

Concept, importance and types of starter cultures in dairy industry



Starter cultures are selected bacterial or fungal strains of food-grade microorganisms of known and stable metabolic activities, either pure or mixed, used to initiate a fermentation process.



- ❑ Starter cultures are group of active, carefully selected and desirable microorganisms used in production of cultured dairy products (dahi, yoghurt and cheese).
- ❑ Starter can produce particular characteristics (appearance, body, texture, flavour) in the milk.
- ❑ Produce lactic acid from lactose. Certain starters specifically produce flavouring compounds (diacetyl).

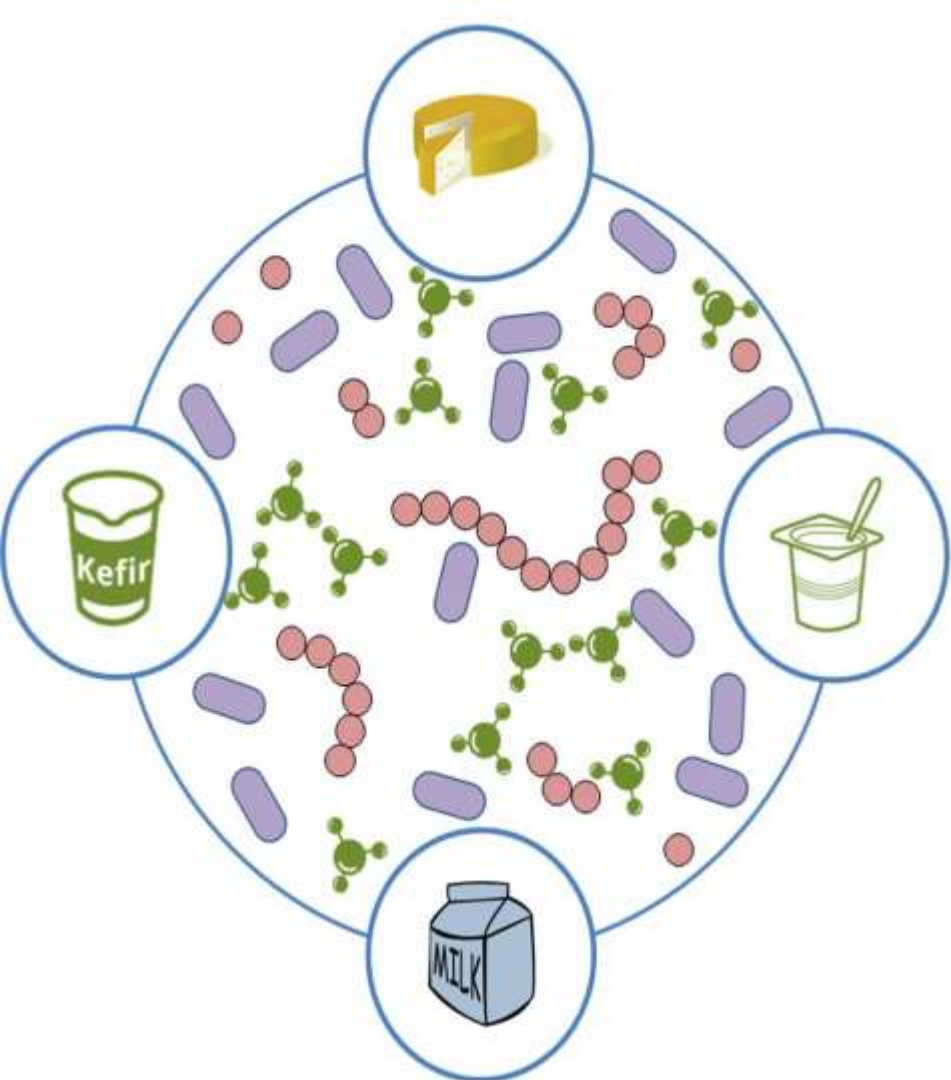


Function of Starters.....

