

Primary liver endothelial cells

Importance of passage number in measuring the uptake of large molecules

by Maureen Bunger, Katherine Dunnick;
Lonza Walkersville, Inc., Walkersville, MD, USA

Introduction

Liver endothelial cells (LEC) act as the primary barrier lining the blood vessels and sinusoids of the liver. A unique subtype of LECs, liver sinusoidal endothelial cells (LSEC), are defined as a subset of endothelial cells found at the interface between the liver sinusoids and hepatocytes¹ where oxygen rich blood of the hepatic artery mixes with the nutrient rich blood of the portal vein. LSECs provide a highly fenestrated permeable barrier and are distinguished from general LECs (including vascular and lymphatic endothelial cells) by the ability to absorb a broader range of molecules coming from the enterohepatic blood circulation.

Liver sinusoidal endothelial cells are a major site of antibody recycling^{2,5}, to the degree that much of the pharmacokinetics of antibody therapeutics can be attributed to the clearance capabilities in the liver endothelium³. As such, LSECs are desired for cell culture applications to assess uptake and turnover of antibody therapeutics in development. Primary LSECs can be isolated from intact livers using a combination of tissue digestion, centrifugation, and affinity purification. However, little is known about the ability of isolated LSECs cultured *in vitro* to recapitulate *in vivo* function, especially with respect to culture conditions over time.

Acetylated low density lipoprotein (ALDL) is a ~500 kDa molecule naturally taken up by LSECs at faster rates than by LECs through scavenger receptor mediated uptake⁴. These scavenger receptors are a type of endocytic receptor, similar to Fc receptors important in antibody recycling⁵. Recent research has demonstrated that in cell culture, primary isolations of LSECs quickly lose their permeability to large molecules and become phenotypically similar to LECs¹. In this Tech Note, we demonstrate the importance of using the early passages of isolated mixed LECs for maintaining optimal permeability function of LEC/LSECs isolated from whole human livers. Through these data, we feel that early passage mixed LECs can therefore function as a physiologically relevant *in vitro* model for large molecule uptake and recycling by the sinusoidal endothelium.

Methods

Primary LEC cells were isolated from whole liver, plated into flasks, and cryopreserved when the monolayer reached approximately 80-90% confluence. This was called passage 1.

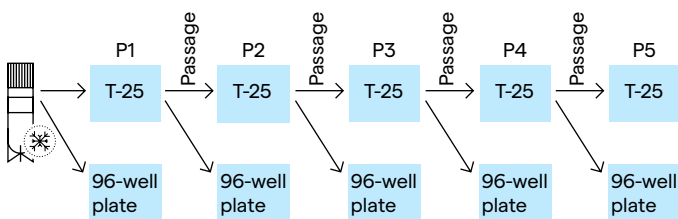


Figure 1. Schematic method of serial passaging to determine effect of passage on ability to uptake ALDL.

Passaging cells

1. Cryopreserved LEC cells at passage 1 (P1) were thawed and plated in flasks at 10,000 cell/cm² using complete EGM™ 2 Medium.

2. Once the monolayer reached ~70% confluence, cells were passaged using standard trypsin methods.
3. Cells were passaged repeatedly until reaching passage 5 (P5).

Cell analysis

1. During initial thaw and after each passage of flasks, a fraction of the cells were plated in 96-well tissue culture plates at 10,000 cells/cm².
2. Once the monolayer reached ~70% confluence, plates were incubated with 15 µg/mL ALDL (ThermoFisher, L23380) for 3 hours at 37°C.
3. Cells were washed 3 times with PBS to remove excess ALDL, incubated with Hoechst nuclear stain, and imaged with the GFP (ex450-490/em500-550nm) and DAP (ex325-375/ em435-485nm) filter cubes.
4. This process was continued until cells reached P5 (Figure 1).

