TEX-VAL Consortium:

Building Cross-Sector Consensus on the Credibility of Complex *In Vitro* Models

Courtney Sakolish

Veterinary Physiology & Pharmacology
Texas A&M University

IF YOU
BUILD IT,
THEY
WILL
COME
- FIELD OF DREAMS

You've Built It.
Will They
Come?

F A C T
K E

TEX-VAL: Tissue Chip TESTING Center (funded by NIH-NCATS)

Oct. 2016 – Sept. 2018 (TEX-VAL 1.0) **Oct. 2018 – Sept. 2020 (TEX-VAL 2.0)**

- Did we get these academic lab-made devices to work outside of the developer lab?

  Mostly yes
- Can we replicate the results from the developers? **Mostly yes**
- What was the biggest challenge to technology transfer? **Availability of the functional primary cells**
- Were the devices "ready" for testing drug safety in the "real world"? **Most were not**
- What was the most important "learning" from these studies? **Developers learning about the limits of their technologies and how to make them useful to the end-users**

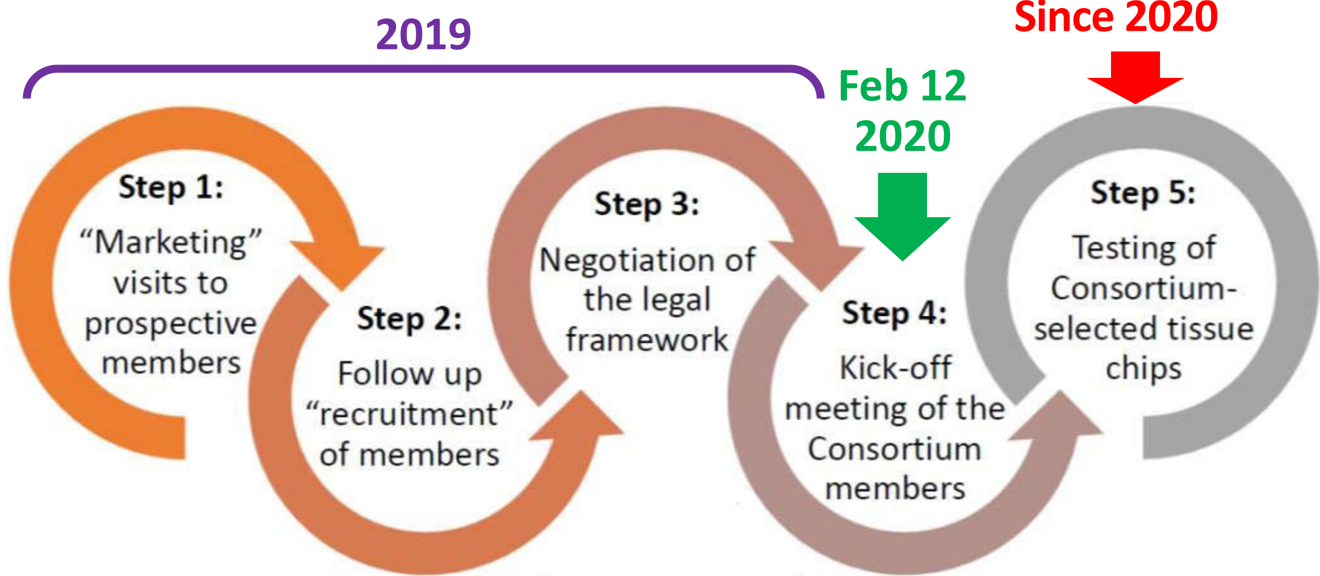
Collaborative research and technology transfer agreements	Tissue chip testing without cells	Reproducibility testing of tissue chips	Extending the utility of the tissue chips
•Execution of all legal agreements •Sharing of the protocols •TAMU staff training with developers	•Assembling of tissue chips •Testing of the flow and operation •Testing drug binding to devices •Development of LC-MS methods	•Replicating published studies •Evaluation of key findings •Detailed protocols and SOPs	•Defining the "context of use" •Conducting additional studies •Depositing data into MPS-Db

4-8 months period of testing for each tissue chip/microphysiological system (MPS)

TEX-VAL Tissue Chip Testing Center → Consortium

Aim 3: To establish revenue-generating activities for MPS validation beyond NIH funding:

- conduct site visits and seminars with stakeholders,
- identify interested parties for Consortium membership,
- negotiate a consortium agreement, and
- conduct tissue chip testing "*happily ever after… NCATS*"



Goals of the Consortium:

- Bring together industry, trade association and government agencies to define a work plan and deliverables
- Defining a ***work plan***: identifying ***common*** needs for "tissue chips": organs, platforms, cells, chemicals (+/- controls), phenotypes, etc.

Texas A&M University role:

Execute on a Consortium's ***work plan***:

- Procuring equipment and consumables
- Establishing the models in the lab
- Verifying reproducibility of cell sourcing
- Replicating key published findings
- Refining the models based on feedback

TEX-VAL Consortium: Is There a "Value Proposition"?

