How 3D bioprinting helps to design and engineer life

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Increasing assay efficiency with four-color detection

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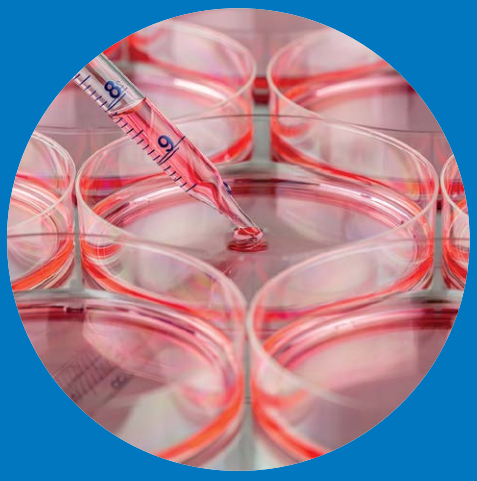
We have your solution for cell biology

At VWR, part of Avantor, our expanding product offering will guide you through every step of the cell biology workflow, from growing cells for research to performing analysis. Our approach encompasses an unrivaled breadth of products across all life science research areas, while still providing key research applications with innovative technologies to give you the best choice.

We understand that many factors directly affect your bottom line. Focus: Equipment and Instruments highlights equipment, instrumentation, technical services, and consumables that are critical to your success, and includes great promotional offers on top quality products. We provide you with the technical information you need to make educated decisions about the products and services essential to your workflow.

TO LEARN MORE, VISIT VWR.COM



For more information on specifications and accessories, simply enter the Cat. No. on **vwr.com**.

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VWR Life Science cell culture media and reagents

CLASSICAL MEDIA, BUFFERED SALT SOLUTIONS, AND SUPPLEMENTS & REAGENTS

To view additional products for your cell culture workflow, visit **vwr.com/cellculture**

Dulbecco's Modified Eagle's Medium (DMEM)
A modification of Basal Medium Eagle (BME), Dulbecco's Modified Eagle's Medium contains approximately four times as much vitamins and amino acids and two to four times as much glucose as the original formulation. DMEM is suitable for most types of cells, including human, monkey, hamster, rat, and mouse. DMEM is available in a variety of formulations including high or low glucose, with or without sodium pyruvate, and with or without L-glutamine.

RPMI-1640
RPMI-1640 was developed by Moore et. al. at Roswell Park Memorial Institute, hence the acronym RPMI. The formulation is based on the RPMI-1630 series of media utilizing a bicarbonate buffering system and alterations in the amounts of amino acids and vitamins. RPMI-1640, when properly supplemented, has demonstrated wide applicability for supporting growth in many types of cultured cells.

Dulbecco's Phosphate Buffered Saline (DPBS)
Dulbecco's Phosphate Buffered Saline is a balanced salt solution used for the handling and culturing of mammalian cells. Phosphate buffering maintains the pH in the physiological range. Calcium and magnesium facilitate cell binding and clumping. DPBS without these ions can be used to wash and rinse suspended cells.

Hank's Balanced Salt Solution (HBSS)
Hank's Balanced Salt Solution is a buffer used to maintain a physiological pH for cells maintained in non-CO_2 atmospheric conditions. HBSS can be used for washing cells or as a solution for transporting cells and tissue culture.

L-glutamine
L-glutamine is an essential amino acid. It is used as an energy source for cells in cell culture. L-glutamine is stable as a dry powder and as a frozen solution but degrades rapidly in liquid media or stock solutions.

Trypsin (0.25%) EDTA
Trypsin (0.25%) EDTA (1X) is used to release adherent cells from tissue culture plasticware for harvesting and passaging. Contains Trypsin=0.25%, EDTA=0.04%

Description	Size, mL	Cat. No.	Case of
DMEM with 1.0 g/L Glucose, L-Glutamine, and Sodium Pyruvate	500	**VWRL0111-0500**	10
DMEM with 1.0 g/L Glucose, without L-Glutamine, and with Sodium Pyruvate	500	**VWRL0149-0500**	10
DMEM with 4.5 g/L Glucose, L-Glutamine, and Sodium Pyruvate	500	**VWRL0101-0500**	10
DMEM with 4.5 g/L Glucose, L-Glutamine, and without Sodium Pyruvate	500	**VWRL0100-0500**	10
DMEM with 4.5 g/L Glucose, without L-Glutamine, and with Sodium Pyruvate	500	**VWRL0148-0500**	10
DMEM with 4.5 g/L Glucose, without L-Glutamine, and without Sodium Pyruvate	500	**VWRL0102-0500**	10
DPBS 1X, without Calcium Chloride and Magnesium Chloride	100	**VWRL0119-1000**	06
DPBS 1X, without Calcium Chloride and Magnesium Chloride	500	**VWRL0119-0500**	10
HBSS 1X, without Calcium, Magnesium or Phenol Red	500	**VWRL0121-0500**	10
L-Glutamine 100X, 200mM	100	**VWRL0131-0100**	48
RPMI 1640, with L-Glutamine	500	**VWRL0105-0500**	10
RPMI 1640, without L-Glutamine	500	**VWRL0106-0500**	10
Trypsin-EDTA 0.25% 1X	100	**VWRL0154-0100**	48

For more information on specifications and accessories, simply enter the Cat. No. on **vwr.com**.

VWR Life Science Seradigm Fetal Bovine Sera (FBS) and FBS Alternatives

Learn more about the fastest growing, global sera brand in the market!
vwr.com/seradigm

Cell culture experts everywhere are discovering how well their cells thrive on nutritionally superior sera from VWR Life Science Seradigm, making it the fastest growing, global sera brand in the market! VWR Life Science Seradigm's unique collection and manufacturing techniques preserve more of the naturally-occurring growth factors in sera that cells require to thrive. Our proven track record for performance and consistency enables sera users to switch to a brand that yields more of the results they seek – no matter the application, scale, or budget.

Contact us today and we'll help you discover why cells choose VWR Life Science Seradigm.

Ultimate Grade FBS
The ultimate in product quality and viral safety, this grade undergoes additional BVD virus testing using qPCR technology. Proprietary collection and production techniques provide additional features that elevate product quality, enhance traceability, and improve regulatory compliance. Ultimate grade is 100% US origin.

