Cytell™ Cell Imaging System

The Cytell Cell Imaging System (Fig 1) combines the functionalities of a digital microscope, an image cytometer, and a cell counter in a single benchtop instrument. This compact, application-driven, automated cell imaging system provides robust quantitative results through the use of preconfigured biological applications (BioApps). Each BioApp is an easy-to-use, automated module that covers all steps of a specific biological application or assay. Cytell Cell Imaging System comes bundled with five BioApps to simplify routine cell lab tasks while providing high-quality scientific data.

Key features

Flexibility

- Cytell can be used as a digital microscope, image cytometer, and cell counter. This flexibility simplifies logistics in the laboratory, reducing both the amount of equipment required and the dependence on core imaging facilities and associated expertise.

- Cytell works with multiwell plates, slides, Petri dishes, and flasks, so you can capture great images from a range of samples.

- Images and numerical data are saved in standard formats that can be imported into a variety of image analysis and statistical data programs.

- Four color channels allow you to multiplex up to four fluorescent markers; with spectral optics optimized for commonly used dyes such as Hoechst™, GFP, Cy™3, and Cy5 (Table 1).

Fig 1. Cytell Cell Imaging System.

- Ready-to-use reagent kits are available from GE Healthcare for cell counting, cell cycle, and cell viability applications. Alternative reagents are also supported as long as they match the four available fluorescent channels.

Table 1. Examples of recommended fluorophores for each fluorescent channel

Channel	Example Dyes
Blue	DAPI, Hoechst, Alexa Fluor™ 405
Green	GFP, Fluorescein, Calcein AM, Alexa Fluor 488, Cy2
Orange	Cy3, Rhodamine, TRITC, Alexa Fluor 546, Propidium Iodite, DsRed
Red	Cy5, DRAQ5, Alexa Fluor 660, TOTO™-3

Hardware highlights

- Out-of-the-box installation and operation

- No preventive maintenance required

- Solid-state illuminator: lifetime of 10 000 h, which is approximately 5× longer than a typical lamp

- Automated XY stage, objective changer, Z-axis focus adjustment, emission filter changer, and autofocus; control all hardware components with user-adjustable imaging protocols

- Sample motion, imaging operations, and other steps of the experimental procedure are performed either automatically or manually using the highly intuitive graphical user interface (GUI); automation simplifies instrument use and minimizes the possibility of user errors

Ergonomics

- The compact design (48 × 58 cm/19 × 23 inches) easily fits on a lab workbench and allows easy placement of one or more instruments in convenient locations throughout the laboratory. The low profile and sliding door for sample loading minimize interference with above-bench shelving.

- Wide, open sample docking position provides easy access for both left- and right-handed use.

- The all-in-one PC for instrument control saves space and incorporates a large touch screen display for easy viewing of detailed images and results.

- The user interface can be operated using a touch screen or mouse and keyboard, adapting to individual preferences. The touch screen is responsive to gloved hands.

- Minimal cabling is required. Only a network cable is needed to link the instrument with the all-in-one PC.

Some of the key ergonomic features of Cytell are shown in Figure 2.
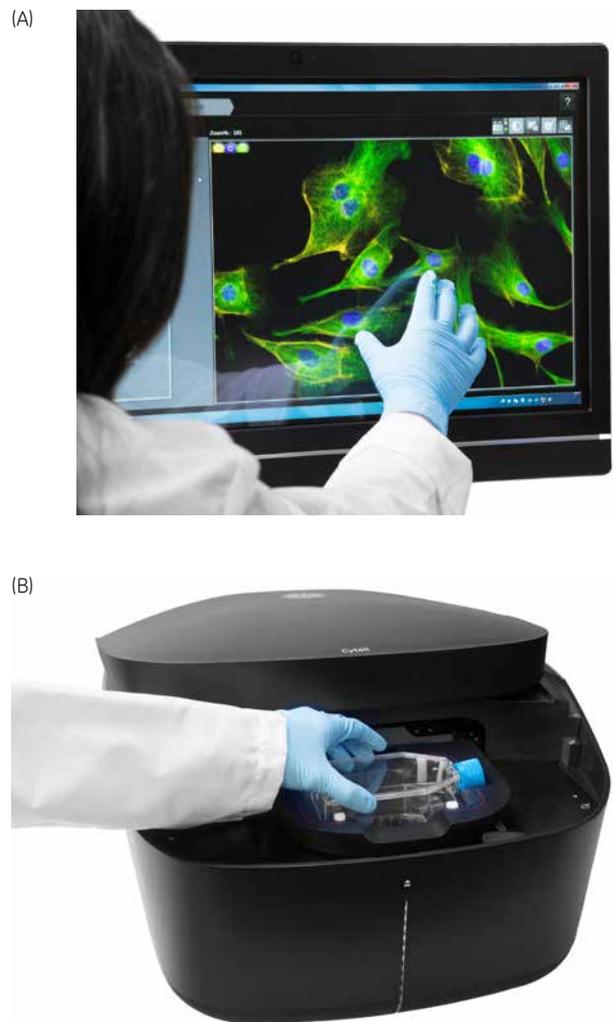
(A)