Members provide to TEX-VAL:

- Funding ($100,000/year/member) Texas A&M charges 0% overhead
- 2-3 scientists to participate in TEX-VAL activities (1-2/mtgs month)
- Input on the annual work plan (i.e., "this is what my organization needs to be accomplished this year…")

Members receive from TEX-VAL:

- Access to all data, protocols, etc. (embargoed access for 1 year)
- Opportunity to engage in open discussions and learn from each other on how MPS are used
- Unlimited technical and scientific support from scientists experienced in 50+ MPS models
- Co-authorship on publications

TEX-VAL Consortium Member Organizations

N=5
+NCATS

N=7
+Unilever
+Merck

N=7

N=7
-BMS
+Roche

N=7
-EPA
+Abbvie

N=7
-ACC
+Genentech

N=9
+Battelle
+NIH-ORIVA

TEX-VAL Consortium Members' Organs/Tissues of Interest

2020		2021		2022		2023		2024		2025		2026	
Organ	#Asks	Organ	#Asks	Organ	#Asks	Organ	#Asks	Organ	#Asks	Organ	#Asks	Organ	#Asks
Liver	4	Liver	5	Liver	5	Liver	7	Liver	7	Liver	7	Liver	7
BBB	1	BBB	4	BBB	4	BBB	6	BBB	2	BBB	3	BBB	7
Kidney	3	Kidney	4	Kidney	4	Kidney	4	Kidney	5	Kidney	4	Kidney	4
GI	2	GI	5	GI	5	GI	4	GI	2	GI	3	GI	3
Repro	2	Repro	4	Repro	4	Repro	4	Repro	3	Repro	1	Repro	1
Cardio	1	Cardio	1	Cardio	1	Cardio	2	Cardio	1	Cardio	1	Cardio	2
Vascular	0	Vascular	0	Vascular	0	Vascular	1	Vascular	0	Vascular	2	Vascular	3
Lung	2	Lung	1	Lung	1	Lung	1	Lung	1	Lung	3	Lung	3
								Ocular	1	Ocular	0	Ocular	0
								Bone Mar.	1	Bone Mar.	1	Bone Mar.	1
								Skin	1	Skin	1	Skin	1
										CNS/PNS	3	CNS/PNS	3

TEX-VAL Consortium: Is There a "Value Proposition"?

2021

		Chips
Kidney	Glomer. (Mimetas)	160
	Tubule (Mimetas CN-Bio Transwell)	524
Liver	Mimetas CNBio	1,072 110
Gut	Caco-2 (Transwell CNBio)	243
	Enteroids (Transwell CNBio)	456
BBB	Transwell	32

Total: 2,600

2022

		Chips
Kidney (Tubule)	Mimetas CNBio T12 Transwell	431 216 24
Liver	CNBio	623
Gut	Caco-2 (Transwell CNBio)	249
	Enteroids (Transwell CNBio)	392
BBB	Transwell	58
FMI	FMi-OOC (Han Lab)	120

Total: 2,100

2023

		Chips
Kidney	CNBio	252
	Transwell	240
	Mimetas	160
Liver	CNBio	216
	Mimetas	288
Gut	Traswell	1,014
BBB	Traswell	529
	Traswell	249

Total: 3,000

2024

		Chips
Vascular	IdenTX (3 & 40), Mimetas	574
Liver	Elplasia (96), TissUse, CN Bio LC12, Mimetas (2 & 3 Lane)	1,435
Kidney	96-well TW/ plate	3,872
Gut	96-well TW	1,312
Lung	96-well TW	196
BBB	24/96-well TW	810

Total: 8,200

2025

		Chips
Vascular	IdenTX (3 & 40), Mimetas	457
Liver	IdenTX3, MPCC, Elplasia (96), ULAP, TissUse, CN Bio LC12, Mimetas (2 & 3 Lane)	1,797
Kidney	96-well TW/ plate, MatTek, 384 wp	5,536
Gut	96-, 24-well TW	284

Total: 8,100

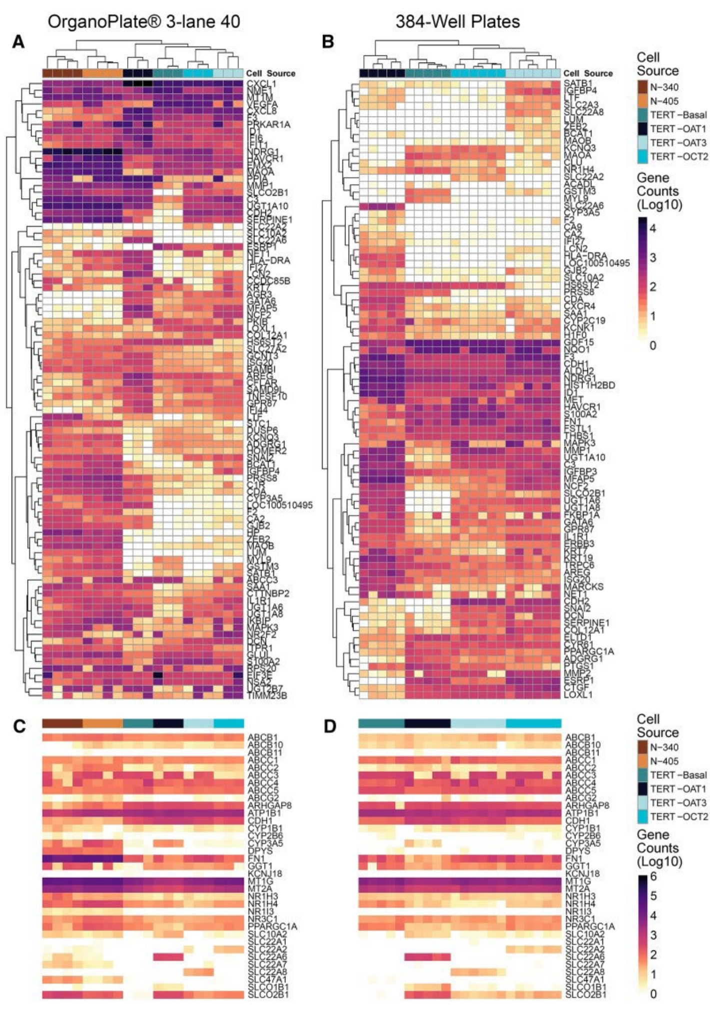
Evidence-Based Qualification by TEX-VAL Consortium