Premium Grade FBS
Widely used by cell culturists who require a high quality, high performance FBS for a variety of applications. Proprietary manufacturing technology preserves performance-enhancing factors for consistent results. Premium Grade FBS is 100% US origin.

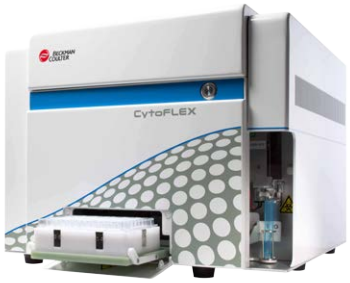
USDA Approved Origin FBS
This FBS is an affordable, quality product that provides consistent performance for use in cost-sensitive applications. USDA Approved Origin FBS is sourced from Mexico and countries in Central America.

Ultra Low IgG FBS
Purified of immunoglobulin (IgG) using a chromatographic process that delivers significantly reduced levels of IgG (≤5µg/mL). Ideal for cell culture and protein purification applications where naturally occurring levels of IgG are too high. Ultra Low IgG FBS is 100% US origin.

ISIA Traceability Certified Sera

FB Essence
This is a nutritionally rich, cost-effective alternative to Fetal Bovine Serum (FBS) and is proven effective across a broad range of cell types and origins, including both suspension and adherent cell types and recognized finicky cell lines. FB Essence contains FBS, Bovine Calf Serum, Equine Serum, and a proprietary blend of supplements, vitamins, minerals, and growth factors. FB Essence is 100% US Origin.

Iron Supplemented Bovine Calf Serum (BCS)
Iron Supplemented Bovine Calf Serum is sourced from animals aged up to six months and raised on a diet consisting mainly of formula. Due to their unique diet, source animals have naturally high levels of transferrin. When the serum is supplemented with iron, the iron binds to the unbound transferrin, resulting in a product with three to four times the amount of available iron compared to FBS or equine serum. This product is an excellent, cost-effective alternative to FBS and often performs as well as FBS in many established cell lines. In some applications, it even out-performs FBS and equine serum. Iron Supplemented Bovine Calf Serum is 100% US Origin.



CYTOFLEX FLOW CYTOMETER, BECKMAN COULTER

DESIGNED TO DELIVER SUPERIOR PERFORMANCE WITH EASE OF INSTALLATION AND OPERATION FOR RESEARCH APPLICATIONS

Simplified system setup, data acquisition, analysis, and export of experimental results are integrated into a complete workflow solution with CytExpert software.

Description	Cat. No.
CytoFLEX System B2-R2-VO	76183-350

JETOPTIMUS® DNA TRANSFECTION REAGENT, POLYPLUS-TRANSFECTION®

BEST-IN-CLASS DNA TRANSFECTION REAGENT, BASED ON A NOVEL CATIONIC NANOTECHNOLOGY ALLOWING HIGH EFFICIENCY WITH LOW VOLUME OF REAGENT

- Highly efficient: reach maximal gene expression in hard-to-transfect cells
- Cost-effective: use minimum reagent volume and DNA quantity
- Biologically relevant: keep an excellent cell viability & morphology
- Time-saving: transfect with an optimized ready-to-use protocol

jetOPTIMUS® transfection reagent improves cellular uptake and endosomal escape of DNA in cells (even in hard-to-transfect cells) resulting in higher transfection efficiency.

Size	Buffer Volume	Cat. No.
0.75 mL	2 x 60 mL	76299-632

2'3'-CGAMP ELISA KIT, CAYMAN CHEMICAL COMPANY

FOR THE QUANTIFICATION OF 2'3'-CGAMP IN CELL LYSATES

- Assay 24 samples in triplicate or 36 samples in duplicate
- Lower limit of detection (LLOD) is 9.6 pg/ml (0.01 pmol/ml)
- Run overnight or incubate for just 2 hours without compromising sensitivity
- Monitor the kinetics of 2'3'-cGAMP formation and hydrolysis in a biological setting
- Identify compounds that modulate cGAS activity

US ONLY

This assay has a range from 100 ng/ml to 6.1 pg/ml with a midpoint of approximately 900 pg/ml (50% B/B0) and a sensitivity of approximately 85 pg/ml (80% B/B0). Powered by BIOLOG Life Science Institute.

Description	Cat. No.
Antiserum, Tracer, Standard, Immunoassay Buffer C Concentrate, Wash Buffer Concentrate, Polysorbate 20, Coated Plate, Substrate Solution, Stop Solution, Tracer Dye, Antiserum Dye, and Conver Sheet	76292-890

This specific product is not available in Canada. Please contact your VWR sales representative to learn about easy access to similar options available in your region.

REACH-IN CO_2 INCUBATORS, NOW WITH H_2O_2 STERILIZATION

CARON

Caron's large reach-ins offer the culture quality, cleanability, and ease of setup & use you've come to expect from small stackable CO_2 units, only in a full-sized chamber.

- Culture quality – IR CO_2 sensor, highly uniform ducted airflow & smart control alerts
- Clean conditions – available two-hour dry H_2O_2 sterilization cycle, tool-free three-minute interior removal, opt. controlled humidification system
- Facility-friendly – easy-use large color touchscreen, standard power plugs & low power usage, 25 cu.ft. units roll thru doorways

Volume, L (cu. ft.)	Electrical	Cat. No.
708 (25)	115V, 60Hz, 16A	**10158-720**
708 (25)	208-230V, 60Hz, 10A	**10158-842**
934 (33)	115V, 60Hz, 16A	**10158-846**
934 (33)	208-230V, 60Hz, 10A	**10158-734**

ALLEVI 2 3D BIOPRINTER, TWO EXTRUDER SYSTEM, ALLEVI

ALLEVI

WORLD'S FIRST DESKTOP 3D BIOPRINTER THAT PRINTS LIVING TISSUE OUT OF HUMAN CELLS. BEAUTIFULLY DESIGNED, PRECISION MANUFACTURED 3D BIOPRINTER THAT PRINTS CELLS AND BIOINKS.

US ONLY

- Two extruder system
- Small footprint fits under any sterile hood
- Accessibility - print both soft and hard tissues
- Precision engineered - 10 micron on each axis

Allevi 2 is the bioprinter for researchers, by researchers. It is the most versatile bioprinter on the market, trusted by leading researchers worldwide, and is easy enough for everyone in the lab to use.

