

Lactobacillus

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Lactobacillus is a genus of Gram-positive, facultative anaerobic or microaerophilic, rod-shaped, non-spore-forming bacteria.^[1] They are a major part of the lactic acid bacteria group (i.e. they convert sugars to lactic acid). In humans, they constitute a significant component of the microbiota at a number of body sites. In women, *Lactobacillus* species are normally a major part of the vaginal microbiota.^{[2][3]}

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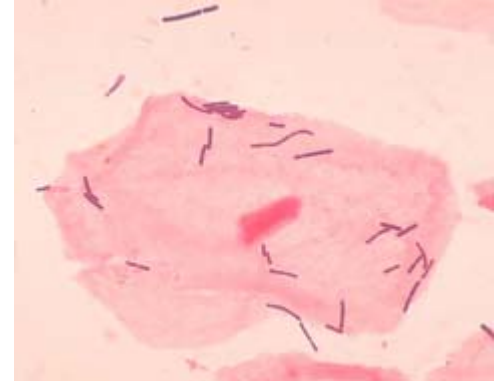
Metabolism

Many lactobacilli operate using homofermentative metabolism (they produce only lactic acid from sugars), and some species use heterofermentative metabolism (they can produce either alcohol or lactic acid from sugars). They are aerotolerant despite the complete absence of a respiratory chain. This aerotolerance is manganese-dependent and has been explored (and explained) in *Lactobacillus plantarum*. Many species of this genus do not require iron for growth and have an extremely high hydrogen peroxide tolerance.

Genome

The genomes of *Lactobacillus* are highly variable, ranging in size from 1.2 to 3.3 Mb (megabases). Accordingly, the number of protein-coding genes ranges from 1,100 to about 3,200 genes.^[4]

Lactobacillus



Lactobacillus near a squamous epithelial cell

Scientific classification

Domain:	Bacteria
Phylum:	Firmicutes
Class:	Bacilli
Order:	Lactobacillales
Family:	Lactobacillaceae
Genus:	<i>Lactobacillus</i> Beijerinck 1901

Species

L. acetotolerans
L. acidifarinae
L. acidipiscis
L. acidophilus
L. agilis
L. algidus
L. alimentarius
L. amylolyticus
L. amylophilus
L. amylotrophicus
L. amylovorus
L. animalis
L. antri
L. apodemi

Lactobacillus consists of a wealth of compound microsatellites in the coding region of the genome, which are imperfect and have variant motifs.^[5]

Taxonomy

The genus *Lactobacillus* currently contains over 180 species and encompasses a wide variety of organisms.^[6] The genus is polyphyletic, with the genus *Pediococcus* dividing the *L. casei* group, and the species *L. acidophilus*, *L. salivarius*, and *L. reuteri* being representatives of three distinct subclades. The genus *Paralactobacillus* falls within the *L. salivarius* group. In recent years, other members of the genus *Lactobacillus* (formerly known as the *Leuconostoc* branch of *Lactobacillus*) have been reclassified into the genera *Atopobium*, *Carnobacterium*, *Weissella*, *Oenococcus*, and *Leuconostoc*. More recently, the *Pediococcus* species *P. dextrinicus* has been reclassified as a *Lactobacillus* species.^[7] According to metabolism, *Lactobacillus* species can be divided into three groups:

- Obligately homofermentative (group I) including:
 - *L. acidophilus*, *L. delbrueckii*, *L. helveticus*, *L. salivarius*
- Facultatively heterofermentative (group II) including:
 - *L. casei*, *L. curvatus*, *L. plantarum*, *L. sakei*
- Obligately heterofermentative (group III) including:
 - *L. brevis*, *L. buchneri*, *L. fermentum*, *L. reuteri*

Clinical uses

Lactobacillus species produce hydrogen peroxide which inhibits the growth and virulence of the fungal pathogen *Candida albicans* *in vitro* and *in vivo*.^{[8][9]} Following antibiotic therapy, certain *Candida* species can suppress the regrowth of *Lactobacillus* species at body sites where they cohabitate, such as in the gastrointestinal tract.^{[8][9]}

Lactobacillus species administered as a single probiotic agent is of no benefit in people with irritable bowel syndrome^[10] or Crohn's disease.^[11] When it is administered in combination with other probiotics, may help people with irritable bowel syndrome, although in a minority of cases may cause negative side effects, uncertainty remains around which type of