(B)

Fig 2. Ergonomic features of Cytell Cell Imaging System. (A) The touch screen is responsive to gloved hands; (B) A wide, open sample docking position provides easy access.

User interface

- Cytell functionality is driven using a set of BioApps. Each BioApp is an easy-to-use, automated software module that covers all steps of a specific biological application or assay, from imaging through analysis, data visualization, and report generation.

- BioApps are hosted within a web-based touch sensitive GUI environment, similar to the apps on newer tablets and smartphones.

- Cytell comes complete with five starter BioApps: Digital Imaging, Automated Imaging, Quick Count, Cell Cycle, and Cell Viability. See the product information for each BioApp for additional details. Software updates and additional BioApps (as they are developed) will be available via the GE Healthcare Life Sciences Web site.

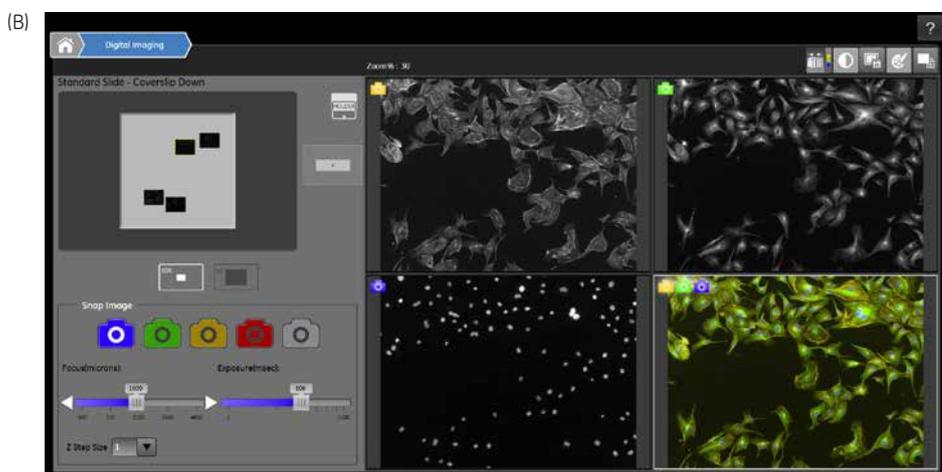Figure 3 provides examples of various screens from the Cytell GUI.

(A)

