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# *L. lactis* Host Cell Proteins

## Immunoenzymetric Assay for the Measurement of *Lactococcus lactis* Host Cell Proteins Catalog # F490

### Intended Use

This kit has been specifically developed and qualified for use in detecting *L. lactis* HCPs as pollutants in products produced by recombinant expression in *Lactococcus lactis*. This kit utilizes antibodies raised against and affinity purified from HCPs derived from *L. lactis* spent culture media. The kit is for **Research and Manufacturing Use Only** and is not intended for diagnostic use in humans or animals.

### Summary and Explanation

Recombinant expression of proteins by *L. lactis* is an efficient method to obtain cost effective quantities of a desired protein. Many of these recombinantly produced proteins are intended for use as therapeutic agents in humans and animals and as such must be highly purified. The manufacturing and purification process of these products leaves the potential for impurities by host cell proteins from *L. lactis*. Such pollutants can result in adverse toxic or immunological reactions and thus it is desirable to reduce host cell impurities to the lowest levels practical.

Immunological methods using antibodies to HCPs such as Western Blot and ELISA are conventionally accepted. *Cygnus Technologies* also sells a Western Blot kit (Cat # F495) using the same antibodies employed in this ELISA kit. While Western Blot is a useful method aiding in the identity of HCPs, it suffers from a number of limitations. We recommend use of Western Blot only for use in establishing the reactivity of the antibodies in this kit to very upstream, concentrated sources of your *L. lactis* strain proteins such as cell lysate or culture media. Western Blot is a complex and technique dependent procedure requiring a subjective interpretation of results. The sensitivity of Western Blot is severely limited by the volume of sample that can be tested and by interference from the presence of high concentrations of the intended product. Western Blot may be able to detect HCPs in samples from upstream in the purification process but will lack adequate sensitivity and specificity to detect HCPs in purified downstream and final product. The microtiter plate immunoenzymetric assay (ELISA) method employed in this kit overcomes the limitations of Western Blots providing on the order of 100 fold better sensitivity. This simple to use, highly sensitive, objective, and semi-quantitative ELISA is a powerful method to aid in optimal purification process development, process control, routine quality control, and product release testing. The antibodies have been generated against and affinity purified from HCPs obtained from the spent culture media of a null cell line. Because of the high sensitivity and broad reactivity of the antibodies, this kit has

been successfully qualified for testing of final product HCPs as well as in-process samples. The suitability of this kit for sample types not previously qualified must be established experimentally by each laboratory. Western blot was used as a preliminary method and established that the antibodies reacted to the majority of HCP bands resolved by the PAGE separation. If you have a need of a more sensitive method to demonstrate coverage to HCPs in your process *Cygnus Technologies* recommends a method that is superior to Western blot called Antibody Affinity Extraction (AAE). AAE is has greatly increased sensitivity and specificity to Western blot which makes it a better predictor of how the antibodies will perform in the ELISA. For additional information on AAE please visit our website and read the posted articles under Technical Documents or contact our Technical Services Department.

### Principle of the Procedure

The *L. lactis* assay is a two-site immunoenzymetric assay. Samples containing *L. lactis* HCPs are reacted with a horseradish peroxidase (HRP) enzyme labeled anti-*L. lactis* antibody simultaneously in microtiter strips coated with an affinity purified capture anti-*L. lactis* antibody. The immunological reactions result in the formation of a sandwich complex of solid phase antibody-HCP-enzyme labeled antibody. The microtiter strips are washed to remove any unbound reactants. The substrate, tetramethylbenzidine (TMB) is then reacted. The amount of hydrolyzed substrate is read on a microtiter plate reader and is directly proportional to the concentration of *L. lactis* HCPs present.

### Reagents & Materials Provided

Component	Product #
<b>Anti-<i>L. lactis</i>:HRP</b> Affinity purified goat antibody conjugated to HRP in a protein matrix with preservative. 1x12mL	<b>F491</b>
<b>Anti-<i>L. lactis</i> coated microtiter strips</b> 12x8 well strips in a bag with desiccant	<b>F492*</b>
<b><i>L. lactis</i> Standards</b> <i>L. lactis</i> HCPs in a bovine serum albumin matrix with preservative. Standards at 0, 1, 3, 12, 40, and 100ng/mL. 1 mL/vial	<b>F493</b>
<b>Stop Solution</b> 0.5M sulfuric acid. 1x12mL	<b>F006</b>
<b>TMB Substrate</b> 3,3',5,5' Tetramethylbenzidine. 1x12mL	<b>F005</b>
<b>Wash Concentrate (20X)</b> Tris buffered saline with preservative. 1x50mL	<b>F004</b>

\*All components can be purchased separately except # F492.

