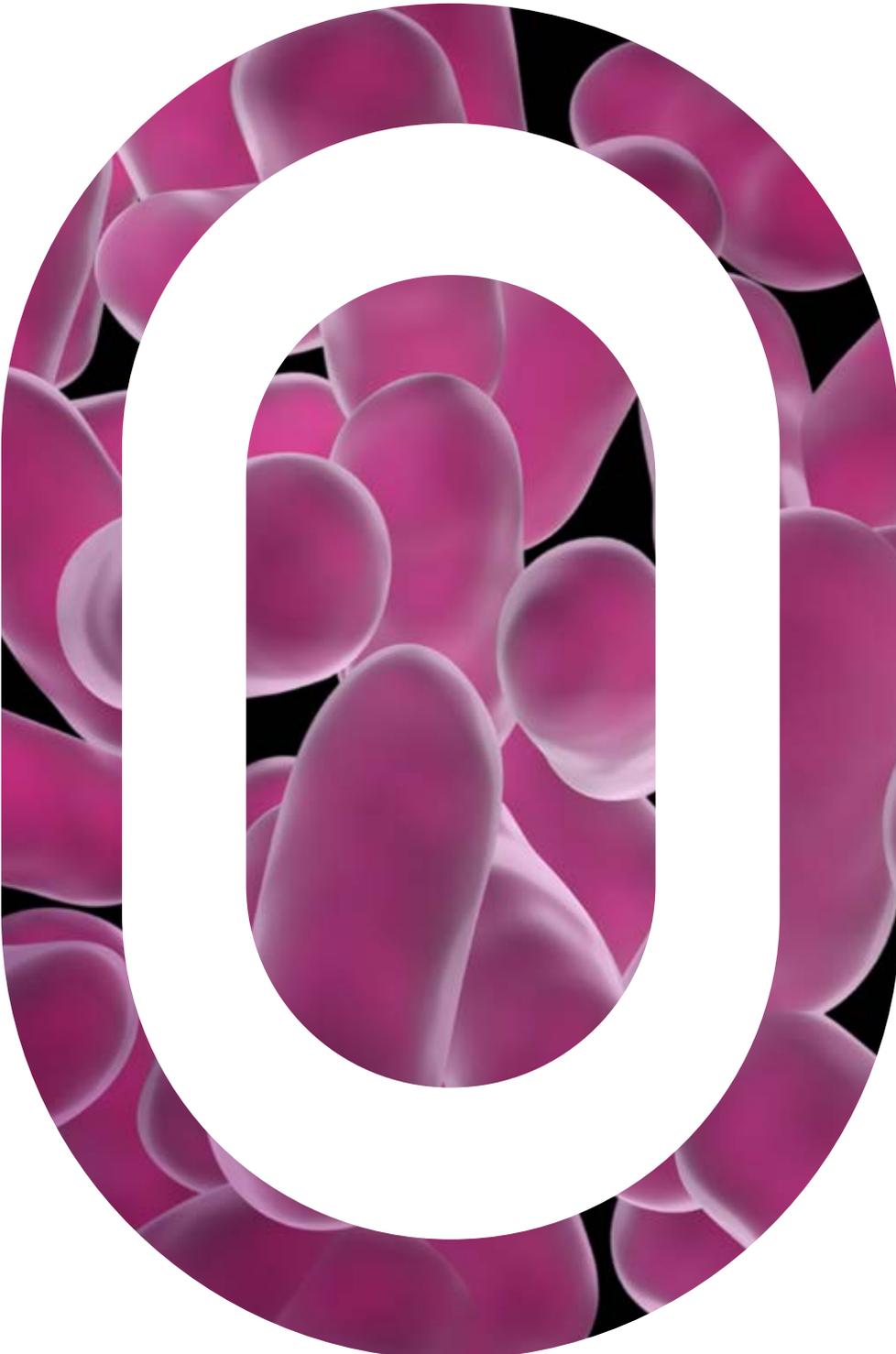


# WINE BACTERIA

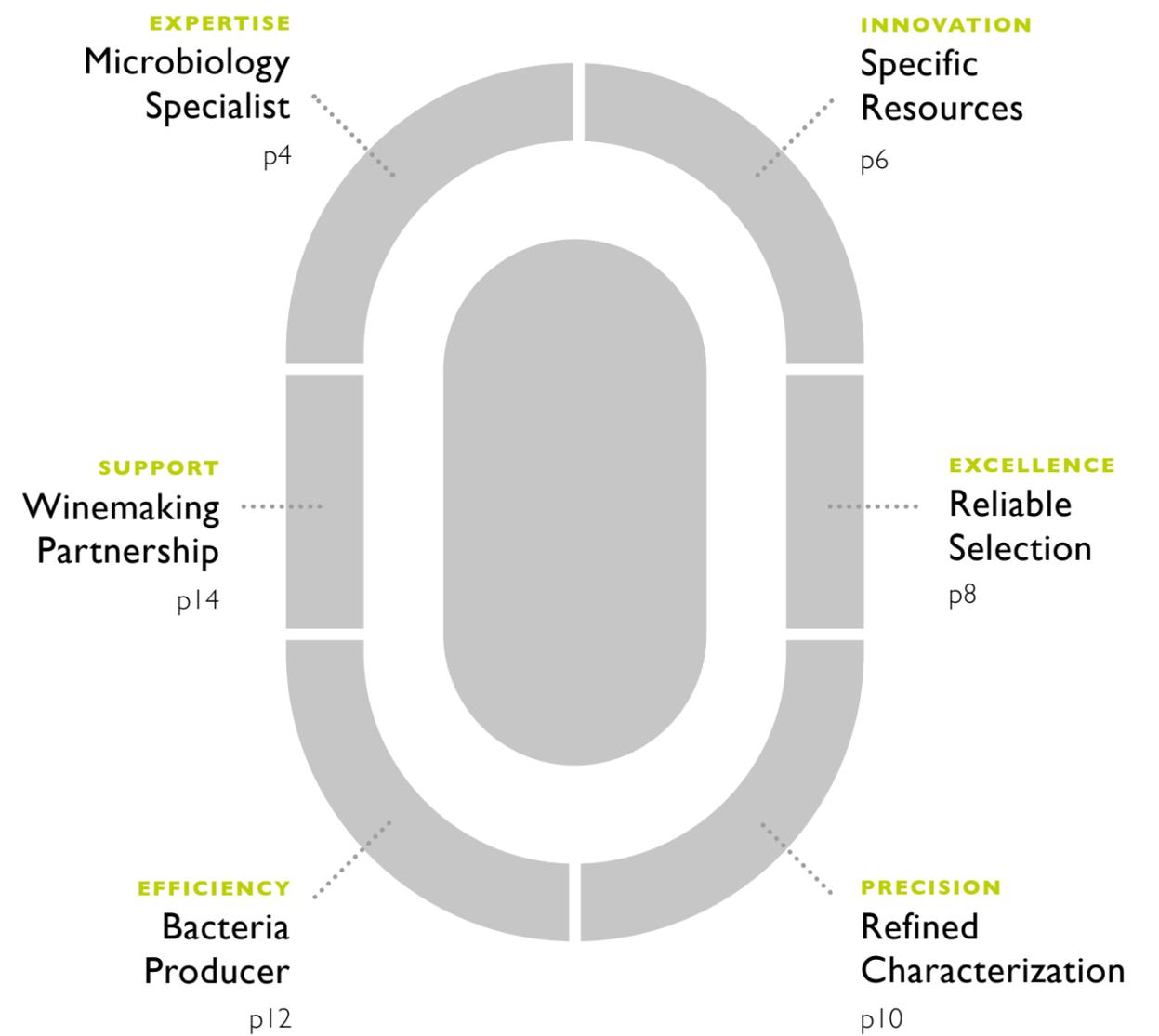




## Lallemand oenology

A world-leading expert in wine bacteria, we develop solutions that ensure the control of winemaking processes and optimize the quality of wines according to desired sensory profiles.

**These natural solutions come from a synergy of 6 essential skills:**



# MICROBIOLOGY SPECIALIST

Lallemand is recognized as a world specialist in microbiology, an expert in the development and production of yeast and bacteria.