L. aviarius
L. bifermantans
L. brevis
L. buchneri
L. camelliae
L. casei
L. catenaformis
L. ceti
L. coleohominis
L. collinoides
L. composti
L. concavus
L. coryniformis
L. crispatus
L. crustorum
L. curvatus
L. delbrueckii subsp. *bulgaricus*
L. delbrueckii subsp. *delbrueckii*
L. delbrueckii subsp. *lactis*
L. dextrinicus
L. diolivorans
L. equi
L. equigenerosi
L. farraginis
L. farciminis
L. fermentum
L. fornicalis
L. fructivorans
L. frumenti
L. fuchuensis
L. gallinarum
L. gasseri
L. gastricus
L. ghanensis
L. graminis
L. hammesii
L. hamsteri
L. harbinensis
L. hayakitensis
L. helveticus
L. hilgardii
L. homohiochii
L. iners
L. ingluviei
L. intestinalis
L. jensenii
L. johnsonii

probiotic works best, and around the size of the effect.^[10] Lactobacillus and bifidobacteria probiotics can reduce clinical symptoms of pouchitis and cholangitis.^[12] *L. acidophilus* is used to prevent necrotizing enterocolitis and other neonatal infections.^[13]

Some *Lactobacillus* species have been associated with cases of dental caries. Lactic acid can corrode teeth, and the *Lactobacillus* count in saliva has been used as a "caries test" for many years. Lactobacilli characteristically cause existing carious lesions to progress, especially those in coronal caries. The issue is, however, complex, as recent studies show probiotics can allow beneficial lactobacilli to populate sites on teeth, preventing streptococcal pathogens from taking hold and inducing dental decay. The scientific research of lactobacilli in relation to oral health is a new field and only a few studies and results have been published.^{[14][15]}

Food production

Some *Lactobacillus* species are used as starter cultures in industry for controlled fermentation in the production of yogurt, cheese, sauerkraut, pickles, beer, cider, kimchi, cocoa, kefir, and other fermented foods, as well as animal feeds. The antibacterial and antifungal activity of *Lactobacillus* species rely on production of bacteriocins and low molecular weight compounds that inhibits these microorganisms.^[16]

Sourdough bread is made either spontaneously, by taking advantage of the bacteria naturally present in flour, or by using a "starter culture", which is a symbiotic culture of yeast and lactic acid bacteria growing in a water and flour medium. The bacteria metabolize sugars into lactic acid, which lowers the pH of their environment, creating a signature "sourness" associated with yogurt, sauerkraut, etc.

In many traditional pickling processes, vegetables are submerged in brine, and salt-tolerant *Lactobacillus* species feed on natural sugars found in the vegetables. The resulting mix of salt and lactic acid is a hostile environment for other microbes, such as fungi, and the vegetables are thus preserved—remaining edible for long periods.

L. kalixensis
L. kefiranofaciens
L. kefiri
L. kimchii
L. kitasatonis
L. kunkeei
L. leichmannii
L. lindneri
L. malefermentans
L. mali
L. manihotivorans
L. mindensis
L. mucosae
L. murinus
L. nagelii
L. namurensis
L. nantensis
L. oligofermentans
L. oris
L. panis
L. pantheris
L. parabrevis
L. parabuchneri
L. paracasei
L. paracollinoides
L. parafarraginis
L. parakefiri
L. paralimentarius
L. paraplanctarum
L. pentosus
L. perolens
L. plantarum
L. pontis
L. protectus
L. psittaci
L. rennini
L. reuteri
L. rhamnosus
L. rimae
L. rogosae
L. rossiae
L. ruminis
L. saerimneri
L. sakei
L. salivarius
L. sanfranciscensis
L. satsumensis

Lactobacilli, especially *L. casei* and *L. brevis*, are some of the most common beer spoilage organisms. They are, however, essential to the production of sour beers such as Belgian lambics and American wild ales, giving the beer a distinct tart flavor.

See also

- Lactic acid fermentation
- MRS agar
- *Pediococcus*
- Probiotics

References

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In vitro, bacterial hydrogen peroxide or organic acids can inhibit *C. albicans* growth and virulence⁶¹
In vivo, *Lactobacillus* sp. can inhibit the GI colonisation and infection of *C. albicans*⁶²
In vivo, *C. albicans* can suppress *Lactobacillus* sp. regeneration in the GI tract after antibiotic therapy^{63, 64}"

L. secaliphilus
L. sharpeae
L. siliginis
L. spicheri
L. suebicus
L. thailandensis
L. ultunensis
L. vaccinostercus
L. vaginalis
L. versmoldensis
L. vini
L. vitulinus
L. zeae
L. zymae

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External links

- Data related to *Lactobacillus* at Wikispecies
- List of species of the genus *Lactobacillus* (<http://www.bacterio.cict.fr/l/lactobacillus.html>)
- *Lactobacillus* at Milk the Funk Wiki (<http://www.milkthefunk.com/wiki/Lactobacillus>)
- *Lactobacillus* at BacDive - the Bacterial Diversity Metadatabase (<http://bacdive.dsmz.de/index.php?search=Lactobacillus&submit=Search>)

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Categories: Lactobacillaceae | Food science | Gut flora bacteria | Garde manger

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