## Storage & Stability

- All reagents should be stored at 2°C to 8°C for stability until the expiration date printed on the kit.
- After prolonged storage, you may notice a salt precipitate and/or yellowing of the wash concentrate. These changes will not impact assay performance. To dissolve the precipitate, mix the wash concentrate thoroughly and dilute as directed in the 'Preparation of Reagents' section.
- Reconstituted wash solution is stable until the expiration date of the kit.

## Materials & Equipment Required But Not Provided

- Microtiter plate reader spectrophotometer with dual wavelength capability at 450 & 650nm. *(If your plate reader does not provide dual wavelength analysis you may read at just the 450nm wavelength.)*
- Pipettors - 50µL and 100µL
- Repeating or multichannel pipettor - 100µL
- Microtiter plate rotator (400 - 600 rpm)
- Sample Diluent (recommended Cat # I028)
- Distilled water
- 1 liter wash bottle for diluted wash solution

## Precautions

- **For Research or Manufacturing use only.**
- **Stop reagent is 0.5M H<sub>2</sub>SO<sub>4</sub>. Avoid contact with eyes, skin, and clothing.**
- **This kit should only be used by qualified technicians.**

## Preparation of Reagents

- Bring all reagents to room temperature.
- Dilute wash concentrate to 1 liter in distilled water, label with kit lot and expiration date, and store at 4°C.

## Procedural Notes

1. Complete washing of the plates to remove excess unreacted reagents is essential to good assay reproducibility and sensitivity. We advise against the use of automated or other manual operated vacuum aspiration devices for washing plates as these may result in lower specific absorbances, higher non-specific absorbance, and increased imprecision. The manual wash procedure described below generally provides lower backgrounds, higher specific absorbance, and better precision. If duplicate CVs are poor or if the absorbance of the 0

standard is greater than 0.200, evaluate plate washing procedure for proper performance.

2. High Dose Hook Effect or poor dilutional linearity may be observed in samples with very high concentrations of HCP. High Dose Hook Effect is due to insufficient excess of antibody for very high concentrations of HCPs present in the samples upstream in the purification process. Samples greater than 250µg/mL may give absorbances less than the 100ng/mL standard. It is also possible for samples to have certain HCPs in concentrations exceeding the amount of antibody for that particular HCP. In such cases the absorbance of the undiluted sample may be lower than the highest standard in the kit however these samples will fail to show acceptable dilutional linearity/parallelism as evidenced by an apparent increase in dilution corrected HCP concentration with increasing dilution. High Dose Hook and poor dilutional linearity are most likely to be encountered from samples early in the purification process. If a hook effect is possible, samples should also be assayed diluted. If the HCP concentration of the undiluted sample is less than the diluted sample this may be indicative of the hook effect. Such samples should be diluted at least to the minimum required dilutions (MRDs) as established by your qualification studies using your actual final and in-process drug samples. The MRD is the first dilution at which all subsequent dilutions yield the same HCP value within the statistical limits of assay precision. The HCP value to be reported for such samples is the dilution corrected value at or greater than the established MRD. The diluent used should be compatible with accurate recovery. The preferred diluent is our Cat# I028 available in 100mL, 500mL, or 1 liter bottles. This is the same material used to prepare the kit standards. As the sample is diluted in I028 its matrix begins to approach that of the standards thus reducing any inaccuracies caused by dilutional artifacts. Other prospective diluents must be tested for recovery by using them to dilute the 100ng/mL standard, as described in the "Limitations" section below.

3. If the substrate has a distinct blue color prior to performing the assay it may have been contaminated. If this appears to be the case, read 100µL of substrate plus 100µL of stop against a water blank. If the absorbance is greater than 0.1 it may be necessary to obtain new substrate or the sensitivity of the assay may be compromised.

4. Strips should be read within 30 minutes after adding stop solution since color will fade over time.

## Limitations

- Before relying exclusively on this assay to detect host cell proteins, each laboratory should qualify that the kit antibodies and assay procedure yield acceptable specificity, accuracy, and precision. A suggested protocol for this qualification can be obtained by contacting our Technical Services Department or at our web site.
- The standards used in this assay are comprised of *L. lactis* HCPs obtained from cultured media. 1D Western blot analysis of the antibodies used in this kit demonstrates that they recognize the majority of distinct PAGE separated bands seen using a sensitive protein staining method like silver stain or colloidal gold. This kit has been extensively qualified for HCP detection in samples types used in a product specific purification procedure. If this kit is to be applied to other products or sample types, it must be qualified to establish acceptable accuracy and specificity for those sample types. If you desire a much more sensitive and specific method than western blot to detect the reactivity of the antibodies in this kit to your individual HCPs *Cygnus Technologies* is pleased to perform AAE as a service to provide coverage information of the antibodies to the HCPs in your process samples.
- Certain sample matrices may interfere in this assay. The product protein itself, high or low pH, high salt, detergents, organic solvents or other components in the sample matrix may result in either positive or negative interference in this assay. It is advised to test all sample matrices for interference by diluting the 100ng/mL standard, 1 part to 4 parts of the matrix containing no or very low HCP pollutants. This diluted standard when assayed as an unknown should give an added HCP value of 16 to 24 ng/mL. Consult *Cygnus Technologies* Technical Service Department for advice on how to quantitate the assay in problematic matrices.