In addition to our in-depth knowledge of yeasts and alcoholic fermentation, we have specialists in malolactic fermentation (MLF) and lactic acid bacteria for winemaking.

## THE METABOLISM OF BACTERIA ALLOWS MUCH MORE THAN THE SIMPLE DEACIDIFICATION OF WINE

MLF, conventionally associated with a deacidification step of degrading malic acid into lactic acid by wine bacteria, is necessary to stabilize wine.

However, as recent scientific studies by researchers (E. Bartowsky, C. Knoll, M. du Toit, P. Lucas) attest, the role played by wine bacteria during MLF can no longer be limited to 'only' degrading malic acid.

The metabolism of lactic acid bacteria is - as in the case for yeast - very complex. During MLF, several metabolic pathways can lead to the transformation of compounds that are naturally present in the must or the wine. These will then directly influence the wine's sensory expression as well as its final quality.

Whereas negative aromas are often associated with an uncontrolled MLF, the use of our selected bacteria can not only stabilize fermentation but also reveal positive aromas and act on the wine's texture.

« We are passionate about wine bacteria and malolactic fermentation »

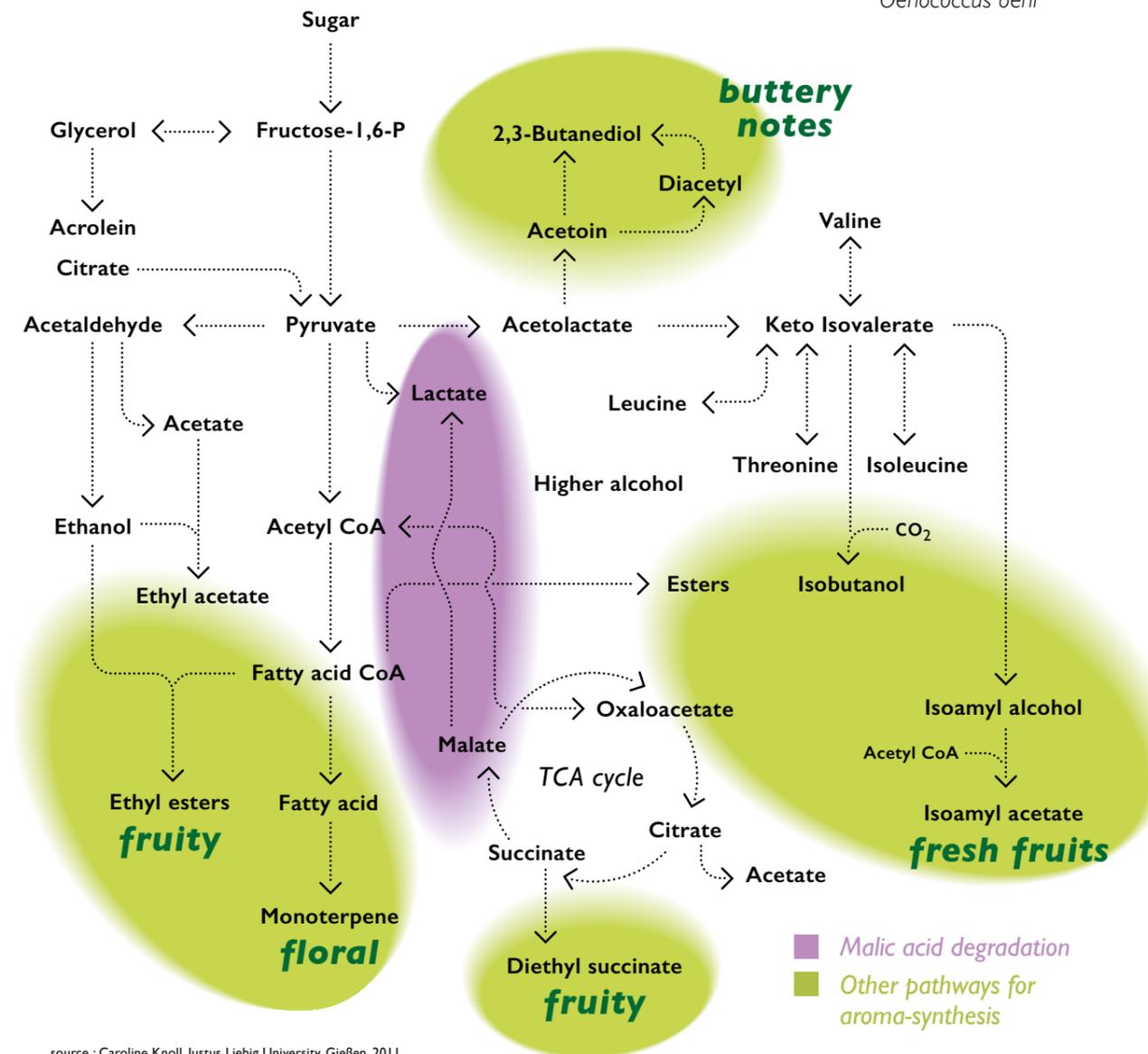


*Lactobacillus plantarum*



*Oenococcus oeni*

## Metabolic pathways : aroma impacts during MLF



source : Caroline Knoll, Justus Liebig University, Gießen, 2011

# SPECIFIC RESOURCES

For 25 years, we have been convinced of the importance of better understanding MLF and the major role that bacteria play in winemaking processes, as such we have continuously invested in:

- deepening our knowledge of MLF and the positive impact of bacteria in wines, by building external partnerships with universities and technical institutes
- enhancing the skills of our fully-dedicated internal MLF team, coordinating together with our regional teams around the world
- production plants and tools to supply high-performance bacteria with the required quality certifications
- innovating and developing different bacteria production processes in freeze-dried form, specific to each bacteria and meeting different winemaking needs
- marketing natural, effective solutions adapted to different oenological conditions

« We innovate and we distinguish ourselves with dedicated resources and long-term investments »



## DEDICATED HUMAN AND MATERIAL RESOURCES

### An R&D team with high level partnerships

To deepen our knowledge, our Research and Development (R&D) team dedicated to wine bacteria, implements research projects in collaboration with scientists from around the world and with our internal research units.

Some of Lallemand Oenology's pioneering solutions have become common practice in wineries for many years. Among them, is co-inoculation (bacteria inoculation 24 to 48 hours after the addition of yeasts), the use of wine bacteria as a bio-control tool to protect wines against the development of contaminating flora and their adverse effects on the final quality, as well as the use of bacteria for their sensory impact (beyond diacetyl).