1. **Comparative analysis of models and cell types/sources:**
    a) MPS are compared to “industry standard” (e.g., 2D) and each other
    b) Testing cells from different vendors/individuals

2. **Comprehensive but sensible phenotyping of each experiment:**
    a) Imaging (phase-contrast and fluorescent/confocal)
    b) Biochemical data (accepted basal function/injury biomarkers)
    c) Analytical chemistry (transport/metabolism, PK modeling)
    d) Model-omics (basal and treatment-induced effects)

3. **Cost-benefit analysis for both “set up” and “operation”:**
    a) “Upfront” costs (buy vs lease equipment)
    b) Operating costs (equipment and consumables, failures…)
    c) Cost to phenotype (what other instruments are needed?)

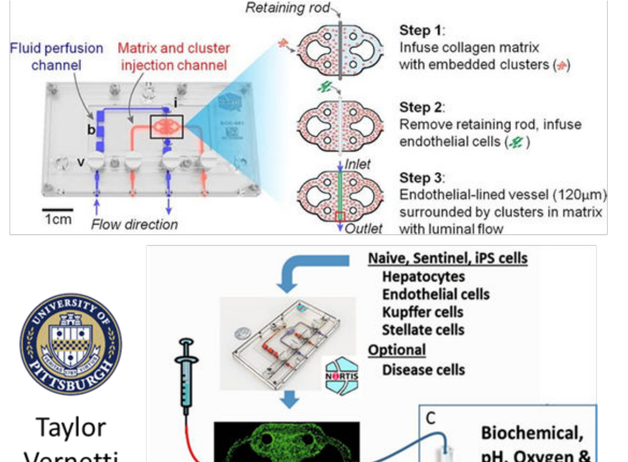
4. **Keeping the “domain of applicability” broad (drugs & chemicals)**



Sakolish et al Toxicol Sci. 2023 Oct 30;196(1):52-70

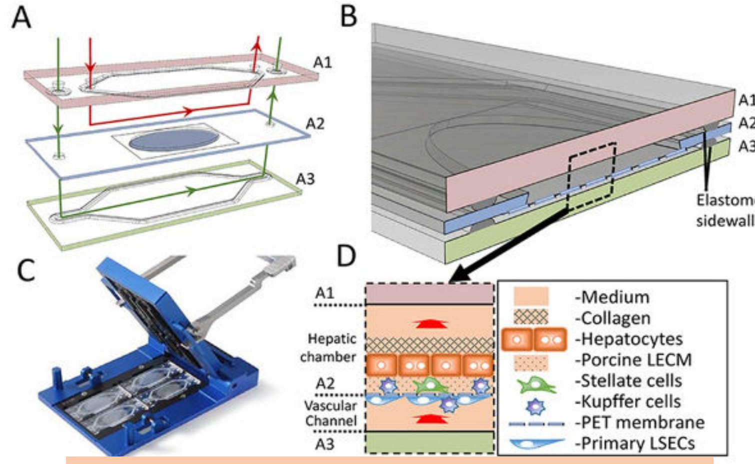
TEX-VAL Liver Models: 2016 - 2022

LAMPS [original publication Vernetti et al 2016]