Description	Dimensions	Cat. No.
3D Bioprinter Device	30.5×30.5×30.5 cm (12×12×12")	**76292-706**

This specific product is not available in Canada. Please contact your VWR sales representative to learn about easy access to similar options available in your region.

How 3D bioprinting helps to design and engineer life

Madeline Winter, COO Allevi

As a species, we are master engineers who have created machines that have completely changed our way of life. We build skyscrapers that peak through the clouds, computers that fit in our pockets and electric cars that go from zero to sixty at a ludicrous speed. And yet, the most precise and well-articulated systems remain those built by nature. The human body is an example of a perfect organic machine that does, from time to time, require replacement parts.

The quest for artificial tissues and organs remains a slow and uphill battle that can be boiled down to the fact that tissues and organs are incredibly complex. Possessing many different compartments that communicate with each other, intricate microarchitecture, and multiple cell types with the need of a continuous nutrient supply. Though master mechanics we may be, we've yet to discover the methods to engineer our own bodies.

3D bioprinting emerged as a possible solution to this problem by making it easy to design and engineer life. 3D bioprinters and bioinks are used by researchers worldwide to ensure that we humans master the field of biological engineering to eradicate diseases and replace broken parts. This technology is laying the groundwork to aid in our search for the holy grail of the artificial, personalized organ.

SO WHAT IS BIOPRINTING?

It involves recreating the 3D structure of a tissue using a fabrication technique wherein a computer program builds a structure layer-by-layer using biocompatible materials (or bioinks) and cells. These bioinks are designed to mimic the architecture of the extracellular matrix in which cells are suspended to aid in their specific differentiation. Additionally, cells themselves can be incorporated into these constructs.

It should come as no surprise that geometry matters within biology. Signaling pathways activated in 2D are very different from 3D and cells on a petri dish do not accurately represent features and functionality of the human body. It's time we added another dimension to the study of biology.

You can start imagining building a complex organ step-by-step using the 3D images, such as those from MRI and CT scans, native cells from a patient, and biologically compatible materials. This technology is still in its nascence and is currently only used in research settings but we are beginning to see the exciting early developments that will lead to life changing clinical applications.

HOW IS BIOPRINTING TECHNOLOGY USED TODAY?

CREATE CUSTOM BONE AND CARTILAGE GRAFTS

How many of us have titanium hips and screws in our joints? By understanding the specific defect size, through either MRI or CT, and combining 3D bioprinting with the correct, advanced biomaterial, a surgeon will one day make a 3D printed structure in the shape of the patient's bone void and implant that structure, resulting in repaired and regenerated, natural bone personalized to each patient. This will prove to have tremendous therapeutic benefit over traditional methods that either don't provide regeneration or can't be personalized.

Dr. Chamith Rajapakse's lab at the University of Pennsylvania used an Allevi bioprinter to print a nasal septal cartilage scaffold that precisely matched patient's nasal defect, in both size and shape. Dr. Rajapakse stated in his publication, "Nasal septal perforations (NSPs) are relatively common. They can be problematic for both patients and head and neck reconstructive surgeons who attempt to repair them. Often, this repair is made using an interpositional graft sandwiched between bilateral mucoperichondrial advancement flaps. The ideal graft is nasal septal cartilage. However, many patients with NSP lack sufficient septal cartilage to harvest. Harvesting other sources of autologous cartilage grafts, such as auricular cartilage, adds morbidity to the surgical case and results in a graft that lacks the ideal qualities required to repair the nasal septum. Tissue engineering has allowed for new reconstructive protocols to be developed."

Dr. Rajapakse uses a patients' CT scans and converts them into a file that the bioprinter could read and reconstruct. This allows him to customize the construct to match the patient's nasal septal defect exactly. This is an amazing first step in the goal to create patient-specific tissue grafts that could be deployed for myriad tissue types.

ALLEVI

REGENERATE CARDIAC, NERVE, AND MUSCLE TISSUE

The nervous system, a highway of electrical communications, regulates all aspects of our physiology, from movement to thoughts by having electricity chemically run across conductive tissue. That is why conductivity is a key integration in the materials used for engineering tissues.

The material science community is developing the new standards in bioinks. One such example is Dimension Inx LLC who offers a cutting edge new bioink exclusively developed for the Allevi bioprinter – 3D Graphene 3D-Paint. This novel material provides users the ability to integrate conductivity into electroactive tissues, such as skeletal and cardiac muscle, peripheral and central nerve, and biomedical devices. This electrically conductive material is one of a kind and a breakthrough in tissue engineering. While it is conductive, it also is cytocompatibile and integrates with ease into living tissue.

Nearly all tissues operate via electrical signaling to some degree; but the biggest one, in addition to both peripheral and central nerves, is muscle (including cardiac muscle). Electrical conductivity as a biomaterial property is highly desirable and necessary in tissue engineering... The problem is that traditional electrically conductive materials, like metals, do not integrate well with soft tissues in the body. Bioprinted 3D-Graphene is different and its ability to be customized within the specific tissue opens up a world of clinical applications.

TEST DRUGS OUTSIDE THE BODY

In 2012 Dr. Dongeun Huh and Dr. Donal Ingber's paper in Science Translational Medicine successfully created a diseased lung-on-a-chip. Their findings demonstrated the ability to identify a drug's life-threatening toxicity that went unnoticed through traditional experimental methods, such as animal testing models. It was a milestone achievement, but since then organ-on-a-chip manufacturing has mostly remained unchanged. Conventional methods gave you little freedom to easily customize and create inner-chip architectures for your experimental models until now. Bioprinters allow researchers to create custom architectures within organ-on-a-chip devices for disease modeling and drug testing.

Dr. Yu Shrike Zhang of MIT uses an Allevi bioprinter to model thrombosis in his lab. Thrombosis (or blood-clotting) constitutes a major reason for morbidity and mortality in cardiovascular diseases and its complications. Dr. Zhang uses his bioprinter to create in-vitro thrombosis models. By printing a 3D hydrogel with microchannels running through the chip, he was able to perfuse the microchannels with endothelial cells to render them biologically active. After creating the vein, he was able to infuse the channel with coagulated blood to form biomimetic thrombosis models, which reproduce the physiology of thrombosis in vivo. This remarkable application means that Dr. Zhang is now able to study thrombosis in his lab on repeatable and customizable human models. By being able to model and study the body outside the body, researchers are speeding up the rate of discovery and are able to create novel therapies and drugs faster and cheaper than ever before.