Function	Result
Acid production	<ul style="list-style-type: none"><input type="checkbox"/> Gel formation<input type="checkbox"/> Expulsion (syneresis) of whey for texturing<input type="checkbox"/> Preservation of milk<input type="checkbox"/> Helps in the development of flavour
Flavour	<ul style="list-style-type: none"><input type="checkbox"/> Formation of flavour compounds like diacetyl and acetaldehyde
Preservation	<ul style="list-style-type: none"><input type="checkbox"/> Lowering of pH and redox potential<input type="checkbox"/> Production of lactic acid<input type="checkbox"/> Production of antibiotics<input type="checkbox"/> Production of H₂O₂<input type="checkbox"/> Production of acetate
Gas formation	<ul style="list-style-type: none"><input type="checkbox"/> Eye formation in certain cheeses<input type="checkbox"/> Production of open texture Ex. blue veined cheese
Stabilizer formation	<ul style="list-style-type: none"><input type="checkbox"/> Development of body and viscosity <p>Ex. Polysaccharide materials</p>
Lactose utilization	<ul style="list-style-type: none"><input type="checkbox"/> Reduces the development of gas and off flavours<input type="checkbox"/> Suitable for lactose intolerant people
Lowering of redox potential	<ul style="list-style-type: none"><input type="checkbox"/> Helps in preservation<input type="checkbox"/> Helps in development of flavour

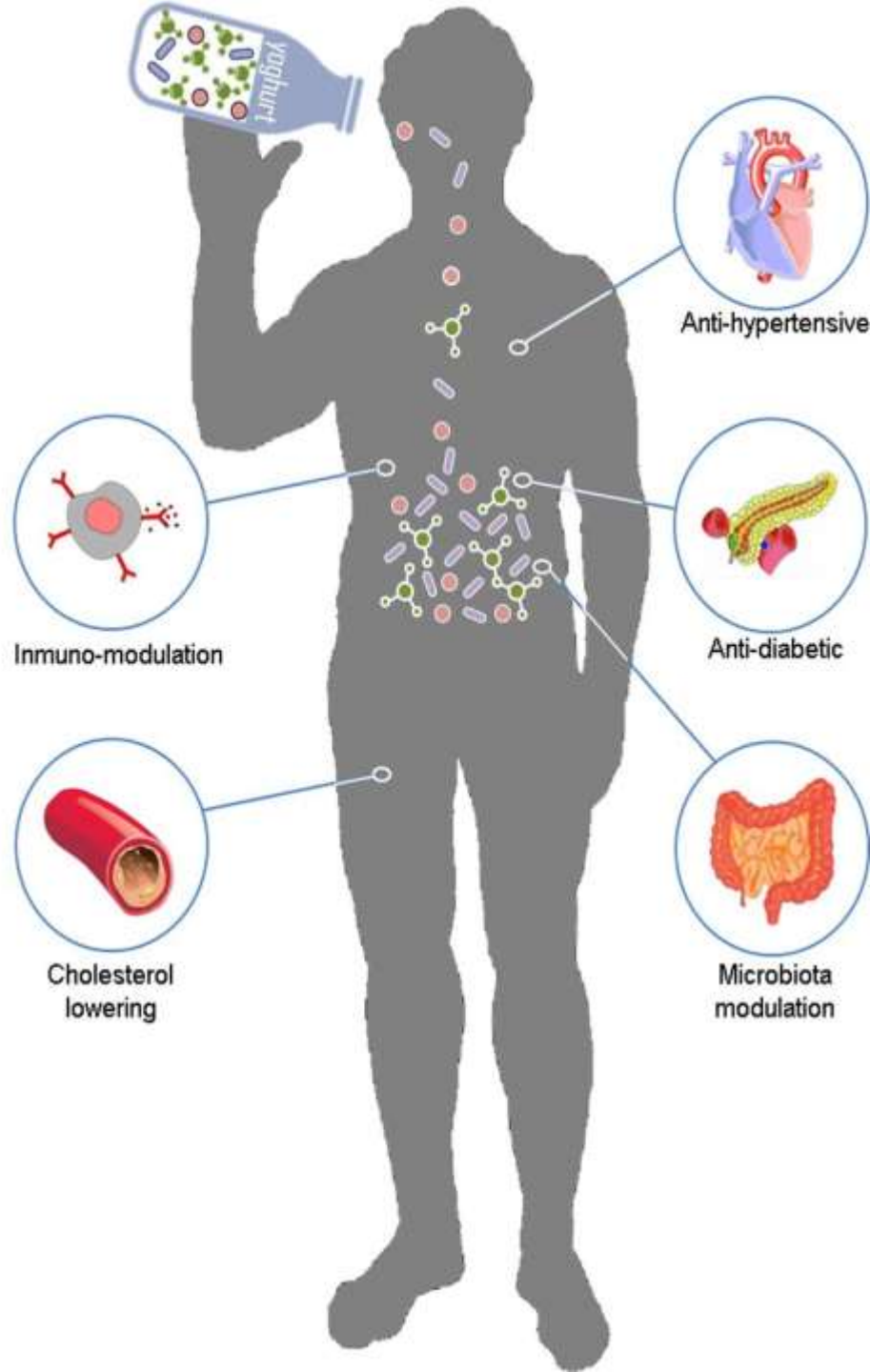
Significance of Starters in Milk Fermentation.....