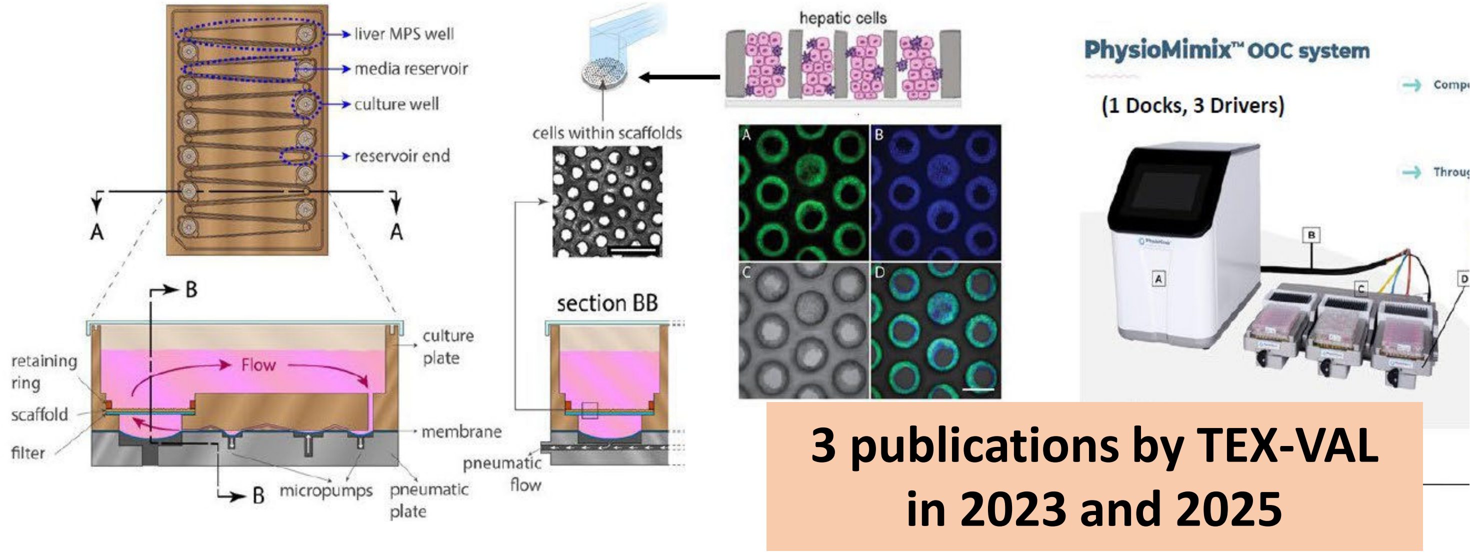
2 publications by TEX-VAL in 2021

vLAMPS [original publication Li et al 2018]



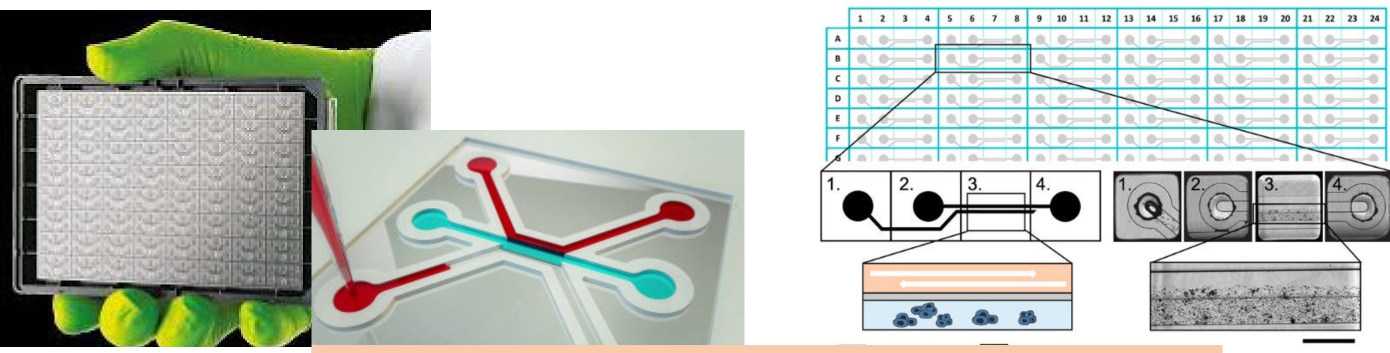
0 publications by TEX-VAL

CNBIO MPS LC12 plate model (12 chips/plate)



3 publications by TEX-VAL in 2023 and 2025

MIMETAS 3-Lane and 2-Lane Devices with liver cells



3 publications by TEX-VAL in 2022-2025

TEX-VAL Liver Models: 2023 -2025

- Onboarding TissUse and Micro-Patterned Co-Culture (MPCC)
- TissUse liver "ring trial" (6 pharma companies and TEX-VAL)
- Comparison of perfused and static spheroids
- Comparison of hepatocytes from different species to HepaRG and iPSC-derived hepatocytes
- Gut-liver models (TissUse and Transwell-based)

Perfused and static spheroids

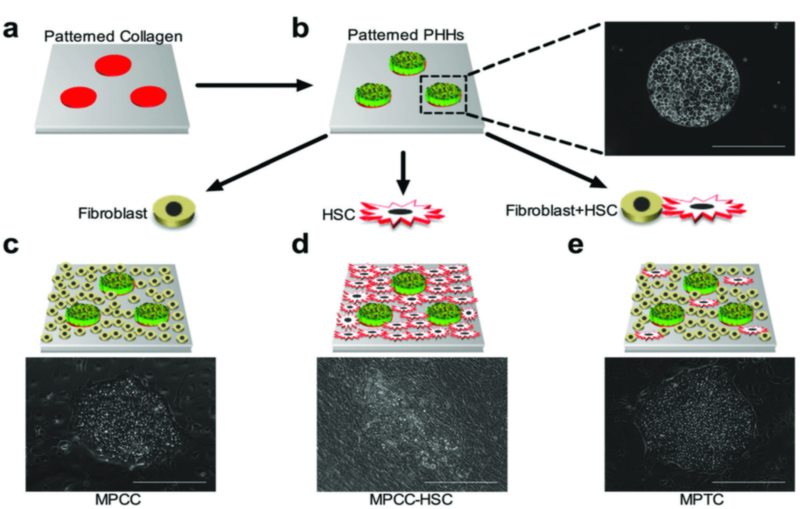
3D-TissUse (94 microcavity/chip) 100,000 cells/chip (6 Chips)

2D-96 well plate 70,000 cells/well

3D-Elplasia ULAP (79 microcavity/wells) 40,000 cells/well

3D-GravityTRAP ULAP (1 spheroid/well) 2000 cells/well

Micro-Patterned Co-Culture



TEX-VAL Consortium’s Cost-Benefit Analysis: What is a “Value Proposition” of different models?

