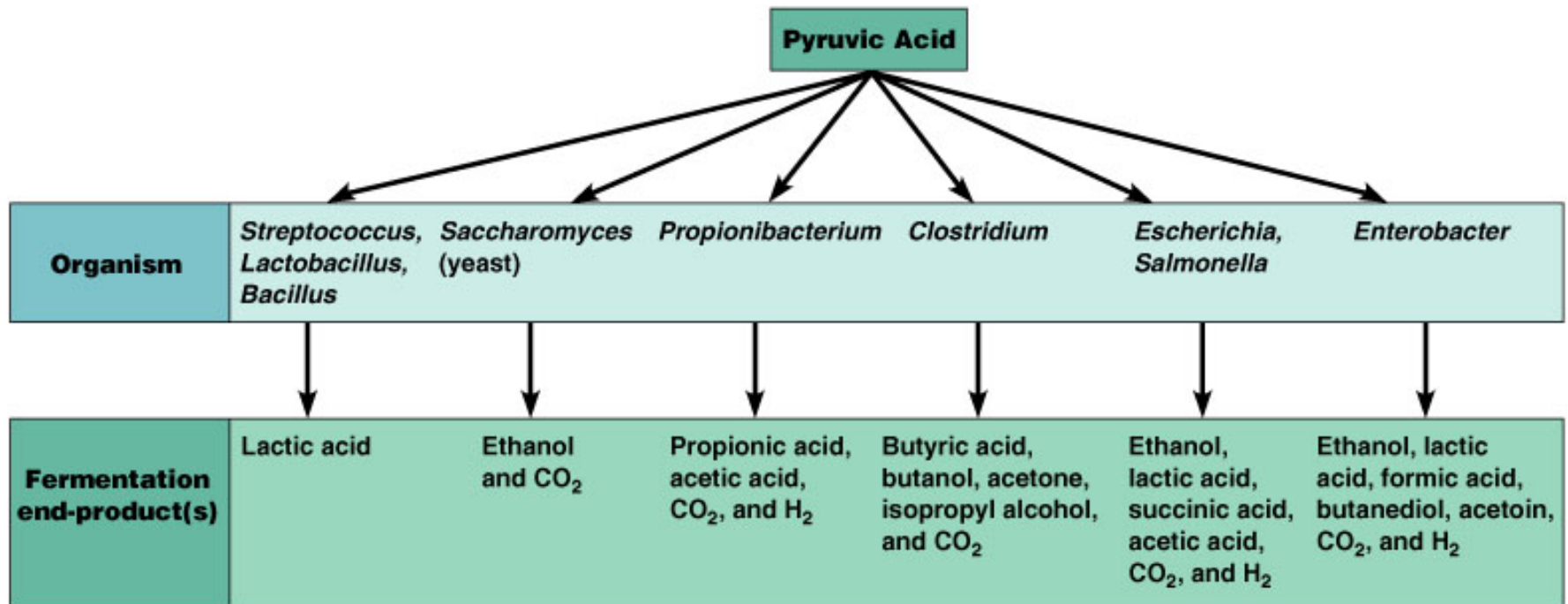
- Under eukaryotic domain
- Asexually (budding) reproductive or some by binary fusion
- Unicellular, but some may become multicellular through the formation of a string of connected budding cells known as pseudohyphae such as in molds
- Size from 3–4 μm but some up to 40 μm
- Many yeast grow in aerobic conditions but some in anaerobic conditions

Fermentation Technology

- Fermentation may refer to different definition base on process:
- The use of fermentation in food preparation
- A metabolic process whereby electrons released from nutrients are ultimately transferred to molecules obtained from the breakdown of those same nutrients

Industrial application

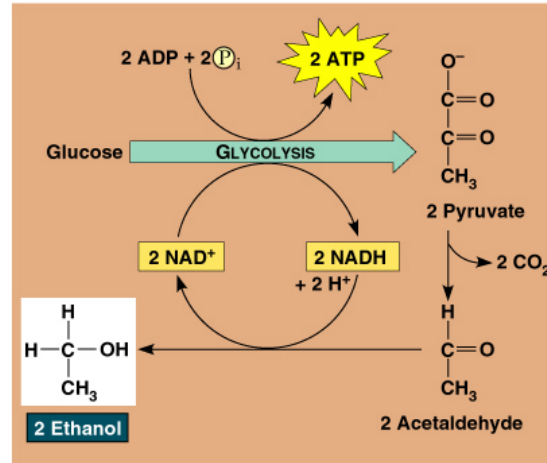
- Winemaking
- Brewing beer
- Ethanol: use in food, alcoholic beverage, fuel and industry
- The reassembly of biochemical for industry
- Tea industry for discard the unwanted chemicals and modify others to develop the flavor