Customized organ-on-a-chip designs will play a major role in the innovation of tissue engineering and pharmaceutical development. This unique high impact application for biofabrication will not only change the field today, but the healthcare industry tomorrow.

WHAT IS THE FUTURE OF BIOPRINTING?

With over a 120,000 people in the US alone on waiting lists for organs and others experiencing chronic problems due to the long-term damaging effects of post-transplant immunosuppression, we are throwing everything we can at this problem.

As a community of scientists, we've already succeeded in bringing together multidisciplinary teams of researchers, physicians, and engineers to take on the biggest challenges to human health such as cancer, AIDS, and now organ regeneration. This cutting-edge technology empowers you to build with life to fundamentally change the way science and patient care is performed.

We imagine a future of truly personalized medicine where we can eliminate the organ waiting list, create custom grafts and cure disease. There is no question that bioprinting will change the course of medicine forever and finally turn biology into an engineering discipline that we can master. We invite you to join the revolution.

The support you need to optimize operations

Learn more at **vwr.com/avantor_services**

Avantor Services provides a wide range of specialized services and digital solutions to help you solve complex challenges.

We've built our reputation on consistent, comprehensive mastery of day-to-day operations, allowing lab, clinical, and production environments to focus their high-value resources on core scientific priorities.

As our customers' needs have evolved, so have our capabilities. We have become experts in scientific operations, improving performance with sophisticated solutions and providing guidance on best practices.

You can select and customize services for peak efficiency, quality, and accelerated innovation.

solutions for every day use

VWR® DISPOSABLE SEROLOGICAL PIPETS, PREMIUM LINE

VWR COLLECTION

POLYSTYRENE, TRANSPARENT AND GRADUATED

- DNase/RNase-free, non-pyrogenic, non-cytotoxic, non-haemolytic
- Graduations are calibrated for accurate dispensing to within ±2%
- Color-coded according to volume
- Sterile pipets are sterilized by gamma irradiation; SAL of 10^{-6} (ISO11137)

Capacity	Color Code	Graduations	Sterility	Packaging	Cat. No.
50 ml	Purple	0.5 ml	Sterile	Individually Wrapped in Paper/Plastic	**75816-088**

VWR® CELL CULTURE FLASKS

VWR COLLECTION

VACUUM GAS PLASMA TREATED FOR CONSISTENT CELL ATTACHMENT AND GROWTH

- Made of crystal clear virgin polystyrene
- Sterile and certified non-pyrogenic
- Volume graduations on both sides with special writing area
- Choice of vented or plug seal caps

The angled-neck design of these flasks allows access to the entire growth surface with either pipets or cell scrapers. Flasks have volume graduations on both sides, and a writing surface to facilitate sample identification.

Capacity	Cap Type	Culture Area	Packaging	Cat. No.
250 mL	Vented	75 cm^2	5/bag	**10062-860**

VWR® CELL CULTURE FLASKS TREATED FOR INCREASED CELL ATTACHMENT, STERILE

VWR COLLECTION

SURFACE TREATMENT THAT CAN IMPROVE CELL SPREADING AND ATTACHMENT

- Available with five different growth areas
- Increased cell attachment surface treated
- Flask surface is flat and free from striation to maximize usable growth area
- Two different cap styles can be used in both open and closed systems

The surface treatment is suitable for cells that may adhere poorly due to cell phenotype, stressful culture conditions, or those which normally require additional biological coatings for attachment.

Size	Packaging	Cat. No.
500 g	Poly Bottle	**10861-646**

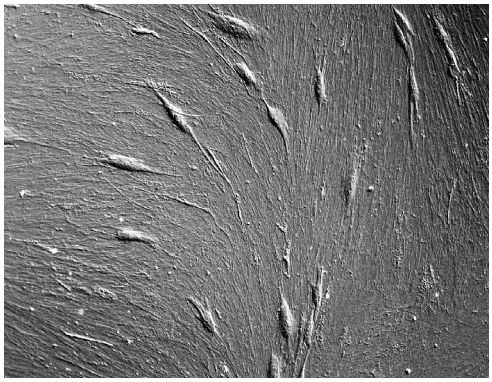
CELL-MATE 3D µGEL 40 KIT, BRTI LIFE SCIENCES

IDEAL MICROENVIRONMENT FOR DISEASE MODELING AND REGENERATIVE MEDICINE RESEARCH

- Tissue-like stiffness better mimics in vivo extracellular environment
- Allows for emergence of complex microtissues/organoids
- Chemically defined and quantifiable Tool
- Replace up to 20%* of hydration fluid with other ECM components for further customization

It is ideal for cancer cells to model the tumor microenvironment and for stem cells to differentiate toward Central Nervous System tissue. The unique microgel design takes advantage of its chemically defined, tissue-like, biomimetic 3D technology. Moreover, the simplicity and ease of use offers a fast set-up in as few as five minutes unlike other 3D products in the market.

Size	Cat. No.
24 microgels	**76093-774**



CELLVO™ MATRIX, STEMBIOSYS®

READY-TO-USE CELL CULTURE SUBSTRATE IN WHICH STEM CELLS NATURALLY RESIDE AND PROLIFERATE

- CELLvo™ Matrix is a natural extracellular matrix synthesized in vitro by bone marrow stromal cells and includes the biochemistry and architecture normally found in the bone marrow
- CELLvo™ Matrix is an advanced stem cell culture system that replicates the three-dimensional "home" in which stem cells naturally reside and proliferate
- Mesenchymal stem cells grown on CELLvo™ Matrix proliferate more rapidly

CELLvo™ Matrix is a ready-to-use cell culture substrate which provides a native microenvironment that replicates the three-dimensional "home" in which stem cells naturally reside and proliferate.

Description	Size	Material		Growth Area	Cat. No.
CELLvo™ Matrix 6-Well Flat Bottom Plate	1.9–2.9 mL	Polystyrene	20839196	9.5 cm^2	**75853-938**

solutions for discovery

VWR® POWER SUPPLY

VWR COLLECTION

IDEAL FOR BASIC ELECTROPHORESIS APPLICATIONS SUCH AS NUCLEIC ACID, AND WET BLOT WESTERN BLOTTING APPLICATIONS

- Compact footprint, takes up minimal lab space
- 500 V/400 mA, 120 W maximum output
- Ideally suited for horizontal DNA gels, vertical protein gels

The color touchscreen control panel is easy to use, allowing setting of voltage, amperage and run time. Four sets of output jacks allow connection of multiple electrophoresis tanks.