Was published in 2012, so anyone can do it, right?

nature biotechnology

Derivation of blood-brain barrier endothelial cells from human pluripotent stem cells

Ethan S Lippmann[1,3], Samira M Azarin[1,3], Jennifer E Kay[1], Randy A Nessler[2], Hannah K Wilson[1], Abraham Al-Ahmad[1], Sean P Palecek[1] & Eric V Shusta[1]

The blood-brain barrier (BBB) is crucial to the health of the brain and is often compromised in neurological disease. Moreover, because of its barrier properties, this endothelial interface restricts uptake of neurotherapeutics. Thus, a renewable source of human BBB endothelium could spur brain research and pharmaceutical development. Here we show that endothelial cells derived from human pluripotent stem cells (hPSCs) acquire BBB properties when co-differentiated with neural cells that provide relevant cues, including those involved in Wnt/β-catenin signaling. The resulting endothelial cells have many BBB attributes, including well-organized tight junctions, appropriate expression of nutrient transporters and polarized efflux transporter activity. Notably, they respond to astrocytes, acquiring substantial barrier properties as measured by transendothelial electrical resistance (1,450 ± 140 Ω cm^2), and they possess molecular permeability that correlates well with *in vivo* rodent blood-brain transfer coefficients.

The BBB is composed of specialized brain microvascular endothelial cells (BMECs) that help regulate the flow of substances into and out of the brain. Complex intercellular tight junctions limit the passive diffusion of molecules into the brain and result in blood vessels exhibiting extremely high trans-endothelial electrical resistance (TEER) *in vivo*[1]. In addition, efflux transporters, such as p-glycoprotein, contribute to barrier properties by returning small lipophilic molecules that diffuse into BMECs back to the bloodstream. Thus, BMECs are endowed with a network of specific transport systems to shuttle essential nutrients and metabolites across the BBB. In addition, because of its substantial barrier properties, the BBB prevents uptake of most small-molecule and virtually all biologic pharmaceuticals delivered intraveneously[2], hampering the development of drugs for neurological disease. Conversely, BBB breakdown and dysfunction is associated with various diseases, including Alzheimer’s disease, stroke, multiple sclerosis and brain tumors[3]. These considerations have led researchers to develop a variety of BBB models to enable detailed mechanistic studies and drug screens *in vitro*.

Most *in vitro* BBB models have been established using brain microvessels isolated from primary animal sources such as cow, pig, rat and mouse[4]. However, given inevitable species differences[5,6], a robust *in vitro* BBB model of human origin would be of great utility for high-throughput screening to identify brain-penetrating molecules or for the study of BBB developmental, regulatory and disease pathways in humans. Human BBB models have been established by culturing primary human (BMECs isolated from autopsy tissue or, more often, from freshly resected brain specimens derived from tumor or epilepsy patients. Issues involving BMEC availability and fidelity limit widespread use of these human BBB models[7]. Another proposed route toward a human BBB model is cell immortalization[8].

However, immortalized BMECs have poor barrier properties, including low baseline transendothelial electrical resistance (TEER)[8–10] and discontinuous tight junction protein expression[8]. We sought to create a robust, scalable human BBB model using hPSCs, including both human embryonic stem cells (hESCs)[11] and human induced pluripotent stem cells (hiPSCs)[12,13], which exhibit virtually unlimited self-renewal and can differentiate into somatic cell types from all three embryonic germ layers. Human endothelial cells have been generated from hPSCs by a variety of methods, including embryoid body differentiation[14–18] and OP9 stromal cell coculture[19,20]. However, endothelial cells develop distinct gene and protein expression profiles that depend on microenvironmental cues during organogenesis[21], and hPSC-derived endothelial cells with organ-specific properties have yet to be reported.

Here we describe a facile hPSC differentiation method that can reproducibly generate pure populations of endothelial cells with BBB properties. The method employs simultaneous endothelial and neural cell co-differentiation followed by purification of the BBB-like endothelial population on selective matrix. The purified endothelial cells express BBB markers, respond to astrocytic cues, and have barrier and transport properties similar to those of primary BMECs.

RESULTS

Differentiation of hPSCs into BBB endothelial cells

In vivo, BBB specification begins as endothelial cells forming the perineural vascular plexus invade an embryonic brain microenvironment comprising neuroepithelial cells, radial glia, neuroblasts and neurons. Notably, much of this early BBB induction occurs in the absence of astrocytes[22–25]. The cells of the developing embryonic brain provide relevant BBB induction cues, such as Wnt7a and

[1]Department of Chemical and Biological Engineering, University of Wisconsin–Madison, Madison, Wisconsin, USA. [2]Central Microscopy Research Facility, University of Iowa, Iowa City, Iowa, USA. [3]These authors contributed equally to the work. Correspondence should be addressed to E.V.S. (shusta@engr.wisc.edu) or S.P.P. (palecek@engr.wisc.edu).