(B)
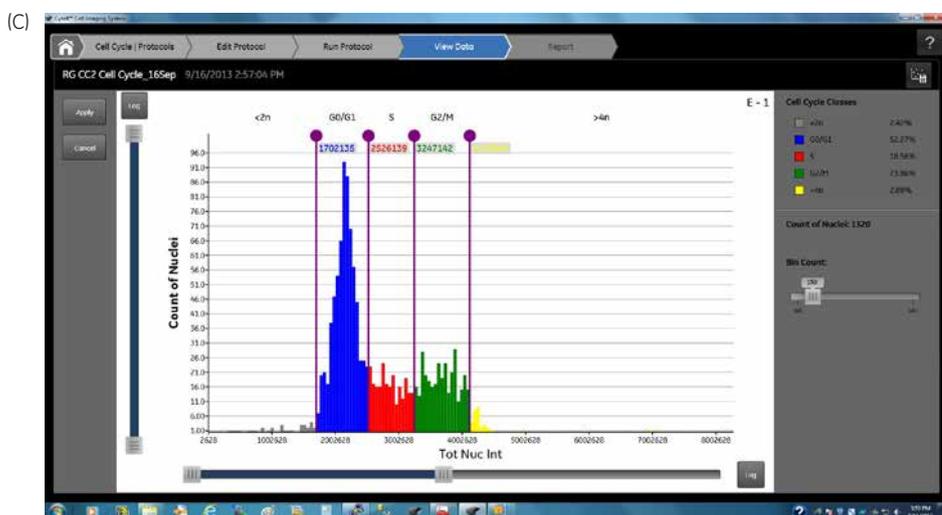
Fig 3. Cytell Cell Imaging System features an easy-to-use graphical user interface. (A) Cytell comes complete with five starter BioApps: Digital Imaging, Automated Imaging, Quick Count, Cell Cycle, and Cell Viability. (B) The intuitive interface guides you through image acquisition and data analysis. (C) Data analysis is simplified with features such as interactive histograms that allow you to adjust population gates and immediately update all data visualizations.

(C)

Imaging performance

Cytell is designed to capture high-quality cellular images suitable for collecting robust statistical measurements from subcellular features and cell populations. This capability is achieved by combining large field of view (FOV) and subcellular imaging resolution.

Performance at low magnification:

- Large FOV (2.2 × 1.6 mm)
- Optimal for imaging whole cells, small organisms, and colonies
- Several hundreds of cells can be captured in one image
- Preview scan large areas to easily find an object of interest

Some of these applications are shown in Figure 4.

Performance at high magnification:

- FOV size: 880 × 660 μm
- High numerical aperture (0.45 NA) and small camera pixel size (4.45 μm) enable submicron resolution imaging
- Imaging and quantitation of subcellular features, including nuclei, cytoplasm, endosomes, mitochondria, and cytoskeletal networks

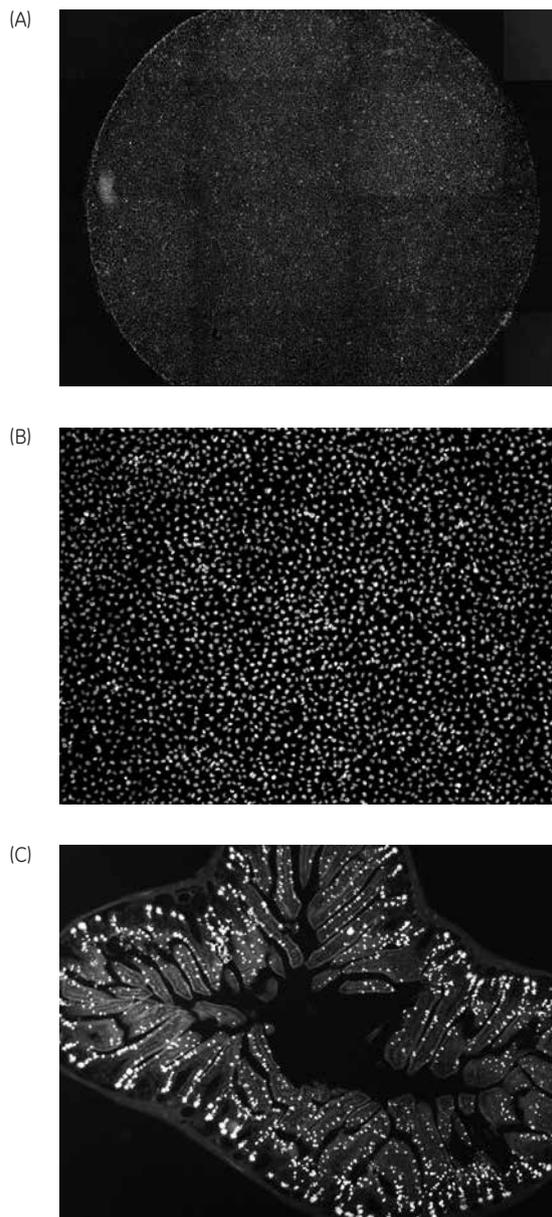Sample images of some subcellular features are shown in Figure 5.