Description	Voltage	Cat. No.
115 VAC Unit		
VWR® Power Supply	10 - 500 V	**76196-454**

VWR® BLUE LIGHT TRANSILLUMINATOR

VWR COLLECTION

PROVIDES A SAFE AND COST EFFECTIVE ALTERNATIVE TO UV TRANSILLUMINATORS FOR VIEWING GELS STAINED WITH DYES EXCITED IN THE BLUE LIGHT SPECTRUM

- Blue wavelength does not damage DNA
- Uniform illuminated surface
- 465 nm wavelength, ideal for most fluorescent DNA stains
- Amber cover is removable and can be set to an angle

VWR's Blue Light Transilluminator provides a safe and cost effective alternative to UV transilluminators for viewing gels stained with dyes excited in the blue light spectrum.

Description	Electrical	Cat. No.
Blue Light Transilluminator	100 to 240VAC (Includes US type plug)	**76151-834**

VWR® EZ-VISION® BLUE LIGHT DNA DYE

VWR COLLECTION

SENSITIVE, NON-MUTAGENIC AND SAFE FLUORESCENT DNA DYE DESIGNED FOR GEL STAINING

As little as 1-2 ng of DNA can be detected with this dye.

Description	Cat. No.
VWR® EZ-VISION® Blue Light DNA Dye	**10791-798**

Bead Ruptor Elite Bead Mill Homogenizer

OMNI International
The Homogenizer Company®

- Homogenize any sample in seconds
- Ideal for DNA/RNA extraction, tissue homogenization, enzyme isolation, protein purification, food safety testing and drug extraction.
- Process up to 24 samples per cycle.
- Process samples from 25 µL to 50 mL
- Wide selection of beads and tubes for ultimate versatility

Description	Cat. No.
Bead Ruptor Elite	76000-746
Choose a Tube Carriage (not included)	
1.5 mL Tube Carriage Kit	10032-524
2 mL Tube Carriage Kit	10032-380
7 mL Tube Carriage Kit	10809-030
30 mL Tube Carriage Kit	10032-384

solutions for discovery

VWR® PCR WORKSTATIONS

VWR® COLLECTION

OFFERS AN IDEAL ENVIRONMENT FOR PCR SAMPLE PREPARATION AND OTHER SENSITIVE PROTOCOLS

- Large working area for stress-free working
- Can accommodate benchtop equipment
- Active decontamination of work surface during non-working time by UV irradiation
- Additional inactivation of aerosol-bound contaminants by shielded UV Air Recirculator during operation

This workstation allows the combination of several working steps without change of location or interruption of workflow, thereby also minimizing the risk of cross-contamination.

Description	Cat. No.
PCR Workstation	10783-132

For more information on specifications and accessories, simply enter the Cat. No. on **vwr.com**.

Axygen® Gel Documentation Systems

CORNING

Axygen Gel Documentation systems easily capture publication quality, 16-bit TIFF images. The systems are quick to set up and have an intuitive user interface for image capture, annotation, and contrast adjustment. Images are easily saved and opened in a common gel analysis software for more detailed analysis.

- Auto exposure. You never have to manually manipulate the camera
- Ready-to-use. Just connect the computer and load the software
- Long-life dual wavelength transilluminators

FEATURES

- Darkroom tab lets you select from UV 302, UV 365, Epi White, or Epi Blue (BL system only) light sources, as well as an optional Trans White light illumination tray.
- Auto Exposure tool calculates the optimal exposure time with just a single click. You can also use the Slider tool to manually adjust the exposure time and view an updated live image.

CHOOSE FROM TWO AXYGEN GEL DOCUMENTATION SYSTEMS

Axygen Gel Documentation System is an ideal system for labs that want good value without compromising ease-of-use or image quality. It includes a dual-wavelength transilluminator, 5.4 MP image resolution camera, and image acquisition software (PC not included).

Axygen Gel Documentation System-BL has all the features of the standard Axygen Gel Documentation system, as well as built-in blue lights and a built-on Microsoft® Windows® tablet. The blue lights are designed for use with EtBr replacement dyes to prevent damage to DNA that will be excised for subsequent analysis.

Description	Cat. No.
Gel Documentation System	**10015-758**
Gel Documentation System-BL	**10015-760**
Gel Documentation System blue light conversion screen for **10015-758**	**10015-762**
Gel Documentation System white light conversion screen for **10015-758** and **10015-760**	**10015-764**

solutions for discovery

VWR® MINI ELECTROPHORESIS SYSTEMS

VWR COLLECTION

AN IDEAL TOOL FOR QUICK AND EFFICIENT NUCLEIC ACID SEPARATIONS

- Complete and convenient system
- Power supply connects to the gel box, no wires are needed

This system is used for quick nucleic acid separations for a range of applications including evaluation of PCR results. The power supply has three voltage choices, connects to the gel tank so no wire leads are needed, and the running tank is compact and does not require a large amount of buffer.

Description	L x W x H	Cat. No.
115 VAC Unit		
VWR® Mini Electrophoresis System	4.5×6.25×2.25"	**76196-486**

solutions for every day use

VWR® NEXT GENERATION PIPET TIP REFILL SYSTEM

VWR COLLECTION

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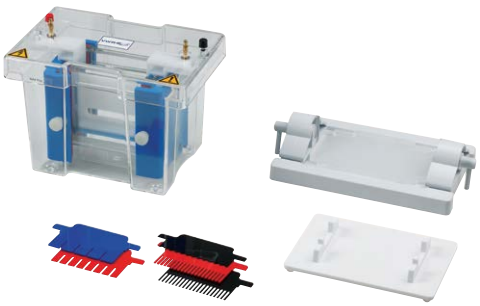

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8 mL	**75856-750**
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1.5mL	2.8mm Ceramic	**10158-602**
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2mL	0.5mm Glass	**10158-606**
2mL	1.4mm Ceramic	**10158-610**
2mL	2.8mm Ceramic	**10158-612**
2mL	2.4mm Metal	**10158-604**