### Production line control and product quality

From the laboratory to our bacteria production plants, we ensure the development of optimized production processes for each bacteria. We guarantee the efficiency of our products, according to specific and reliable quality control criteria.

### Transmission of our know-how

The R&D team shares its know-how with winemakers through events such as the ML School and technical documentation. In parallel, Lallemand Oenology teams - ambassadors of our expertise on bacteria - effectively and sustainably transfer our knowledge of wine bacteria into the winery.

# RELIABLE SELECTION

**As with yeasts, we have set up strict lactic acid bacteria selection programs with various specialized technical institutes from different wine-growing countries or European projects. Our selections are validated at pilot stage and then in wineries, on different grape varieties and in all wine producing countries, before their commercial launch.**

All our selected bacteria have been isolated from spontaneous MLF of interest. Selection consists of identifying performing bacteria within a collection, that are able to meet specific oenological criteria such as resistance to alcohol, acidity, high levels of SO<sub>2</sub> and the temperature of MLF. We also validate their inability to produce biogenic amines.

Selection is a long but essential scientific step to fully appreciate and guarantee the fermentative performances of the selected bacteria and to define its best conditions of use. This professional approach goes well beyond a simple job of isolation or micro-selection.

« We aim to provide an organism with exceptional qualities »

## From the laboratory to the winery in 6 steps and no less than 5 years

- 1 - Compilation of a collection of bacteria isolated from spontaneous MLF
- 2 - Selection of the most promising strains to meet defined criteria
- 3 - Determination of genetic profiles  
- Study the bacteria's malolactic capacities under different oenological conditions
- 4 - Feasibility study for production in freeze-dried form and validation of quality and efficiency of products in the laboratory and experimental tanks  
- In-depth characterization of the bacteria
- 5 - Optimization of production processes  
- Industrial production  
- Winery trials  
- Validation trials in experimental tanks and at wineries throughout the world on different grape varieties
- 6 - Commercial pre-launch of a selected bacteria product



**TESTIMONIAL**  
**VINCENT GERBAUX**  
Bacteria selection partner  
IFV – Beaune, France

“A winery is home to a multitude of micro-organisms that can interfere with vinification. Some will participate in the process favorably and others unfavorably.