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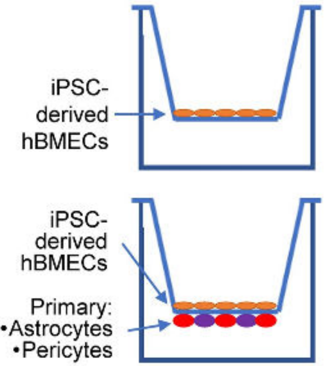
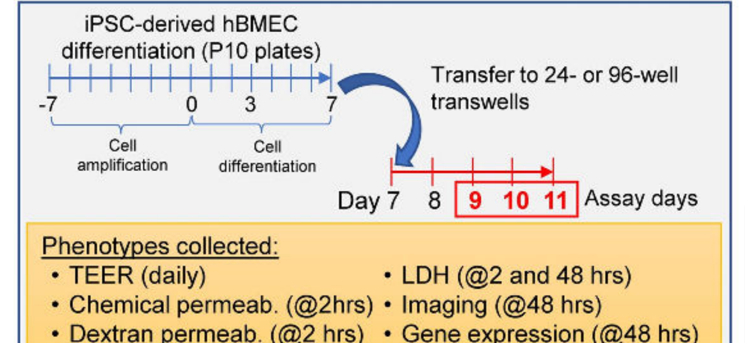
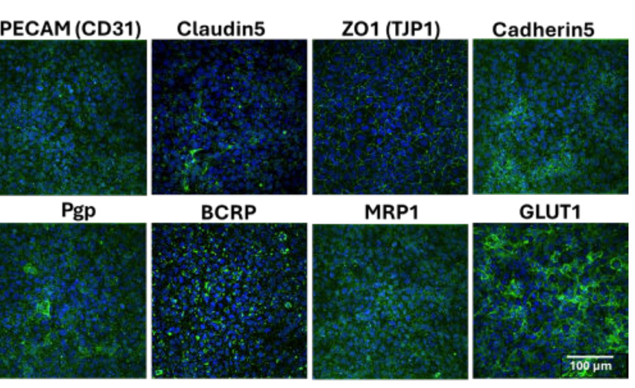






Comparative Analysis of Cost and Performance Among Different Models

Group	Model type	BMECs (side)	Astr.+ Per.	Flow (µL/s)	Top TEER (Ohm*cm2)	Top TEER day #	Top TEER (# days)	Peff (cm/s)	Cost per sample
TEX-VAL BMECs only	TW24 (24 samples)	Top	N	-	~2700	D9	3-4	1.0 x 10^{-7}	$20
	TW96 (96 samples)	Top	N	-	~4000	D10	2-3	3.1 x 10^{-8}	$7
	CNBio TC12 (12 samples)	Bottom	N	0.5	~2400	D9	1-2	2.4 x 10^{-7}	$80
		Bottom	N	1.5	~2400	D9	1-2	1.6 x 10^{-7}	$80
		Bottom	N	2.5	~2500	D9	1-2	1.6 x 10^{-7}	$80
FCDI BBB	TW24 (12 samples)	Top	Y (iPSC-derived)	-	~1700	D5	1	2.7 x 10^{-7}	$450
TAMU BMECs+ ScienCell A+P	TW24 (24 samples)	Top	Y (primary)	-	~3500	D9	3-4	7.5 x 10^{-7}	$23
	CNBio TC12 (12 samples)	Bottom	Y (primary)	2.0	~2600	D9	2	1.6 x 10^{-7}	$83
	TW96 (96 samples)	Top	Y (primary)	-	~3000	D9	2-3	2.5 x 10^{-7}	$8

TW24

TW96

CNBio

FCDI BBB Isogenic Kit

Toxicological Sciences, 2025, 204(2), 181–197

Comparative analysis of C
and duodenal enteroid-de
membrane-based barrier
permeability

Haley L. Moyer[1,†], Leoncio Vergara[2,†], Clifford Stephan[2], Cou
Hsing-Chieh Lin[1], Weihsueh A. Chiu[1], Remi Villenave[3]

Abstract

Intestinal absorption is a key toxicokinetics parameter. Altho
to estimate human drug absorption, models representing ot
tissue-specific markers, and functionality of 3 human int
jejunum (J2), and duodenum (D109) when cultured in the C
Transwells. In both conditions, J2 and D109 formed dome-li
formed tubules. Cells grown on Transwells formed a thicke
junctions). Polarization markers Ezrin and Villin were highe
J2. However, J2 and D109 exhibited poor barrier (70 kDa TRI
Barrier function and drug transport were evaluated using c
blockade; only a small fraction crossed, even without cells
compartmental absorption model to determine whether in v
fraction absorbed was achieved with Transwell-derived da
specific absorption ratios. The impact of this study includes
physiological morphology, but that studies of drug permeabi

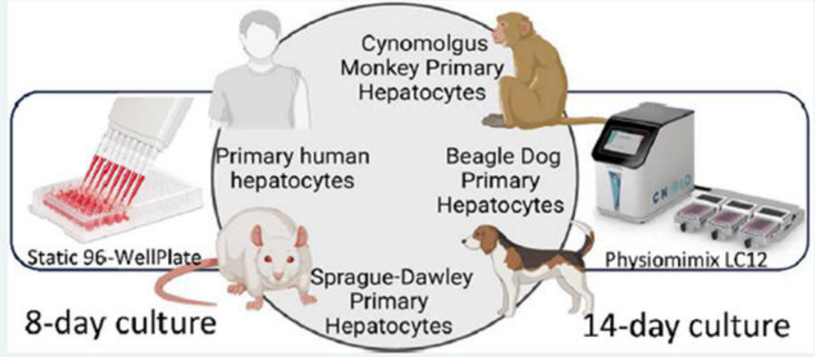
ACS Pharmacology & Translational Science

pubs.acs.org/ptsci Article

Comparative Analysis of Species-Specific Hepatocyte Function and Drug Effects in a Liver Microphysiological System PhysioMimix LC12 and 96-Well Plates

Chander K. Negi, Courtney Sakolish, Han-Hsuan D. Tsai, Katharina Nitsche, Han Gang, Piyush Bajaj, Stephen S. Ferguson, Jason P. Stanko, Philip Hewitt, David A. Kukla, Sarah M. Lloyd, Remi Villenave, and Ivan Rusyn*