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PeproGrow EPC, Endothelial Progenitor Cell Media	1 Kit	**MP700-EPC**
PeproGrow MacroV, Macrovascular Endothelial Cell Media	1 Kit	**MP700-MACROV**
PeproGrow MicroV, Microvascular Endothelial Cell Media	1 Kit	**MP700-MICROV**
PeproGrow HEK293 Media	1 L	**MPAFCDHEK293**
PeproGrow AF-CHO Media	1 L	**MPAFCHO**
PeproGrow-1 Serum-Free Cell Culture Supplement Kit	1 Kit	**MP700-C100**
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Increasing assay efficiency with four-color detection

Joy DeTorres, Product Manager, Azure

INTRODUCTION

The field of Western blot multiplexing – the ability to probe for multiple proteins on a single blot simultaneously – is developing rapidly. Chemiluminescent assays allowed for the detection of a single protein followed by multiple rounds of time consuming stripping and re-probing, with associated potential loss of protein and corresponding signal. Early Western blot multiplex imaging systems allowed for the imaging of two spectrally distinct fluorophores on a single blot. Researchers rapidly used this technique to assay for loading controls and proteins of interest on a single blot, to compare two distinct proteins, and to devise many other methodologies which are discussed in other application notes.

We have previously described an improvement on this two-channel methodology by imaging three proteins simultaneously by combining the fluorescent and nearinfrared (NIR) imaging capabilities offered by the Azure Biosystems c600 digital imager.

In this note we discuss a further improvement – four-color Western blot multiplexing using the Azure Biosystems Sapphire™ Biomolecular Imager. The ability to simultaneously image four colors at one time greatly increases Western blot efficiency and the ability to make meaningful quantitative comparisons. Four-color Western blotting is made possible through the use of four spectrally distinct fluorophores and the Sapphire's selective laser based excitation and sensitive PhotoMultiplier Tube (PMT) and Avalanche PhotoDiode (APD) detection systems.

MATERIALS AND METHODS

RUN AND TRANSFER GEL

Samples of 1.25 to 5 µg of HeLa cell lysate, some spiked with varying amounts of transferrin were electrophoresed on a 4-15% Tris-Glycine gel. After electrophoresis and separation, proteins were transferred to a low fluorescence PVDF membrane using Azure Transfer Buffer.

FOUR-COLOR WESTERN BLOTTING

Following transfer, the membrane was blocked for 30 minutes with Azure Fluorescent Blot Blocking Buffer then probed with rat anti-tubulin (green), rabbit anti-beta actin (red), and chicken anti-GAPDH (gray) primary antibodies; and anti-transferrin (Blue) which had previously been labelled with AzureSpectra 490 dye using the AzureSpectra Labeling Kit.

Blots were rinsed and washed with Azure Fluorescent Blot Washing Buffer before being incubated with AzureSpectra labeled secondary antibodies – goat anti-rat 550 (green), goat anti-rabbit 700 (red), and goat anti-chicken 800 (gray). After incubation, the blot was washed as before in Azure Florescent Blot Washing Buffer followed by a final rinse in PBS.

IMAGE FOUR-COLOR WESTERN BLOT

After rinsing in PBS, the blot was allowed to dry before imaging on the Azure Biosystems Sapphire™ Biomolecular Imager.

RESULTS AND CONCLUSIONS

In this note a single Western blot was probed for four proteins simultaneously. HeLa cell samples, or HeLa cell samples spiked with transferrin were probed with tubulin (green), beta-actin (red) and GAPDH (gray) antibodies followed by isotype appropriate secondary antibodies; as well as transferrin (blue) antibody previously conjugated with AzureSpectra 490 dye for direct analysis.

The Western blot was imaged using the Azure Biosystems Sapphire™ Biomolecular Scanner and Figure 1 shows the grayscale image captured at each wavelength for transferrin (a), tubulin (b), beta-actin (c) and GAPDH (d); together with a merged, colorized image (e). Together the images demonstrate the high level of sensitivity, specificity and lack of background signal it is possible to achieve using this methodology which allows for rapid and accurate quantitative analysis.

The ability to image four proteins on a single blot greatly increases the efficiency of Western blotting, saving time and precious samples and allows for better quantitative analysis. The methodology also allows for the use of novel assays such as investigations of protein:protein interactions or on-blot total vs phosphorylated protein assays.

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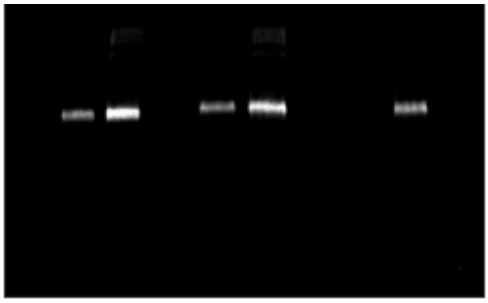
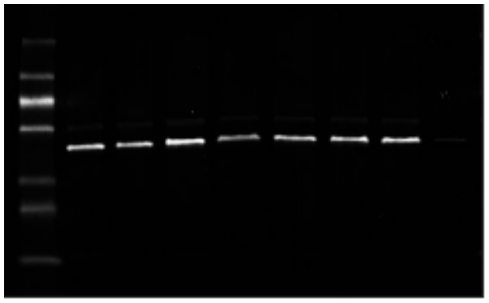
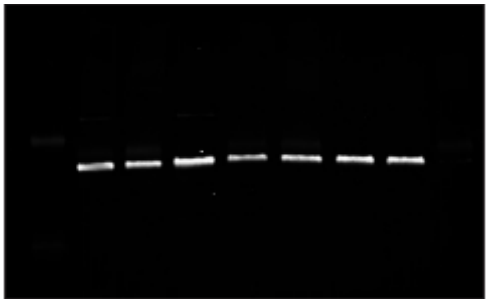
490 – transferrin (blue)



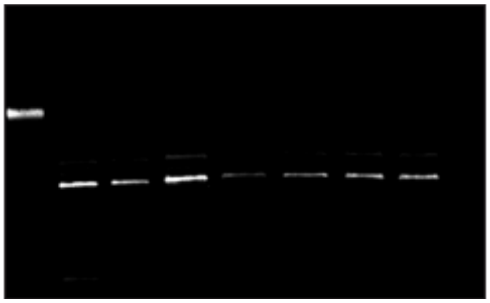
550 – tubulin (green)



700 – actin (red)



800 – GAPDH (gray)