- **Enrichment of human diet through a wide variety of flavours, aroma and texture of foods.**
- **Preservation of foods via lactic acid, alcoholic, acetic acid and alkaline fermentations.**
- **Bio-enrichment of food with proteins, essential amino acids, essential fatty acids and vitamins.**
- **Nutritional benefits (promotion of growth and digestion, improvement of bowel movements, suppression of cancer, suppression of blood cholesterol, suppression of tumors and fulfilling the needs of lactose intolerant people).**



Lactic Acid Bacteria

Bioactive microbial metabolites



Immuno-modulation

Cholesterol lowering

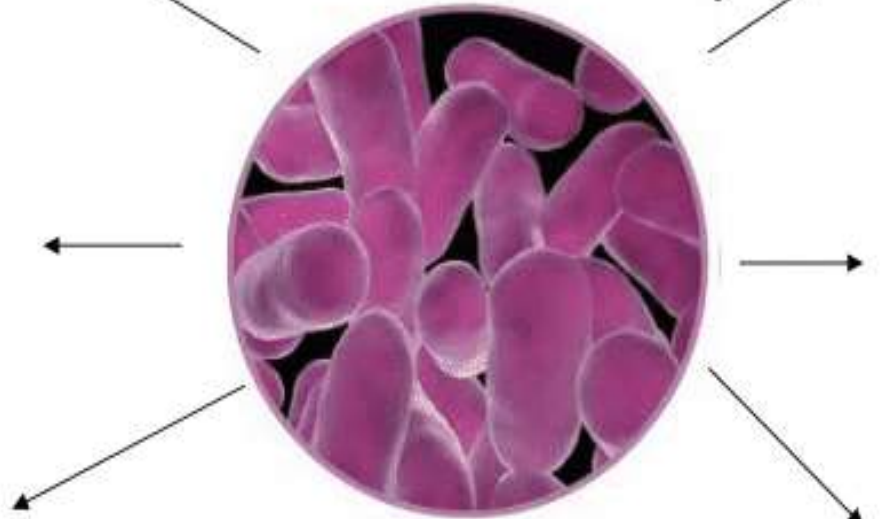
Anti-hypertensive

Anti-diabetic

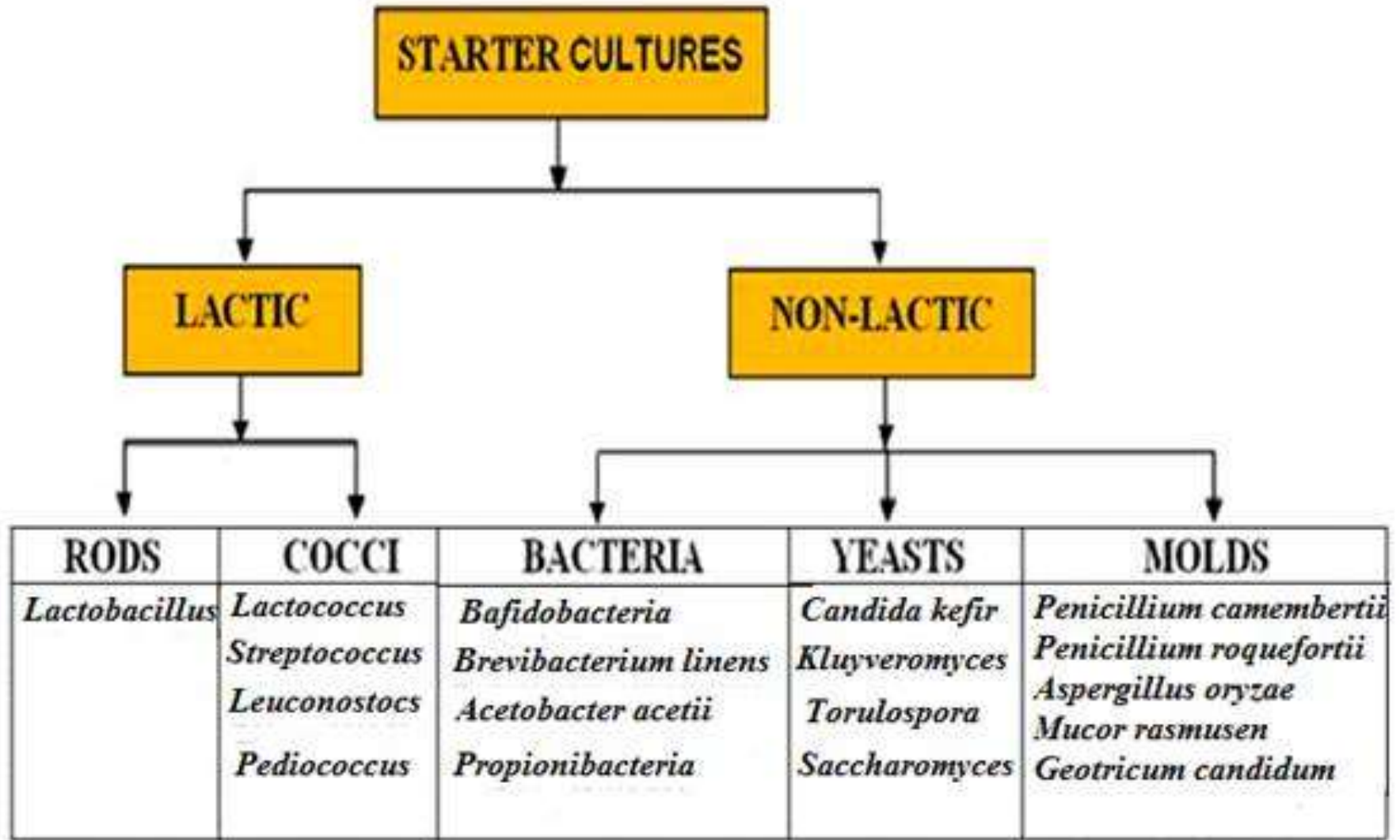
Microbiota modulation

Scope of Fermented Milk Industry.....

- Probiotic based fermented milk products has taken up the fastest market during the last decade. This led to the promotion of value-added products (probiotic and other functional yoghurts, reduced-fat, enriched milk products, fermented dairy drinks and organic cheese).
- Another important global trend is increasing demand for consumer convenience.
- Fermented milks containing various nutrients are being tested as curatives for specific diseases.



