

Chapter 16

AUTOMATION OF URINE AND BODY FLUID
ANALYSIS



History

First reagent strips for urinalysis by chemical test developed in 1950s

Development of instruments to read strips followed

“Yellow Iris” first automation of microscopic examination developed in 1980s

Both types available today

Field of automation continually changing over time

Urine Chemistry Analyzers

Semiautomated analyzers developed to standardize interpretation of reagent strips

User must dip reagent strip and place onto platform

Instrument automatically performs test

Some manufacturers include a color compensation pad

- Can only be read by an automated instrument

Use principle of reflectance photometry

Reflectance Photometry

Quantifies intensity of colored product produced on reagent strip pads

When light strikes strip, some absorbed and rest reflected in all directions

Selects one wavelength of reflected light to read using one of the following:

- Series of filters to isolate one wavelength
- Monochromatic light sources: light-emitting diodes or LEDs

Expressed as percent reflectance (%R)

Percent Reflectance (%R)

%R is ratio of test pad reflectance compared to calibration reflectance multiplied by the percent reflectivity of calibration reference, which is usually 100%

Relationship between cor $\% R = \frac{R_t}{R_c} \times 100$:flectance is not linear
◦ Microprocessor necessar ship to linear

Semiautomated Analyzers

TABLE 16.2 Typical Features of Semiautomated Urine Chemistry Analyzers

Tests performed	Blood, leukocyte esterase, nitrite, protein, glucose, ketone, bilirubin, urobilinogen, pH, specific gravity
Measurement principle	Intensity of color on reagent strip pads measured by reflectance photometry; automatic adjustments made for urine color
Sample handling	User <i>manually</i> dips and places strip onto instrument platform
Sample ID entry	User manually enters, uses a barcode reader, or downloads from LIS
Results	Printout and on-board data storage; can interface to LIS Color and clarity can be <i>manually</i> entered to be included on report and printout.
Daily maintenance	Clean reagent strip platform; empty used reagent strip container



Image courtesy ARKRAY Inc.



Image courtesy Iris Diagnostics.



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Fully Automated Chemistry Analyzers

User places labeled tubes of urine into rack or carousel, and instrument completes testing and measures physical characteristics



Image courtesy Iris Diagnostics.

Automated Microscopy

Currently three analyzers available:

- Iris iQ200 microscopy analyzer
 - Analysis based on digital flow microscopy; also called flow cell digital imaging
 - Urine particle recognition using proprietary neural network software
- UF-1000*i* (and predecessor UF-100) by Sysmex
- AUTION HYBRID by Arkray
 - Uses flow cytometry to identify and categorize urine particles
 - Urine particles identified and categorized on the basis of forward scatter, fluorescence, impedance signals, and adaptive cluster analysis



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Image courtesy Arkray Inc.

Automated Microscopy

Automated cuvette-based digital microscopy

- By 77 Elektronika
- Instrument produces digital images of entire microscopic fields of view of urine sediment on the bottom of a cuvette
- Proprietary software identifies and classifies the urine sediment components



Image courtesy 77 Elektronika.

Fully Automated Systems

TABLE 16.6 Fully Automated Urinalysis (UA) Systems

Fully Automated UA System	Chemistry Analyzer	Microscopy Analyzer and Technology
iRICELL3000, 2000, 1500*	iChem Velocity*	iQ200,* digital flow microscopy
CLINITEK AUWi Work Cell System [†]	CLINITEK Atlas [‡]	UF-1000i, [§] flow cytometry
AUTION HYBRID [†]	AU-4050 [†] (chemistry and microscopy components are integrated into a single analyzer); flow cytometry	
LabUMat 2 with UriSed 2 [¥]	LabUMat 2 [¥]	UriSed 2, [¥] cuvette-based digital microscopy

Automated Body Fluid Analyzers

TABLE 16.7 Selected Automated Body Fluid Analyzers

Analyzer	Body Fluids (FDA approved, USA)
ADVIA 2120i with Body Fluid Software	Cerebrospinal fluid (CSF) Pleural Peritoneal Peritoneal dialysate Serous fluids
iQ200 using Body Fluid Module	CSF Pericardial Peritoneal Peritoneal dialysate Peritoneal lavage Pleural Serous fluids Synovial
Sysmex XE-5000 using Body Fluid mode	CSF Pleural Pericardial Peritoneal Peritoneal dialysate Serous fluids Synovial