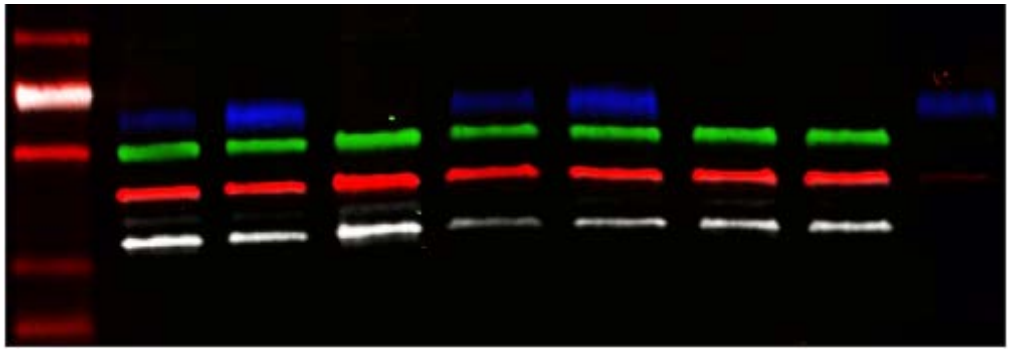


FIGURE 1. Digital images of 4-color Western blot, captured using Azure Biosystems Sapphire™ Biomolecular Imager. Transferrin (a), tubulin (b), actin (c) and GAPHD (d) were probed on a single blot using distinct fluorescent and near-infrared targeting antibodies. Images were captured using the Azure Biosystems Sapphire™ Biomolecular Imager at the specified wavelengths and merged into the four-color multiplex image (e). Sensitive and specific detection of all four proteins was possible with no evidence of background auto-fluorescence or bleed between channels.

Step	Product	Part Number
	4-15% Tris-Glycine gel	N/A
	PVDF Membrane	**10147-300**
Electrophoresis & transfer	Azure Transfer Buffer	**10147-348**
	AzureSpectra Fluorescent Blot Blocking Buffer	**75794-864**
Blocking & antibody labelling	AzureSpectra Labeling Kit – 490	**75794-836**
	Primary Antibodies	Per protein of interest
	AzureSpectra Goat-anti-rat-550	**75794-882**
	AzureSpectra Goat-anti-rabbit-700	**10147-350**
	AzureSpectra Goat-anti-chicken-800	**10147-368**
Probe Blot	PBS	N/A

TABLE 1. Material and product numbers.

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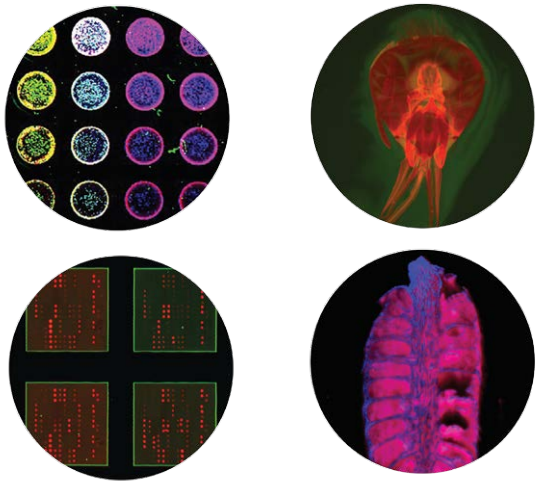
- Chemiluminescent western blot
- Quantitative western blot
- Electrophoretic mobility assay
- Phosphor imaging
- Tissue section imaging



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Sapphire Biomolecular Imager, RGBNIR	Laser excitation wavelengths at 488 nm, 525 nm, 658 nm and 785 nm, Sapphire capture software, laptop computer, AzureSpot analysis software	**76291-944**
Sapphire Biomolecular Imager, PI	Laser excitation wavelength at 658 nm, Sapphire capture software, laptop computer, AzureSpot analysis software	**76291-946**
Accessories		
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Phosphor Imaging module	Add phosphor imaging to Sapphire Biomolecular Imager	**76291-950**
Q-Module, 520 Laser module	Add 520 nm laser and detector to Sapphire Biomolecular Imager, NIR	**76291-952**

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Electronic, single channel, 5-120ul	**MP10161-144**
Picus® pipettes	
Electronic pipette 8 ch. 0.2-10ul	**MP89233-104**
Electronic pipette 1 ch. 0.2-10ul	**MP89233-092**
Tacta pipettes	
Mechanical Pipette, 1-ch, 0.1-3 µl	**MP10835-929**
Mechanical Pipette, 1-ch, 0.5-10 µl	**MP10835-931**
Proline® Plus pipettes	
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Single channel pipette 0.5-10ul	**MP89082-276**

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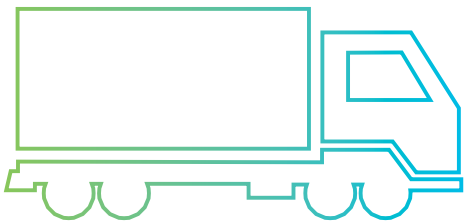

Random access gram stain automation: a review of current approaches

Bruce Bartholomew, Senior Associate for GG&B

Random access processing of gram stain slides provides high-volume laboratories an ideal mix of standardization, labor-efficiency, and throughput. Batch-design automated staining systems have provided some advantages over manual processing, such as increased throughput and reduced waste, but critical drawbacks prevent universal appeal. Cuvette-design stainers can deliver random access capabilities to microbiology labs. Combined with electro-optical decolorizing technology now available, laboratories can realize high-quality slide staining, increased standardization, labor-efficiency, throughput, and reduced waste in their gram stain operations.

RANDOM ACCESS: DEFINITION AND DISCUSSION

Random access instruments have become the norm in most parts of the laboratory. The benefits associated with random access analyzers are well-established and include improved turnaround times, reduced error rates, and reduced labor costs. Random access instruments allow individual specimens to be tested as they are received by the lab. Moreover, they permit unique testing profiles or conditions to be applied to each specimen. Other features, such as reagent and waste monitoring, automated calibration, and automated maintenance routines are also commonly associated with random access systems. At a minimum, "random access," as it applies to gram stain automation, must be defined by at least three features:

- Single slides. A single slide may be loaded and analyzed one at a time.
- Continuous load. Slide(s) may be loaded and testing initiated at any time.
- Individual profile. Unique staining conditions may be applied to each slide.