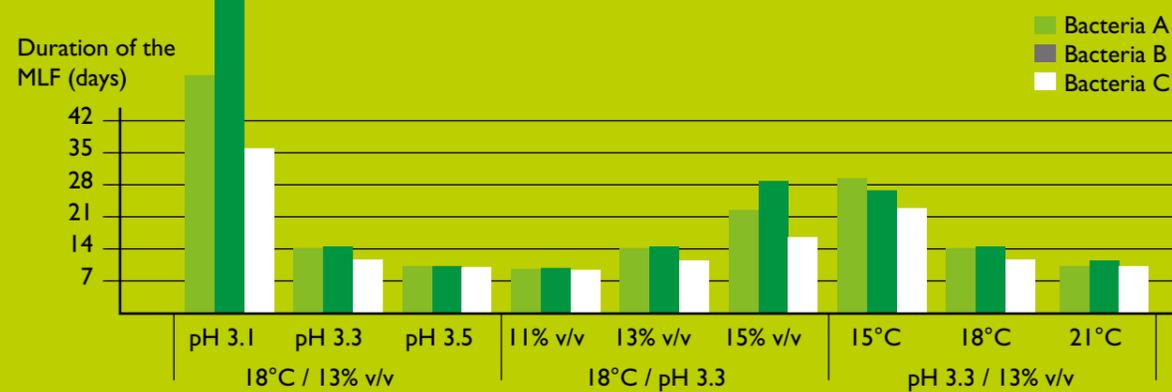
This microcosm is diverse and becomes more so with successive vintages. Each species can be represented by a multitude of strains.

This is the case of the lactic acid bacteria *Oenococcus oeni*, which is very specific to wine. Without exterior influence, it is impossible to predict the development of particular strains and even harder to favor the best of them.

The art of the bacteria selection is therefore to identify the most promising strain for a given oenological application, and then integrate the development of an efficient biomass from this 'rare bird'.

Scientific advancement allows a clearer understanding of how lactic acid bacteria evolve; along with the pure control of MLF, selected lactic acid bacteria are progressively recognized for their sensory impact and bioprotective effect.”

**Fermentation performance control depending on pH, alcohol and temperature**



# REFINED CHARACTERIZATION

No two bacteria have the same abilities. In order to recommend their use according to your different winemaking concerns we need to know them very well. That is why we characterize bacteria according to 14 criteria grouped into 3 main axes: capacity, resistance and sensory contribution.

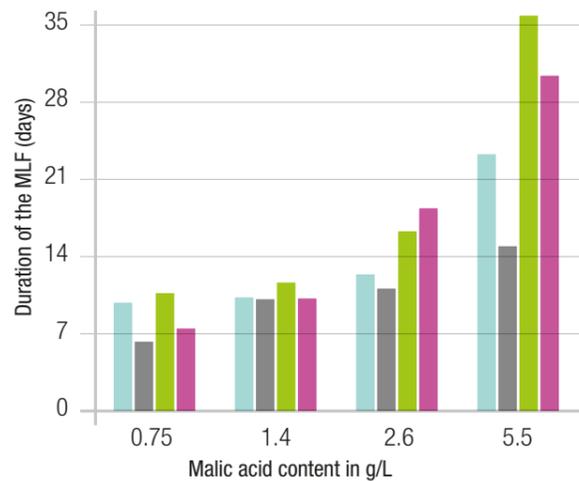
In-depth characterization of our bacteria has become possible thanks to new analysis techniques. Identifying the complete genome of our bacteria, means that we can better characterize them at the phenotype level, that is to say better understand their expressions in musts and wines.