(A)

(B)

(C)

Fig 4. Uses of Cytell at low magnification. (A) Preview scan of a whole well in a 96-well plate; (B) image of a sample with high cell density; (C) image of a tissue slide to demonstrate the large FOV.
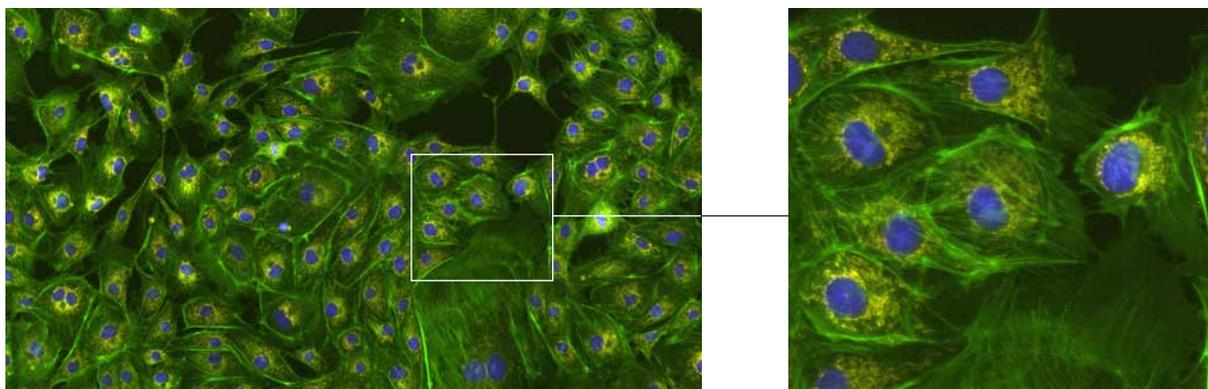

Fig 5. Cytell images taken at high magnification showing nucleus, cytoskeleton, and mitochondria.

Data visualization

Cytell provides a variety of interactive graphical tools to analyze and visualize experimental data from multiple wells, cell populations, and subpopulations. Five of the most commonly used tools, graphs, and plots are:

- **Histogram:** examine population intensity distributions and apply gating thresholds to identify subpopulations; a histogram is an important tool for cell cycle phase analysis

- **Scatter plot:** view individual cell data in two dimensions with color coding to identify subpopulations and assess the effectiveness of applied gating

- **Plate heat map:** see at a glance how a single experimental parameter varies across the plate, for example in a dose-response experiment

- **Pie chart:** visualize the relative size of cell subpopulations in a well or across a plate; in plate map view, the size of the individual pie charts can be set proportional to the total cell number per well

- **Bar chart:** assess the change in a single experimental parameter across multiple samples