Classification /taxonomic groups as per Bergey's Manual



Genus *Lactococcus*:

- *L. lactis* subsp. *lactis*, subsp. *cremoris* and subsp. *lactis* biovar *diacetylactis*.
- Characteristics (a) possession of identical isoprenoid quinones and enzyme, β -phosphogalactase (b) indistinguishable lactic dehydrogenase
- *L. lactis* is of significance in dairy fermentations. When grown in milk, >95% of their end product is lactic acid.
- Optimum growth temperature is between 25-30°C and weakly proteolytic.
- *L. lactis* subsp. *lactis* var. *diacetylactis* converts citrate to diacetyl, CO₂, and other compounds.

<i>Lactococcus lactis</i> subsp <i>lactis</i>	Acid producer but non-flavour producer
<i>Lactococcus lactis</i> subsp <i>cremoris</i>	Acid producer but non-flavour producer
<i>Lactococcus lactis</i> subsp <i>lactis</i> biovar <i>diacetylactis</i>	Both acid & flavour producer

Genus *Streptococcus*:

- Gram-positive organisms that usually form pairs or chains.
- Four general groups designated by Sherman are (1) pyogenic (*S. agalactiae*) (2) viridans (*S. thermophilus*) (3) enterococcus (*S. faecalis*) (4) lactic (*S. lactis*, *S. cremoris*, *S. diacetylactis*).
- Starter culture is *Streptococcus thermophilus*. This is a yoghurt culture, thermophilic with optimum growth temperature of 38-42 C.



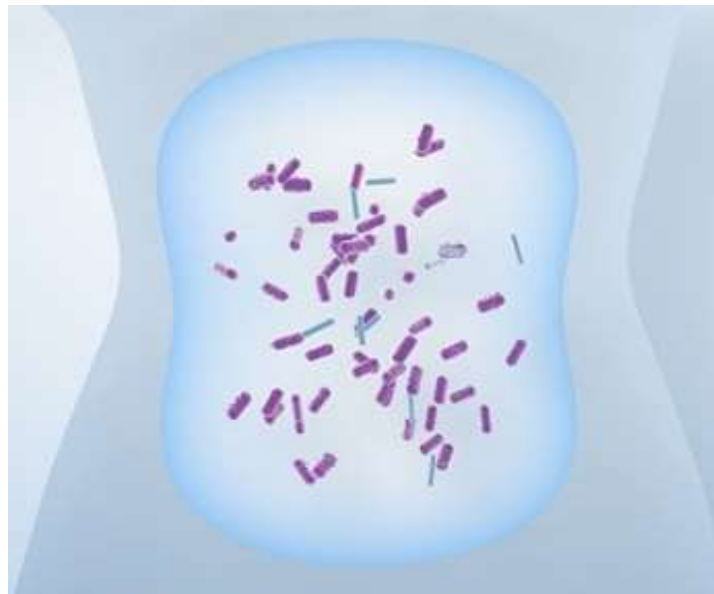


Genus *Leuconostoc*:

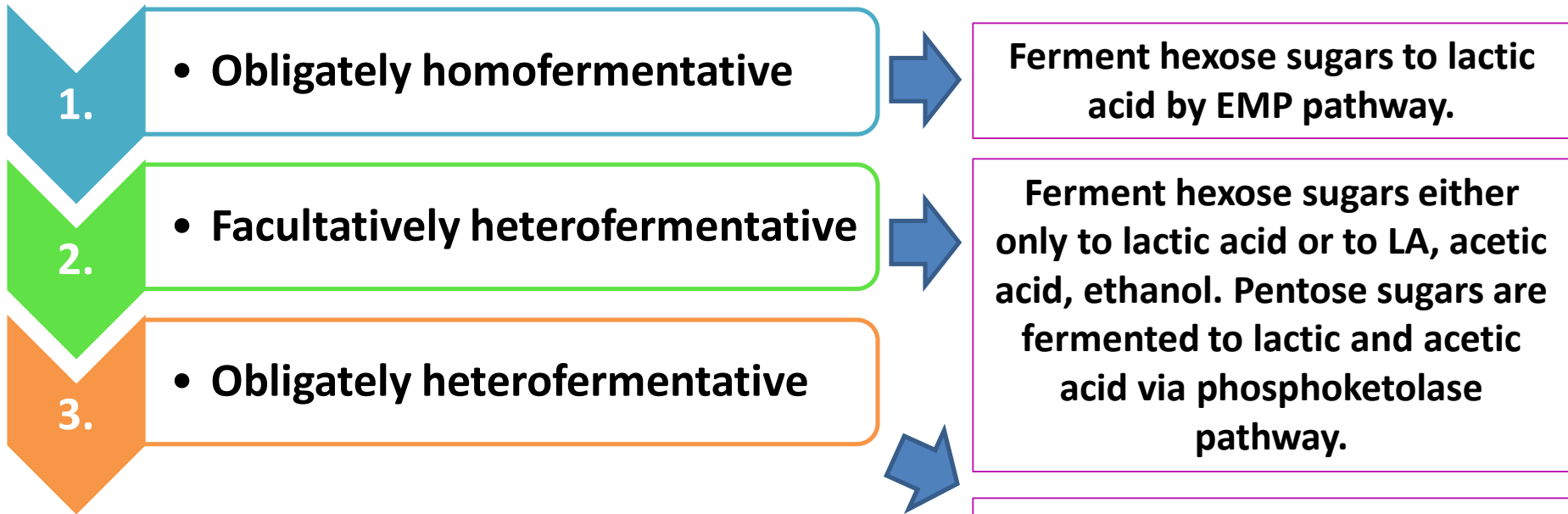
- *Leuconostoc* spp. used in dairy industry are heterofermentative, produce diacetyl, carbon dioxide, and acetoin from citrate.
- Normally used along with lactic acid bacteria in multiple or mixed strain starter cultures for producing flavour compounds.
- Grow poorly in milk and lack sufficient proteolytic ability to grow in milk.
- Convert excess acetaldehyde to diacetyl, thus reducing undesirable “green” flavor. *L. cremoris*, *L. dextranicum*

Genus *Lactobacillus*:

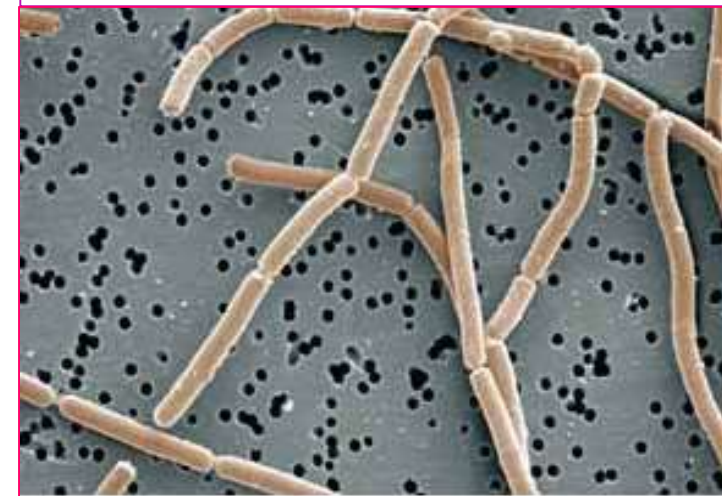
- *Lactobacillus delbruekii* subsp. *bulgaricus* is used for the preparation of yoghurt along with *Streptococcus thermophilus* (symbiotic relationship).
- *Lactobacillus acidophilus* is a probiotic culture, used for preparation of acidophilus milk and other probiotic milk products like Bioghurt etc.