ABSTRACT: Drug-induced liver injury (DILI) remains a challenge in drug development, and interspecies differences in liver toxicity represent a need where comparative analyses may inform preclinical safety study design. In vitro testing for species-specific liver effects, especially in complex models such as microphysiological systems (MPS), may help predict toxicity before advancing from animal to human studies, or derisk spurious findings in preclinical species. This study assessed the utility of the perfusion-based PhysioMimix LC12 MPS as compared to 2D cultures and evaluated species-specific DILI using primary hepatocytes from human, monkey, rat, and dog. Functional, phenotypic, and transcriptional profiles were evaluated for up to 14 days. Also, cells were exposed to species-specific hepatotoxicants such as bosentan (BOS), fialuridine (FIAU), and a common hepatotoxicant for all species, chlorpromazine (CPZ)—in both PhysioMimix LC12 and traditional 2D cultures. Hepatocytes in PhysioMimix LC12 showed more stable albumin and urea production as compared to 2D cultures. Concentration−response studies with CPZ, BOS, and FIAU were performed in 2D; then, repeated (5 × every 2 days) exposures to sub-100 × C_{max} concentrations were tested in PhysioMimix LC12. Species-specific differences in cellular and molecular effects of the drugs were observed in both models; data from PhysioMimix LC12 were reflective of the expected effects in both animals and humans. Still, variability and low throughput are limitations of MPS for prospective studies of species-specific responses. Overall, this study confirms the utility of liver safety studies using PhysioMimix LC12 and also provides suggestions for experimental designs to overcome the limitations of more complex test systems.



TEX-VAL

1. Exploring the potential of liver microphysiological systems of varied configurations to model cholestatic chemical effects. Nitsche KS, et al. Arch Toxicol. 2025. doi: 10.1007/s00204-025-04263-1.
2. Comparative Analysis of Species-Specific Hepatocyte Function and Drug Effects in a Liver Microphysiological System PhysioMimix LC12 and 96-Well Plates. Negi CK, et al. ACS Pharmacol Transl Sci. 2025; 8(11):4138-4158.
3. An in vitro-in silico workflow for predicting renal clearance of environmental chemicals and drugs. Sakolish C, et al. Toxicology. 2026; 519:154336.
4. Comparative Analysis of Proximal Tubule Cell Sources for In Vitro Studies of Renal Proximal Tubule Toxicity. Sakolish C, et al. Biomedicines. 2025; 13(3):563.
5. Comparative analysis of Caco-2 cells and human jejunal and duodenal enteroid-derived cells in gel- and membrane-based barrier models of intestinal permeability. Moyer HL, et al. Toxicol Sci. 2025; 204(2):181-197.
6. Comparative analysis of the physiological and transport functions of various sources of renal proximal tubule cells under static and fluidic conditions in PhysioMimix T12 platform. Sakolish C, et al. Drug Metab Dispos. 2025; 53(1):100001.
7. An in vitro-in silico workflow for predicting renal clearance of PFAS. Lin HC, et al. Toxicol Appl Pharmacol. 202;489:117015.
8. Reproducibility and Robustness of a Liver Microphysiological System PhysioMimix LC12 under Varying Culture Conditions and Cell Type Combinations. Lim AY, et al. Bioengineering (Basel). 2023; 10(10):1195
9. Analysis of reproducibility and robustness of a renal proximal tubule microphysiological system OrganoPlate 3-lane 40 for in vitro studies of drug transport and toxicity. Sakolish C, et al. Toxicol Sci. 2023; 196(1):52-70.
10. Evaluation of Metabolism of a Defined Pesticide Mixture through Multiple In Vitro Liver Models. Valdiviezo A, et al. Toxics. 2022; 10(10):566.
11. Analysis of reproducibility and robustness of OrganoPlate® 2-lane 96, a liver microphysiological system for studies of pharmacokinetics and toxicological assessment of drugs. Kato Y, et al. Toxicol In Vitro. 2022; 85:105464.
12. Microphysiological Systems Evaluation: Experience of TEX-VAL Tissue Chip Testing Consortium. Rusyn I, et al Toxicol Sci. 2022 188(2):143-152.
13. A Model of Human Small Airway on a Chip for Studies of Subacute Effects of Inhalation Toxicants. Sakolish C, et al. Toxicol Sci. 2022; 187(2):267-278.
14. Prediction of hepatic drug clearance with a human microfluidic four-cell liver acinus microphysiology system. Sakolish C, et al. Toxicology. 2021; 463:152954.
15. Heart Muscle Microphysiological System for Cardiac Liability Prediction of Repurposed COVID-19 Therapeutics. Charrez B, et al. Front Pharmacol. 2021; 12:684252.
16. Editorial overview of the special issue on application of tissue chips in toxicology. Rusyn I, Roth A. Toxicology. 2021; 450:152687.
17. Analysis of reproducibility and robustness of a human microfluidic four-cell liver acinus microphysiology system (LAMPS). Sakolish C et al. Toxicology. 2021; 448:152651.
18. Human in vitro vascularized micro-organ and micro-tumor models are reproducible organ-on-a-chip platforms for studies of anticancer drugs. Liu Y et al. Toxicology. 2020; 445:152601.
19. Predicting tubular reabsorption with a human kidney proximal tubule tissue-on-a-chip and physiologically-based modeling. Sakolish C, et al. Toxicol In Vitro. 2020; 63:104752.
20. Tissue-Engineered Bone Tumor as a Reproducible Human in Vitro Model for Studies of Anticancer Drugs. Sakolish C, et al. Toxicol Sci. 2020; 173(1):65-76.
21. Technology Transfer of the Microphysiological Systems: A Case Study of the Human Proximal Tubule Tissue Chip. Sakolish C, et al. Sci Rep. 2018; 8(1):14882.