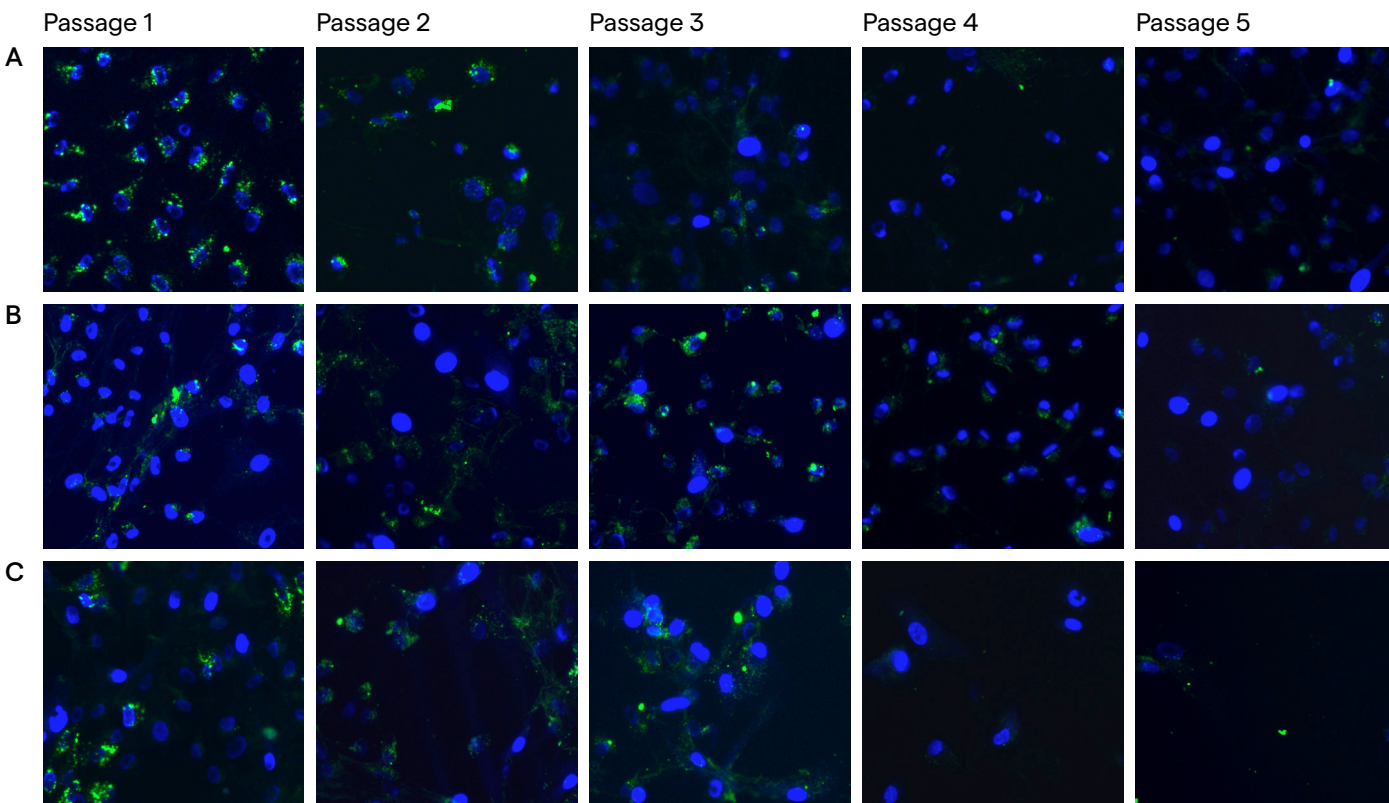


Figure 2. LEC grown from P1 to P5 and assessed for ALDL uptake. (A, B, C) represent three separate lots of LECs. (A) 14 year old Caucasian male (B) 28 year old Caucasian male (C) 51 year old Caucasian female. Nuclei were stained with Hoechst nuclear stain (blue), while ALDL is represented by green fluorescence.

Results

LEC uptake of ALDL decreases throughout passaging

To determine the permeability of the LEC/LSEC population for large molecules, we assessed fluorescently labeled ALDL uptake over 3 hours as a function of passage number. Results demonstrate that as cells are continuously cultured and serially passaged, their ability to take-up ALDL decreases (Figure 2). Donor-to-donor

variability was assessed by assaying LEC/LSECs from three independently isolated donors. Data was collected for 3 donors and demonstrates donor-to-donor variability in the rate of ALDL uptake from P1 to P5. All donors demonstrated decreased ALDL uptake by P3 and little to none by P4 (Figures 2 and 3, Table 1). Donor C showed slowed growth, preventing cells from reaching confluence by passage 5. Additionally, Donor C had declined ALDL uptake in P1 relative to Donors A and B (Table 1).

| | P1 | P2 | P3 | P4 | P5 |
|---|----|----|----|----|----|
| A | 97 | 77 | 24 | 8 | 4 |
| B | 66 | 52 | 70 | 32 | 5 |
| C | 38 | 53 | 58 | 14 | 33 |

Table 1.

Relative % of cells associated with ALDL. Nuclei were counted and compared to number of nuclei associated with fluorescent ALDL. Values are percentages. Note: Donor C's slowed growth limited number of cells for ALDL uptake assessment.

ALDL uptake in LEC cells

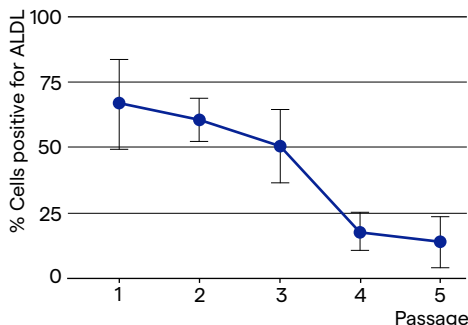


Figure 3. Results were calculated as percentage nuclei associated with ALDL and are shown as mean \pm SEM. Note: Donor C was unable to reach 70% confluence due to slowed growth in culture between passage 4 and 5.

| Catalog no. | Description |
|-------------|---|
| HLECP1 | Human Liver-Derived Endothelial Cells P1 |
| HLECP2 | Human Liver-Derived Endothelial Cells P2 |
| CC-3162 | EGM [®] 2 Endothelial Cell Growth Medium-2 BulletKit [®] |
| CC-3156 | EBM [®] 2 Endothelial Cell Basal Medium-2 |
| CC-4176 | EGM [®] 2 Endothelial Cell Growth Medium-2 SingleQuots [®] Supplements and Growth Factors |

Table 2

Lonza's current liver endothelial cell and media offerings.