## Quality Control

- It is recommended that each laboratory assay appropriate quality control samples in each run to ensure that all reagents and procedures are correct. **You are strongly urged to make controls in your typical sample matrix using HCPs derived from your cell line. These controls can be aliquoted into single use vials and stored frozen for long-term stability.**
- Precision on duplicate samples should yield average % coefficients of variation of less than 10% for samples in the range of 1 – 100 ng/mL. CVs for samples less than 3ng/mL may be greater than 10%.

## Assay Protocol

- The assay is very robust such that assay variables like incubation times, sample size, and other sequential incubation schemes can be altered to manipulate assay performance for more sensitivity, increased upper analytical range, or reduced sample matrix interference. Before modifying the protocol from what is recommended, users are advised to contact our technical services for input on the best way to achieve your desired goals.
- The protocol specifies the use of an approved orbital microtiter plate shaker for the immunological step. These can be purchased from most laboratory supply companies. If you do not have such a device it is possible to incubate the plate without shaking, however, it will be necessary to extend the immunological incubation step by about one hour in order to achieve comparable results to the shaking protocol. **Do not shake during the 30-minute substrate incubation step as this may result in higher backgrounds and worse precision.**
- Bring all reagents to room temperature.
- Thorough washing is essential to proper performance of this assay. Automated plate washing systems or other vacuum aspiration devices are not recommended. The manual method described in the assay protocol is preferred for best precision, sensitivity and accuracy. A more detailed discussion of this procedure can be obtained from our Technical Services Department or on our web site. In addition, a video demonstration of proper plate washing technique is available in the 'Technical Help' section of our web site.
- Set-up plate spectrophotometer to read dual wavelength at 450nm for the test wavelength and 650nm for the reference wavelength. We suggest blanking the instrument using the zero standard wells after assay completion.
- All standards, controls and test samples should be assayed at least in duplicate.
- Maintain a repetitive timing sequence from well to well for all assay steps to ensure that all incubation times are the same for each well.
- Make a work list for each assay to identify the location of each standard, control, and sample.

## Assay Protocol

1. Pipette 100 $\mu$ L of anti-*L. lactis*:HRP (#F491) into each well.
2. Pipette 50 $\mu$ L of standards, controls and samples in duplicate wells indicated on work list.
3. Cover & incubate on orbital shaker at 400-600 rpm for 2 hours at room temperature, 24°C  $\pm$  4°C.
4. Dump contents of wells into waste. Blot and gently but firmly tap over absorbent paper to remove most of the residual liquid. Overly aggressive banging of the plate or use of vacuum aspiration devices in an attempt to remove all residual liquid is not necessary and may cause variable dissociation of antibody bound material resulting in lower ODs and worse precision. Fill wells generously to overflowing with diluted wash solution using a squirt bottle or by pipetting in  $\sim$ 350 $\mu$ L. Dump and tap again. Repeat for a total of 4 washes. Wipe off any liquid from the bottom outside of the microtiter wells as any residue can interfere in the reading step. Do not allow wash solution to remain in wells for longer than a few seconds. Do not allow wells to dry before adding substrate.
5. Pipette 100 $\mu$ L of TMB substrate (#F005).
6. Incubate at room temperature for 30 minutes. DO NOT SHAKE.
7. Pipette 100 $\mu$ L of Stop Solution (#F006).
8. Read absorbance at 450/650nm.

## Calculation of Results

The standards may be used to construct a standard curve with values reported in ng/mL. The preferred data reduction algorithm is point-to-point. Other curve fitting routines such as 4 parameter and cubic spline have also been demonstrated to provide accurate interpolation results. **Do not use linear regression analysis to interpolate values for samples as this may lead to significant inaccuracies!** Data may also be manually reduced by plotting the absorbance values of the standards on the y-axis versus concentration on the x-axis and drawing a smooth point-to-point line. Absorbances of samples are then interpolated from this standard curve.