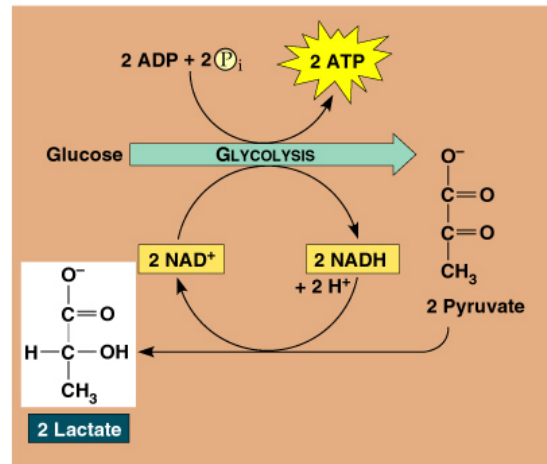
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2 Types of fermentation



(a) Alcohol fermentation



(b) Lactic acid fermentation

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Alcoholic fermentation in food processing

Alcoholic beverages

- Contained ethanol (C_2H_5OH) from carbohydrates fermentation under anaerobic or low-oxygen conditions
- Eg wine, beer, distilled spirits, whiskey and rum
- Components other than ethanol such as water, esters and other alcohol will account for its flavor

Beer

- Fermented by brewers yeast
- 2 type of brewing yeasts :
- 1. "top cropping" : Form a foam at the top. Eg. *S. cerevisiae* or called "ale yeast"
- 2. "bottom cropping" : Produce lager type beer. Eg. *S. carlsbergensis*)
- Lambic beer:
 - Spontaneous fermentation by wild yeasts and bacteria such as from *Brettanomyces lambicus*, *B. bruxellensis* and *B. claussenii* from Famili *Brettanomyces* which native to Senne Valley in Belgium

Wine

- Different *S. cerevisiae* yeast strains have differing physiological and fermentative properties
- From grape
- Family Zygosaccharomyces and Brettanomyces cause the wine to spoil
- "*Brettanomyces character*", and are often described as antiseptic or "*barnyard*" type aromas

Baking

- *S. cerevisiae* converts fermentable sugars in dough into gas carbon dioxide that make the the dough expand or rise
- Yeast growth can be accelerates by adding eggs, sugar or potato boiling water
- *S. minor* is a wild yeast found on plants, fruits, and grains that is occasionally used for baking.
- Addition of sugar and vinegar provide the best conditions for yeast to ferment
- Sugar and vinegar are the best conditions for yeast to fermented

Industrial ethanol production

- Addition of sulphuric acid or α -amylase into sugar cane, field or other cereal to break down the starches into complex sugars.
- Then, gluco amylase is added to break the complex sugars down into simple sugars
- After this, yeasts are added to convert the simple sugars to ethanol, distilled to obtain 96% ethanol
- In industrial involve of agriculture residue, paper waste and wood chips, *Saccharomyces* yeasts can be use to ferment xylose
- Therefore, production of ethanol can be efficiently produced from inexpensive feed stocks

Lactic acid fermentation in food

- Produce cheese, sour cream, yogurts
- Sharp or sour flavor due to lactic acids
- Examples : *Streptococcus thermophilus*, *Lactobacillus bulgaricus* and *Lactococcus lactis*
- Natural preservatives in meat products and sausages such as *Lactobacillus sakei* (ward off growth of other microbes)

Use of fermentation in industry

- Acetic acid and ethanol from *Acetobacter* sp
- Ethanol from malt extract by *S. cereviasie* (beer), wine from grape while glycerol for industrial purposes
- Citric acid for flavouring from *Aspergillus* sp
- Aceton and butanol from *Clostridium acetobutylicum*
- Sorbus for vitamin C from *Acetobacter*

Medical application

- Production of insulin for treatment of diabetes
- Antibiotic: Substance produce by microbes that inhibit the growth of other microbes
- A type of antimicrobial drug

Degradation and Bioremediation

- Degradation of waste product and bioremediation
- Help microorganism degrade waste rapidly and efficiently
- Ice-minus bacteria lacking the gene responsible for ice-nucleating surface protein production. This lack of surface protein provides a less favorable environment for ice formation