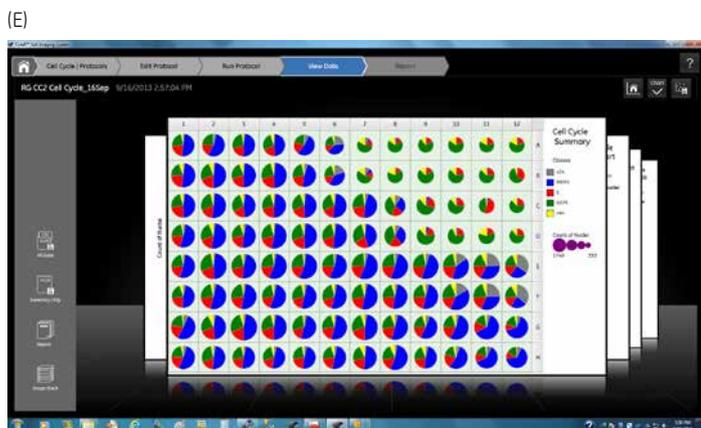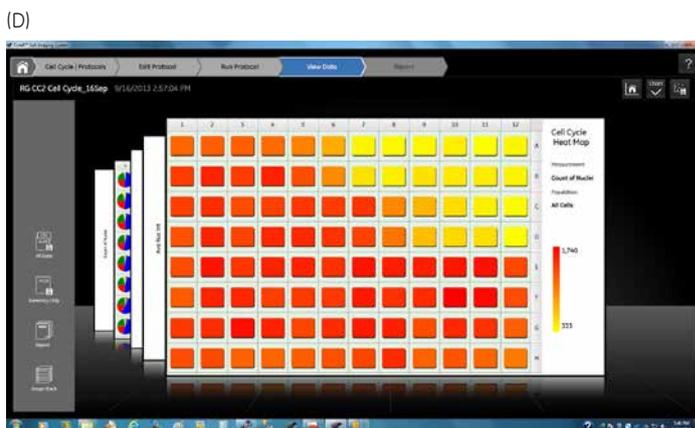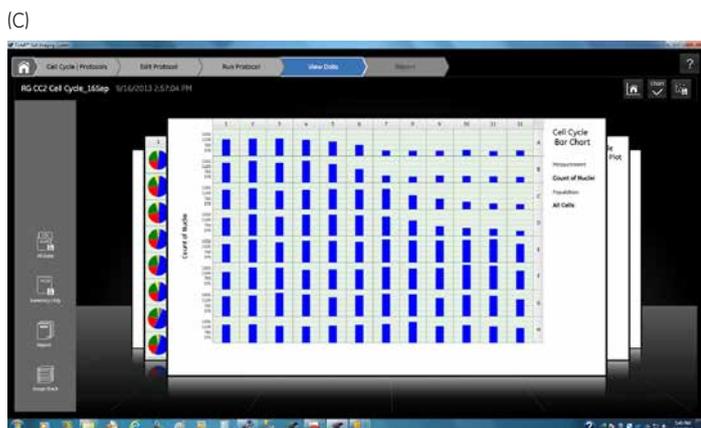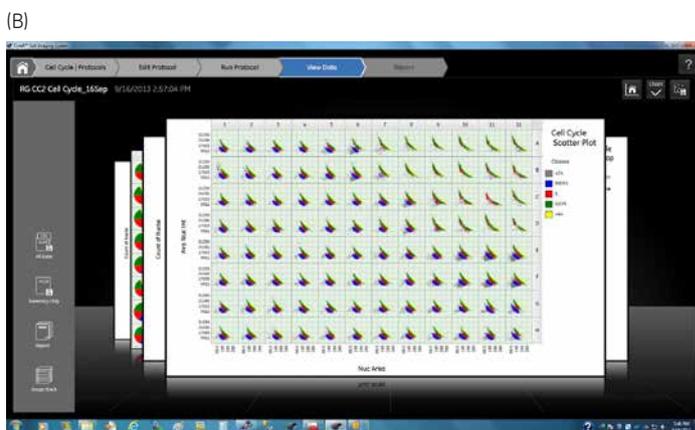Figure 6 provides examples of screen shots for these five tools.

(A)
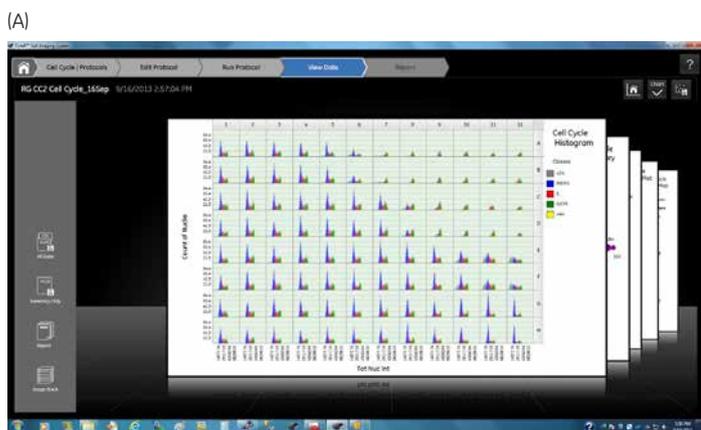

(B)

(C)

(D)

(E)

Fig 6. Cytell automatically displays results in charts and plots. Swipe or click through the selection of data displays to investigate the results at multiple levels. Five of the most commonly used data visualization toos are: (A) histogram; (B) scatter plot; (C) bar chart; (D) plate heat map; (E) pie chart.