## Example Data

Well #	Contents	Abs. at 450-650nm	Mean Abs.
A1	Zero Std	0.086	0.089
B1	Zero Std	0.091	
C1	1ng/mL	0.139	0.139
D1	1ng/mL	0.138	
E1	3ng/mL	0.230	0.225
F1	3ng/mL	0.219	
G1	12ng/mL	0.573	0.578
H1	12ng/mL	0.582	
A2	40ng/mL	1.497	1.520
B2	40ng/mL	1.543	
C2	100ng/mL	3.185	3.172
D2	100ng/mL	3.159	

## Performance Characteristics

*Cygnus Technologies* has qualified this assay by conventional criteria as indicated below. This qualification is generic in nature and is intended to supplement but not replace certain user and product specific qualification and qualification that should be performed by each laboratory. At a minimum each laboratory is urged to perform a spike and recovery study in their sample types. In addition, any of your samples types containing process derived HCPs within or above the analytical range of this assay should be evaluated for dilutional linearity to ensure that the assay is accurate and has sufficient antibody excess for your particular HCPs. Each laboratory and technician should also demonstrate competency in the assay by performing a precision study similar to that described below. A more detailed discussion of recommended user qualification protocols can be obtained by contacting our Technical Services Department or at our web site.

### Sensitivity

The lower limit of detection (LOD) is defined as that concentration corresponding to a signal two standard deviations above the mean of the zero standard. LOD in our laboratories was determined to be  $\sim$ 0.125 ng/mL.

The lower limit of quantitation (LOQ) is defined as the lowest concentration, where concentration coefficients of variation (CVs) are less than 20%. The LOQ is conservatively stated as less than 0.5 ng/mL in our laboratories.

## Precision

Both intra (n=20 replicates) and inter-assay (n=10 assays) precision were determined on 3 pools with low (~3ng/mL), medium (~12ng/mL), and high concentrations (~40ng/mL). The % CV is the standard deviation divided by the mean and multiplied by 100.

Pool	Intra assay CV	Inter assay CV
Low	4.8%	4.9%
Medium	2.7%	2.3%
High	2.6%	2.2%

## Specificity/Cross-Reactivity

Each end user must qualify that this kit is adequately reactive and specific for their samples. 1D Western blot is highly orthogonal to ELISA and to non-specific protein staining methods such as silver stain or colloidal gold. As such, the lack of identity between silver stain and western blot does not necessarily mean there is no antibody to that protein or that the ELISA will not detect that protein. If you desire a much more sensitive and specific method than Western blot to detect the reactivity of the antibodies in this kit to your individual HCPs *Cygnus Technologies* is pleased to perform AAE as a service to provide coverage information of the antibodies to the HCPs in your process samples.

. This method has been shown to be much at least 100 fold more sensitive than Western blots in detecting antibody reactivity to individual HCPs. The same antibody as is used for both capture and HRP label can be purchased separately.

Cross reactivity has not been extensively investigated with this kit. HCPs obtained from a lysate of *L. lactis* react broadly with this kit and as evidenced by Western blot analysis. *E.coli*, *Pseudomonas*, and *Staphylococcus* bacterial proteins were not shown to have significant cross reactivity in this assay. You should evaluate components in your samples for positive interferences such as cross reactivity and non-specific binding. Negative interference studies are described below.

## Recovery/ Interference Studies

Various buffer matrices were evaluated by adding known amounts of *L. lactis* HCP preparation used to make the standards. Because this assay is designed to minimize matrix interference most of these buffers yielded acceptable recovery defined as between 80-120%. The standards used in this kit contain 8mg/mL of bovine serum albumin intended to simulate non-specific protein affects of most sample proteins. However very high concentrations in the mg/mL range of some product proteins may interfere in the accurate measurement of HCPs. In general, extremes in pH (less than 6.0 and greater than 8.5), high salt concentration, high polysaccharide concentrations, organic solvents, and most detergents can cause under-recovery. Each user should qualify that their sample matrices yield accurate recovery. Such an experiment can be performed, by diluting the 100ng/mL standard provided with this kit, into the sample matrix in question as described in the "Limitations" section.

## Hook Capacity

Increasing concentrations of HCPs greater than 100 ng/mL were assayed as unknowns. The hook capacity, defined as that concentration which will give an absorbance reading less than the 100ng/mL standard. In such an experiment the hook capacity was determined as greater than 250µg/mL.

## Ordering Information/ Customer Service

*Cygnus Technologies* also offers kits for the extraction and detection of CHO Host Cell DNA. The following kits are available:

- Residual Host Cell DNA extraction:

Cat # D100W, DNA Extraction Kit in 96 deep well plate  
Cat # D100T, DNA Extraction Kit in microfuge tubes

To place an order or to obtain additional product information contact *Cygnus Technologies*:

[www.cygnustechnologies.com](http://www.cygnustechnologies.com)

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