## CAPACITY

- Ability to co-inoculate
- Does not produce biogenic amines
- Ability to consume high levels of malic acid
- Non-production of precursors of ethylphenols (cinnamyl esterase activity)
- Bio-control against development of *Brettanomyces*

### Ability of 4 bacteria to degrade different levels of malic acid

Legend: Bacteria 1 (light blue), Bacteria 2 (grey), Bacteria 3 (green), Bacteria 4 (purple)

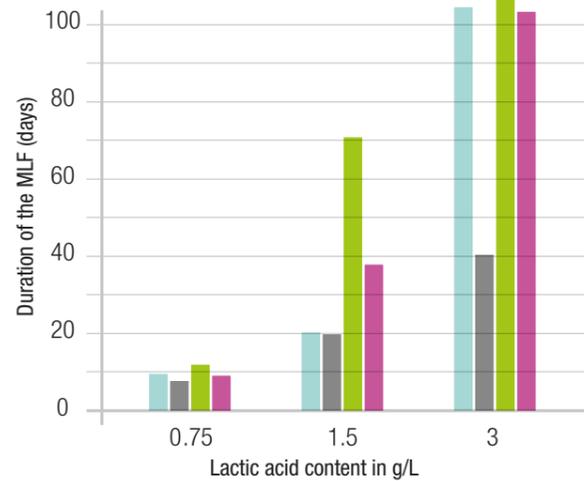


## RESISTANCE

- Tolerance to alcohol, pH, SO<sub>2</sub> and the temperature of MLF
- Low nutritional needs
- Resistance to lactic acid inhibition for some bacteria
- Resistance to polyphenols in wines
- Resistance to certain metals and pesticides

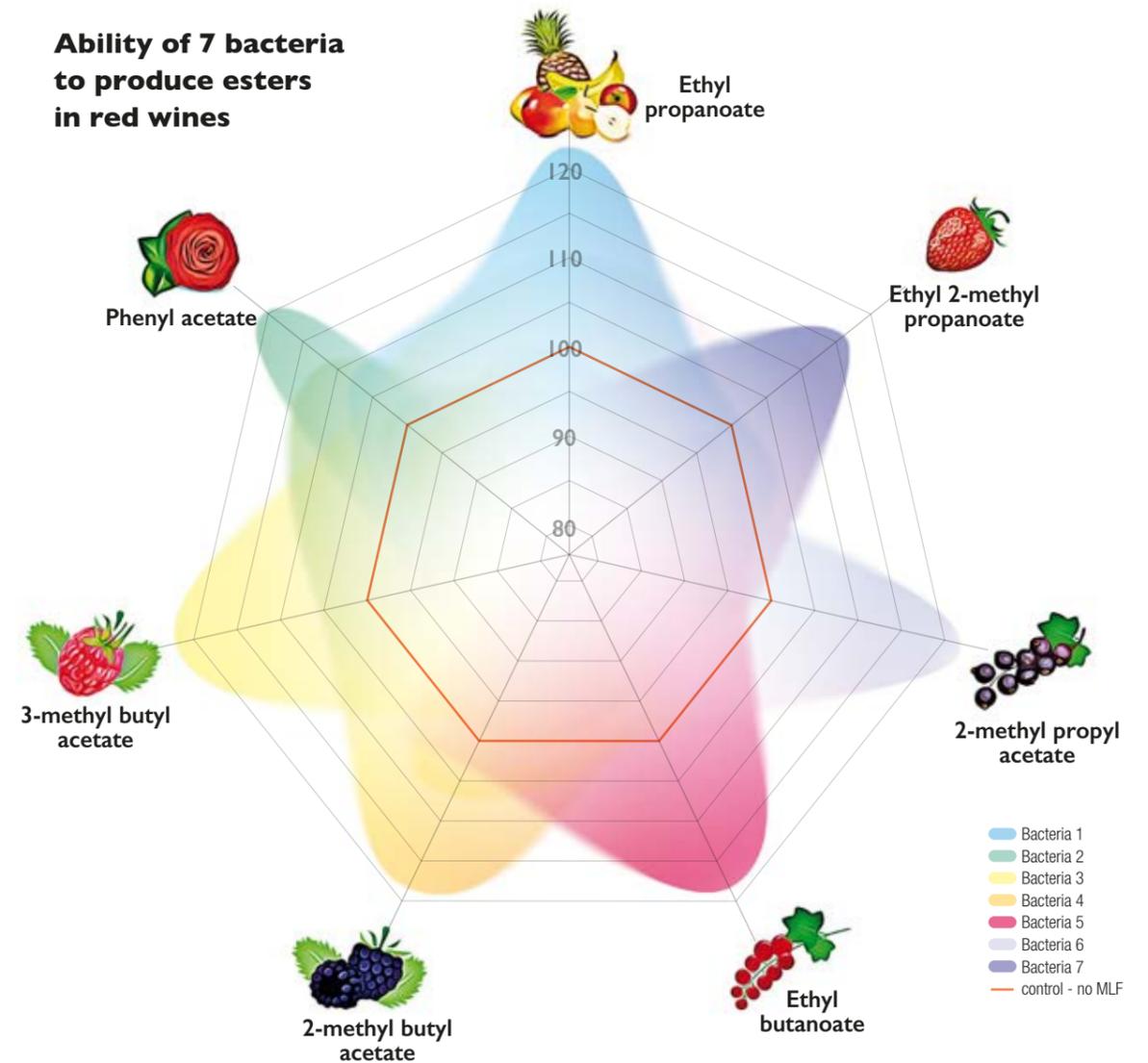
### Resistance of 4 bacteria to different lactic acid concentration