Past gram stain automation options do not meet these three criteria. Systems are not designed to efficiently process one sample. Second, once a run has begun, current systems do not permit additional samples to be loaded. Third, for each batch setup, all samples are subjected to identical staining conditions. The recent introduction of multi-slide, cuvette-design automated stainers represents a leap forward in delivering random access features for gram staining.

AUTOMATION CHALLENGES

Slide preparation: The variability of specimen sources requiring the gram stain has made standardized automation of sample preparation (the application of sample material to a microscopic slide) unfeasible thus far. Swabs, sputum, CSF, and cultures are delivered to the lab in different containers, volumes, and consistency. They do not lend themselves to standardized sample prep automation. While new automation offers the potential to automate slide preparation for some specimen types, most labs continue to prepare slides manually. For this reason, gram stain automation approaches have focused on processing slides after samples are applied and fixed to the slide.

Decolorization: Decolorization is the step most likely to cause problems in the gram stain procedure. The rate of decolorization depends upon many factors including sample type, slide fixation, wash steps, and reagent quality.[1] All automated systems using time-based decolorization suffer from the inherent problem of sample variability. While a skilled laboratorian can start, monitor, and stop decolorization for an individual slide using visual cues, batch processors by design apply the same decolorization timing to every slide in the batch, regardless of variability. As a result, some slides will be over-decolorized and some will be under-decolorized in batch-design systems.

Labs have attempted to work around this weakness by 1) batching certain types of samples together, 2) running some samples manually, or 3) "reading around" non-optimally decolorized slides. These options necessarily create compromises. Holding certain specimen types for batching delays turnaround time and risks slide misplacement. Running samples manually results in decreased labor efficiency, increased waste generation, and reduced standardization. "Reading around" poor-quality slides consumes more time and is a skill-dependent solution, raising the risk of errors.

Single-slide processing: In a random access gram stain system, each slide should receive its own unique reagents and washes. Individual slide processing avoids two problems inherent in bath stainers: over/under- decolorization and carryover. Without single-slide processing, it is impossible to adjust decolorization to individual slide requirements, as all slides are subjected to the same decolorizing conditions. In addition, bath stainers hold greater potential of carryover or precipitate effects. Incompletely fixed sample material may wash off in the bath and create anomalies that potentially affect other slides in the bath.

With single-slide processing in mind, automation options would likely mandate parallel processing in order to meet throughput requirements. Given that individual gram stains take two to four minutes each, a lab running more than 50 gram stains per day cannot wait for the sequential analysis of so many slides. A system must parallel-process stain incubations for turnaround times to be acceptable.

REVIEW OF CURRENT AUTOMATION OPTIONS

With these definitions and challenges in mind, let us review the advantages and disadvantages of current gram stain options. We limit this discussion to six desired features, summarized in the priority shown from the input of more than 50 high-volume gram staining labs:

Reduced maintenance. Non-burdensome maintenance accuracy/quality. Distinct, easy-to-read staining results standardization/consistency. The same results across all staff and shifts ease of use/simplicity. Reduced complexity and intuitive operation labor efficiency. Conserved time and reduced opportunity costs Reduced waste generation. Reduced hazards and lower costs of disposal.

Manual staining. Manual staining by a skilled technologist offers the best quality slides to the laboratory. For this reason, many high-volume labs continue to run manually, or supplement their automation with manual staining of certain slides or sample types. The disadvantage of manual staining is that laboratorians are not equally skilled, and therefore standardization is impossible. Manual staining is not labor-efficient and generates large amounts of waste for which the disposal can be a significant cost.[2]

Bath stainers. Bath stainers incorporate a series of reagent baths and wash stations into which multi-slide carriers are immersed. The primary advantage of bath stainers is their high throughput. Standardization is also an advantage over manual staining, especially within-run. Accuracy/quality is considered a disadvantage for two reasons: some bath-stainer users express carryover concerns and report precipitate formation; and bath stainers are subject to non-optimal decolorization.

Spray strainers. Spray-design stainers use nozzles to spray reagents onto slides loaded inside a carousel/centrifuge carrier. In this way, each slide receives unique reagents, and the carryover risk of bath stainers is avoided. These stainers consume the smallest volumes of reagents, making waste generation a primary advantage. Spray stainers offer the advantage of standardization, as each slide in a batch receives identical staining parameters, configured for each run. The primary disadvantage is the high maintenance required to keep the systems operating well. Laboratories using these spray-stainers often refer to their extensive maintenance burden. Spray stainers also may suffer from non-optimal decolorization, negatively impacting accuracy/quality, which frequently induces labs to run some samples manually.

Cuvette stainers. Cuvette-designed stainers have an inherent advantage in delivering "custom" decolorization for each slide. In this design, reagents are pumped into and immerse slides in a narrow, slide-shaped cuvette. In one manufacturer's design, an "electro-optical eye" continuously monitors the effluent draining from an actively-decolorizing slide and identifies the optimal "stopping point," just as a skilled technologist stops decolorizing based on visual cues. In this way, cuvette-designed stainers offer a means of adjusting decolorization automatically for each slide. This is a major advantage in generating consistently high-quality slides, independent of sample type and thickness variability.

Multi-slide systems available today incorporate automated maintenance and calibration routines, making operation simple and vastly reducing the maintenance burden associated with spray and bath stainers. They offer standardization across all slides and consume minimal reagents, generating large reductions in waste disposal over manual staining.

Multi-slide cuvette stainers with electro-optical decolorization now offer the benefits of random access gram staining to high-volume microbiology laboratories. Cuvette stainers process each slide separately. They adjust decolorization for every slide, offering labs the ability to deliver unique staining conditions to every gram stain slide. Finally, multi-slide cuvette stainers, which parallel process slides in multiple cuvettes, deliver high-volume throughput, permit labs to load one or many slides at a time, and offer continuous load capability.

Editor's note: The author analyzes manual staining and the currently available automation options of bath stainers, spray stainers, and cuvette stainers, reaching the conclusion that the last of these is the best choice. MLO would be pleased to print concurring or opposing views, both from clinical laboratory professionals as well as industry leaders, in an upcoming issue.

Bruce Bartholomew is a Senior Associate at Mountain Summit Advisors and a sales/marketing consultant for GG&B Company, which manufactures automated slide stainers for hematology and microbiology.

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