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In-Depth Reviews

IN-DEPTH REVIEWS

Microphysiological Systems Evaluation: Experience of TEX-VAL Tissue Chip Testing Consortium

Ivan Rusyn,[*,1] Courtney Sakolish,[*] Yuki Kato,[*] Clifford Stephan,[†] Leoncio Vergara,[†] Philip Hewitt,[‡] Vasanthi Bhaskaran,[§] Myrtle Davis,[§] Rhiannon N. Hardwick,[¶] Stephen S. Ferguson,[||] Jason P. Stanko,[||] Piyush Bajaj,[|||] Karissa Adkins,[|||] Nisha S. Sipes,[||||] E. Sidney Hunter 3rd,[||||] Maria T. Baltazar,[#] Paul L. Carmichael,[#] Kritika Sadh,[#] and Richard A. Becker[**]

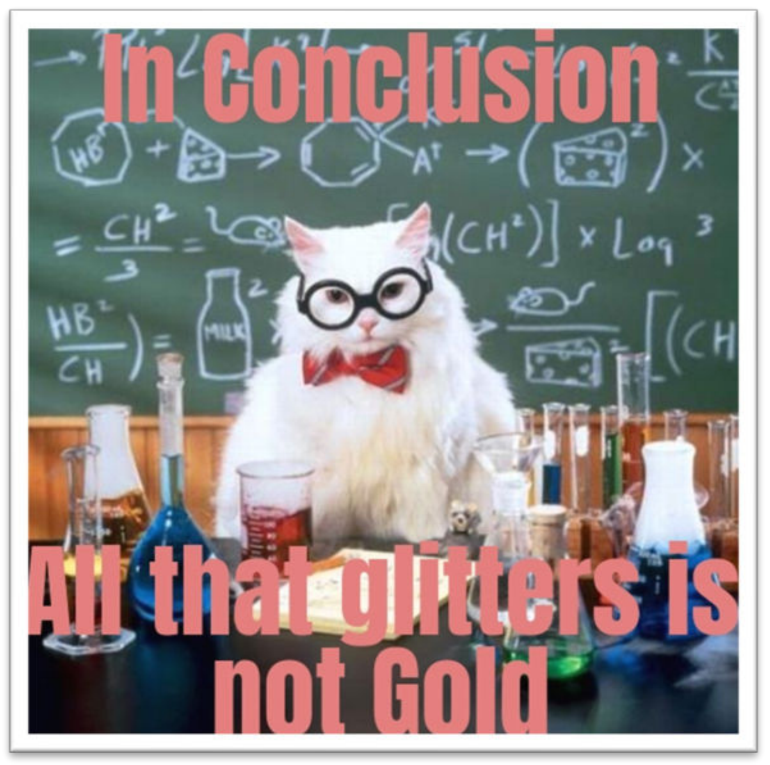
[*]Department of Veterinary Physiology and Pharmacology, Texas A&M University, College Station, Texas 77843, USA; [†]Institute of Biosciences and Technology, Texas A&M University, Houston, Texas 77030, USA; [‡]Chemical and Preclinical Safety, Merck Healthcare KGaA, Darmstadt, Germany; [§]Discovery Toxicology, Bristol Myers Squibb, Princeton, New Jersey 08543, USA; [¶]Discovery Toxicology, Bristol Myers Squibb, San Diego, California 92130, USA; [||]Division of the National Toxicology Program, National Institute of Environmental Health Sciences, Research Triangle Park, North Carolina 27709, USA; [|||]Global Investigative Toxicology, Preclinical Safety, Sanofi, Framingham, Massachusetts 01701, USA; [||||]Center for Computational Toxicology and Exposure, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711, USA; [#]Unilever Safety and Environmental Assurance Centre, Bedfordshire, Sharnbrook MK44 1LQ, UK; and [**]American Chemistry Council, Washington, District of Columbia 20002, USA

Overall, we conclude that it is unlikely that a rodent- or human-equivalent model is achievable through a finite number of microphysiological systems in the near future; therefore, building consensus and promoting the gradual incorporation of these models into tiered approaches for safety assessment and decision-making is the sensible path to wide adoption.

TEX-VAL Consortium – Is it a Success?

- A robust collaboration of diverse stakeholders who continue their participation each year
- The "value proposition" exists for "**try before you buy**" operations through TEX-VAL
- Example "LEARNINGS" of the Consortium:

a. Selecting models for testing (organs/tissues of interest)
b. Can MPS be used for ADME/PK (individual chemicals and mixtures)?
c. Can MPS be used for barrier function studies (effect of a gel layer)?
d. Are there required/reproducible cells to seed each MPS?
e. What is the "value of information" vs complexity/cost?
f. What phenotyping methods are needed to test "performance"?
g. What is the "true" operational cost and throughput (# of replicates)?
h. What other equipment is needed (in addition to the "tissue chips")?



"Success" = decision to onboard (or not) an MPS in a Consortium member's lab