Legend: Bacteria 1 (light blue), Bacteria 2 (grey), Bacteria 3 (green), Bacteria 4 (purple)



« We are the only producer to perform such in-depth characterization of bacteria »

### Ability of 7 bacteria to produce esters in red wines



## SENSORY CONTRIBUTION

- Speed of consumption of citric acid and ability to produce more or less diacetyl
- Ability to produce esters through esterase activities
- Reduce levels of aldehydes (responsible for plant and herbaceous flavors)
- Overall sensory contribution to aromatic expression and wine structure (esterase activities and glycosidases)

# BACTERIA PRODUCER

Lallemand's eight production plants offer a wide range of selected bacteria. The facility in France alone ensures the production of more than 30 different wine bacteria (*Oenococcus oeni* and *Lactobacillus plantarum*), as well as a kosher passover bacteria.

Wine bacteria production is a rigorous and lengthy procedure, that requires technical expertise to provide bacteria that can survive and grow as soon as they are inoculated into the extreme environment of wine.

### THREE SPECIFIC METHODS

Our solution to the great diversity of oenological conditions, is to have developed three main processes for bacteria production: the **MBR™** process, the **I-STEP™** process and the **Standard™** process.

**Our MBR™ bacteria are recognized for their unequaled robustness as soon as they are directly introduced into wine, a factor that is equally if not more important than the initial concentration of bacteria.**



### TESTIMONIAL

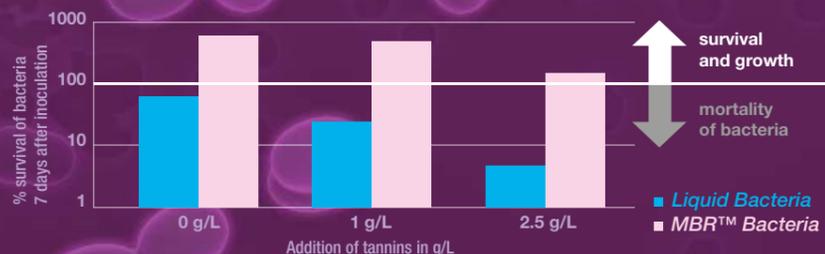
**PATRICK LUCAS**  
Scientific partner  
ISVV - Bordeaux  
University - France

### PERFORMANCE OF THE MBR™ PROCESS (direct inoculation)

“When studying the resistance of bacteria to polyphenols, we noticed that the preparation method of the starter culture is crucial.

Once the bacteria were removed from wine and cultured in the laboratory in liquid form, the bacteria changed their metabolism and partly lost their ability to survive in wine. Lallemand's MBR™ industrial preparation mode restores this capacity. This is clearly visible when one examines the behavior of strains with increasing amounts of tannins.”