Classification of *Lactobacillus* based on glucose fermentation

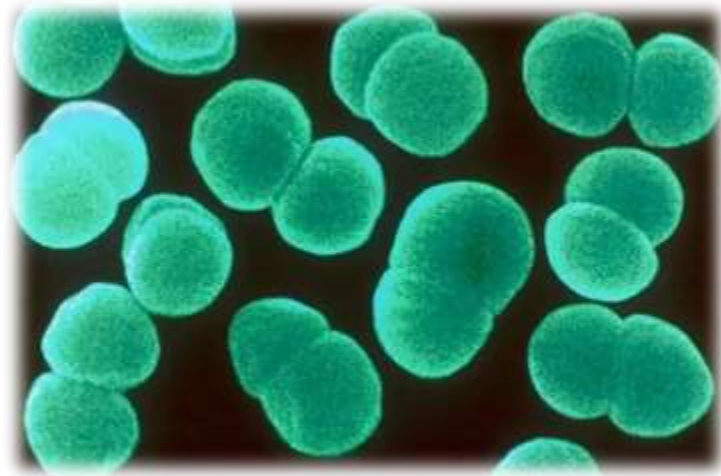


Species	Products	Growth		Lactic acid isomer
		at 15°C	at 45°C	
Homofermentative				
<i>L. delbrueckii</i> subsp. <i>bulgaricus</i>	Yogurt, koumiss, kefir, Italian and Swiss cheeses	-	+	D
subsp. <i>lactis</i>	Hard cheese	-	+	D
<i>L. acidophilus</i>	Acidophilus milk, laban	-	+	DL
<i>L. helveticus</i>	Yogurt, Swiss cheese	-	+	DL
Facultatively heterofermentative				
<i>L. casei</i> subsp. <i>casei</i>	Hard cheese	+	-	L
Obligately heterofermentative				
<i>L. kefir</i>	Kefir	+	-	DL



Genus *Pediococcus*:

- Dairy starter: *P. acidilactici* and *P. pentosaceus*.
- It divide alternatively in two perpendicular directions to form tetrads that differentiate them morphologically from other lactic acid bacteria.
- Cells do not form spores or capsules, Gram-positive cocci of uniform size, produce DL-lactate, catalase negative and non-motile.
- *Pediococcus* spp. have been found in cheese.



Genus *Bifidobacterium*:

- Produce lactic and acetic acids in the ratio of 2:3.
- Possess enzyme fructose-6-phosphate phosphoketolase which is lacking in LAB.
- Found in gut of infants, intestines of man, animals and honeybees.
- Used in preparation of therapeutic fermented milk products.
- Members: *B. bifidum*, *B. longum*, *B. infantis* etc.
- Optimum growth temperature: 37-41°C.
- Anaerobic conditions are essential for optimum growth.
- Milk fermented with bifidobacteria has distinctive vinegar taste due to production of acetate plus lactate from the metabolism of carbohydrates.

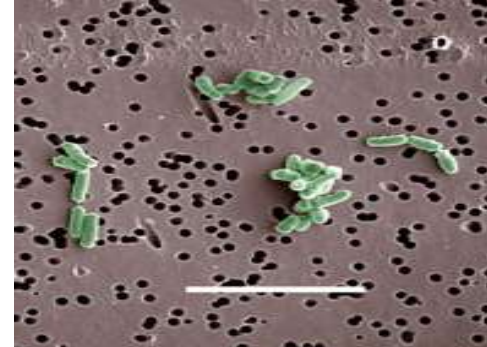


Genus *Propionibacterium*:

- **Non-spore-forming, pleomorphic, Gram-positive rods that produce large amounts of propionic, acetic acid and CO₂ from sugars and LA.**
- ***P. freudenreichii* and *P. shermanii* are used in Swiss cheese.**
- **Ability to produce large gas holes in cheese during ripening/maturation period. *P. jensenii*, *P. thoenii* are other organisms in these genera.**

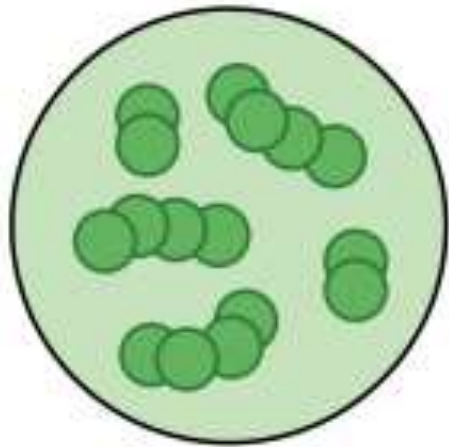
Genus *Brevibacterium*:

- ***B. linens* is used in preparation of bacterial surface ripened cheeses.**
- **Imparts distinctive, reddish orange colour to the rind of Brick cheese.**



Genus *Enterococcus*:

- Gram-positive, catalase-negative cocci, produce L(+) lactic acid homofermentatively from glucose, and also derive energy from degradation of amino acids.
- Used as food safety indicators and have a possible involvement in foodborne illness.
- Enterococci are also used as starter cultures in some southern European cheeses.
- *E. faecalis* and *E. faecium* are probiotics for prevention and treatment of intestinal disorders.



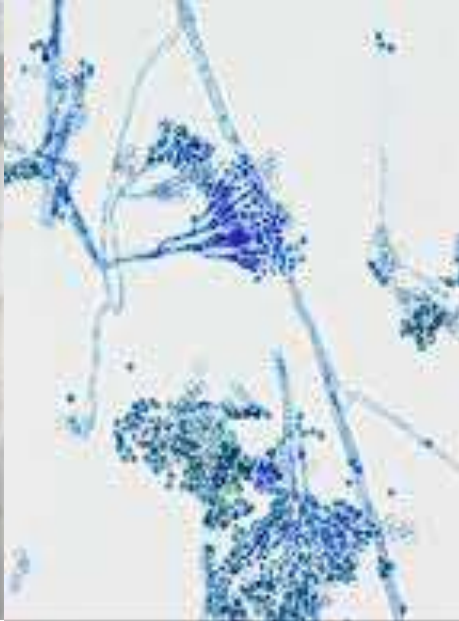
Enterococcus



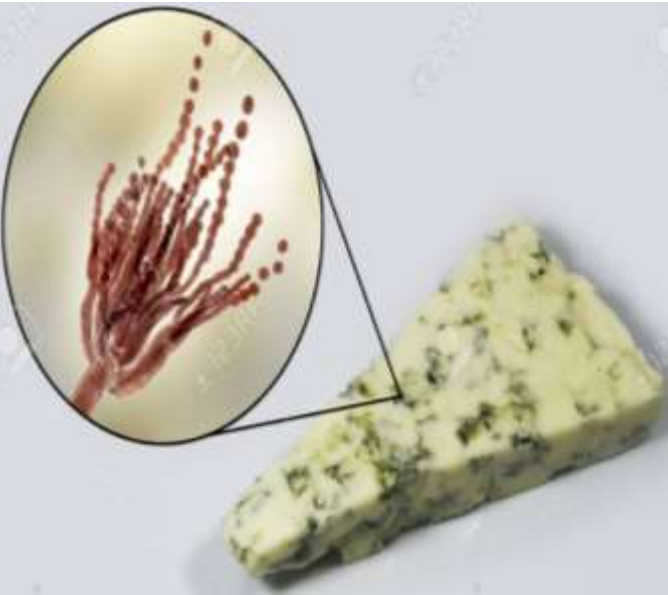
Enterococcus faecium

- White mold is used in manufacture of surface mold ripened cheese (Camembert). eg: *P. camemberti*,
- Blue mold is used in manufacture of internal mold ripened cheese (Roquefort). eg: *P. roqueforti*
- *Geotrichum candidum* is used in the manufacture of Viili (cultured product of Finland) where the mold grows on the surface of the milk to form the white velvety layer.





Mold ripened dairy products



Yeasts are used in the manufacture of Kefir and Kumiss

Kefir grains: Kefir grains consist of a mixture of microorganisms (*Candida kefir*, *Kluyveromyces marxianus*, *Saccharomyces kefir*).

Kumiss: Important starter microflora of kumiss include *Torulopsis* spp., *Kluyveromyces marxianus* var *lactis*, *Saccharomyces cerevisiae*