Summary

In the process of isolating and purifying endothelial cells from liver, pure populations of LSECs are difficult to obtain and maintain once in culture². Therefore, providing P1 cryopreserved cells with mixed population of LEC and LSECs helps ensure the populations maintain permeability to large molecules as they would *in vivo*.

Our data indicates that P1 mixed LEC/LSEC cells take-up ALDL, indicating the presence of functional LSECs in the mixed population. Though variable between donors, continuing passage of the cells dramatically decreases their uptake and growth potential. By using mixed population of LECs at an early passage, researchers are able to recapitulate the *in vivo* function of uptake and recycling of large molecule nutrients and therapeutics in an *in vitro* setting.

Further, while ALDL can be taken up by other cells in the liver (kupffer, dendritic, etc)², all Human LEC Passage 1 (HLECP1) cells are screened for purity via FACS to ensure that ALDL uptake is not due to the presence of other cell types. Providing a relative uptake percentage of ALDL allows researchers to select lots with appropriate permeability and uptake capabilities for their research.

Liver Endothelial Cell specifications (HLECP1):

- Viability post thaw $\geq 70\%$
- Yield $\geq 1 \times 10^6$ cells/vial
- Purity $\geq 80\%$
- ALDL uptake and LSEC percentage provided as FIO

References:

1. Poisson, J., Lemoine, S., Boulanger, C., Durand, F., Moreau, R., Valla, D., & Rautou, P.-E. (2017). Liver sinusoidal endothelial cells: Physiology and role in liver diseases. *Journal of Hepatology*, 66(1), 212–227. <https://doi.org/10.1016/j.jhep.2016.07.009>.
2. Maretti-Mira, A., & DeLeve, L. (2017). Liver Sinusoidal Endothelial Cell: An Update. *Seminars in Liver Disease*, 37(04), 377–387. <https://doi.org/10.1055/s-0037-1617455>
3. Ganesan, L. P., Kim, J., Wu, Y., Mohanty, S., Phillips, G. S., Birmingham, D.J., Robinson, J. M., Anderson, C. L. (2012). FCγIIb on liver sinusoidal endothelium clears small immune complexes. *Journal of Immunology*, 189(10), 4981-1. <https://doi.org/10.4049/jimmunol.1202017>
4. Ling, W., Lougheed, M., Suzuki, H., Buchan, A., Kodama, T., & Steinbrecher U. P. Oxidized or acetylated low density lipoproteins are rapidly cleared by the liver in mice with disruption of the scavenger receptor class A type I/II gene. *The Journal of Clinical Investigation*, 100(2), 244-252. <https://doi.org/10.1172/JCI119528>
5. Ganesan, L. P., Mates, J. M., Cheplowitz, A. M., Avila, C. L., Zimmerer, J. M., Yao, Z., Maiseyeu, A., Rajaram, M. V. S., Robinson, J. M., & Anderson, C.L. Scavenger receptor B1, the HDL receptor is expressed abundantly in liver sinusoidal endothelial cells. *Scientific Reports*, 6, 20646. <https://doi.org/10.1038/srep20646>

Contact us

North America

Customer Service: +1 800 638 8174 (toll free)
 order.us@lonza.com
 Scientific Support: +1 800 521 0390 (toll free)
 scientific.support@lonza.com

Europe

Customer Service: +32 87 321 611
 order.europe@lonza.com
 Scientific Support: +49 221 99199 400
 scientific.support.eu@lonza.com

International

Contact your local Lonza distributor
 Customer Service: +1 301 898 7025
 scientific.support@lonza.com

Lonza Walkersville, Inc. – Walkersville, MD 21793

Learn more.



For research use only. Not for use in diagnostic procedures. All trademarks belong to Lonza, registered in USA, EU or CH or to third party owners and used only for informational purposes. The information contained herein is believed to be correct and corresponds to the latest state of scientific and technical knowledge. However, no warranty is made, either expressed or implied, regarding its accuracy or the results to be obtained from the use of such information and no warranty is expressed or implied concerning the use of these products. The buyer assumes all risks of use and/or handling. Any user must make his own determination and satisfy himself that the products supplied by Lonza Group Ltd or its affiliates and the information and recommendations given by Lonza Group Ltd or its affiliates are (i) suitable for intended process or purpose, (ii) in compliance with environmental, health and safety regulations, and (iii) will not infringe any third party's intellectual property rights. The user bears the sole responsibility for determining the existence of any such third party rights, as well as obtaining any necessary licenses. For more details: www.lonza.com/legal.

©2025 Lonza. All right reserved.

CD-DS044 10/25

bioscience.lonza.com
lonza.com/endothelial-cells