Results and other data files

Each Cytell BioApp creates a number of data files to capture protocols, system configuration, and experimental results:

- **Protocols:** these files manage experimental procedures and capture the sample format, imaging parameters, and analysis parameters. Protocols may be re-used for repetitive procedures or as templates for new experiments.

- **Images:** all images are saved in .tif format. Individual images can also be saved in .jpg format. .tif images can be imported into image editing and analysis software such as IN Cell Analyzer (GE Healthcare) or third-party tools such as CellProfiler and ImageJ. Image stack metadata are saved in .xdce format for compatibility with IN Cell Investigator analysis software.

- **Data files:** Cell-by-cell and population measurements are saved in standard .csv format for easy import into third-party data analysis software such as Excel™ and FlowJo™.

- **Experimental reports:** these .pdf files capture the essential outcomes of each experimental run performed by a BioApp: the date, sample information, imaging parameters, analysis parameters, and resulting graphs and data visualization plots.

- **Sample definitions:** these configuration files describe the geometry of sample holders that can be imaged using Cytell. The system comes with a comprehensive list of supported multiwell plates, Petri dishes, and flasks. Users can create new sample definitions using the utility feature within the Cytell GUI.

System specifications

Installation	Self-installed, out-of-the-box operation
Instrument dimensions	483 (W) × 292 (H) × 584 (D) mm (19 × 11.5 × 23 inches)
Weight	27 kg (59.8 lb)
Input voltage	110–240 VAC, 50/60 Hz
Power requirements	2.5 A at 24 VDC
Imaging modes	Epi-fluorescent and transmitted light wide field imaging
Illumination	Solid-state illuminator for fluorescence imaging LED for transmitted light imaging
Fluorescence channels	Blue: Ex 390 nm/Em 430 nm Green: Ex 473 nm/Em 512.5 nm Orange: Ex 544 nm/Em 588 nm Red: Ex 631 nm/Em 702 nm
Camera	2.8 megapixel, 14-bit CCD camera, 4.54 µm pixels
Objective lens changer	2-position, automated objective selection
Objectives	High resolution 10×/NA=0.45 objective Large FOV 4×/NA=0.2 objective
Autofocus	Contrast-based autofocus Laser hardware autofocus
Stage operation	Automated X-Y-Z position control
Sample formats	Supports multiwell plates (6- to 384-well), microscope slides, Petri dishes (35, 60, 100 mm), and flasks (T-25, T-75) Adapters for microscope slides, 35, 60, and 100 mm Petri dishes, and T-25 and T-75 flasks included with each Cytell system
Workstation	HP™ 8300 touch screen, all-in-one PC Operating system: Windows 7, 64-bit
Pre-installed BioApps	Digital imaging, Automated Imaging, Cell Cycle, Cell Count, Cell Viability
File output	16-bit .tif, .jpg, .pdf, and .csv
Software tools	Plate Map Creator, System Backup
Data storage	Workstation hard drive and network drive capable
Reagents	Supports GE supplied kits and off-the-shelf reagents

Ordering information

Products	Code number
GE Cytell Cell Imaging System comprising instrument, workstation, microscope slide holder, 35 mm Petri dish holder, 60 mm Petri dish holder, 100 mm Petri dish holder, T-25 flask holder, T-75 flask holder, reference slide	29-0567-49

Accessories	Code number
Cytell Microscope Slide Holder	29-0626-75
Cytell 35 mm Petri Dish Holder	29-0626-76
Cytell 60 mm Petri Dish Holder	29-0626-77
Cytell 100 mm Petri Dish Holder	29-0626-78
Cytell T-25 Flask Holder	29-0626-79
Cytell T-75 Flask Holder	29-0626-80
Cytell Quick Count slides	29-0626-81

Related Reagents	Code number
Cytell Quick Count/Viability Reagent	29-0574-95
Cytell Cell Viability Kit	29-0574-96
Cytell Cell Viability Plus Reagent	29-0574-97
Cytell Cell Cycle Kit	29-0574-98

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