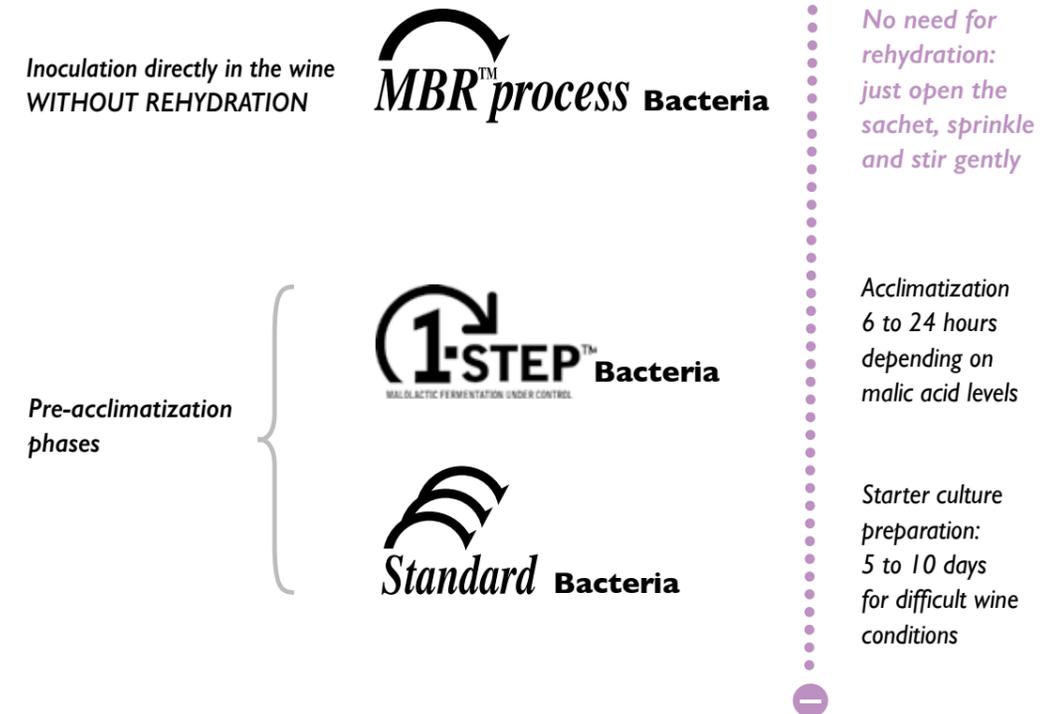
**MBR™ products retain full viability, whereas the same laboratory-grown liquid strains have a high or very high mortality rate.**



Capacity of the same bacteria produced in liquid form or in MBR form to survive in red wine (average of 4 different bacteria).

« Our goal is to offer easy to use freeze-dried bacteria »

### EASY TO USE



### UNIQUELY EASY LOGISTICS

#### Flexibility in shipping methods and possibility of breaking the cold chain without risk.

The robustness of our MBR™ bacteria coupled with our stringent quality criteria, allow them to handle a break in the cold chain shipment. Our research has shown that if the temperature of the bacteria does not exceed 25°C for more than 3 weeks, the quality and the shelf-life of the product are not affected.

### EASY CONSERVATION

#### No special equipment and very long shelf-life.

Our MBR™ bacteria can be stored for 36 months at -18°C (normal freezer) or 18 months at 4°C (fridge). No special freezer equipment is required.

# WINEMAKING PARTNERSHIP

Our goal is to provide wine bacteria that meet the individual needs of your winery. As concerns differ according to vintage, wine region and commercial objectives, we have developed a wide range of bacteria that correspond with different oenological conditions and objectives.

In parallel, our regional teams, established in the world's major wine growing areas, transmit our technical know-how, bringing you informed and personalized advice on how biotechnological tools are essential for good fermentation control and quality of wine.

An understanding of individual situations allows our teams to recommend wine bacteria for integration into your winemaking process.

This winemaking partnership provides you with the necessary support to make a choice of bacteria, understand its correct use and select the most suitable moment for inoculation to achieve your expected results.



« We offer personalized oenological advice »

« We support you as you integrate bacteria into your winemaking process »



ENZYMES



WINE YEASTS



PROTECTORS AND NUTRIENTS



WINE BACTERIA



SPECIFIC INACTIVATED YEASTS

