### 3 glass technique
For detection of prostatic infection
1. 1st portion of voided urine
2. Middle portion of voided urine: Serves as control for kidney and bladder infection
   - If (+), result for #3 is considered invalid
3. Urine after prostatic massage
   Compare WBC and Bacteria of specimen 1 and 3
   Prostatic infection: 1 < 3 (10x)

### Pediatric specimen
Wee bag

### Drug Specimen Collection
**Chain of custody:** step by step documentation of handling and testing of legal specimen
- Required amount: 30-45 mL
- Temperature (urine): 32.5-35.7°C (within 4 mins)
- Blueing agent → Toilet bowl (to prevent adulteration)

### Types of Urine Specimen

<table>
<thead>
<tr>
<th>Occasional/Single/Random</th>
<th>Routine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative UA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>24 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st voided urine → discarded</td>
</tr>
<tr>
<td>w/ preservative</td>
</tr>
<tr>
<td>Ex. 8AM → 8AM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. 8AM → 8PM</td>
</tr>
<tr>
<td>Addis count: measure of formed elements in the urine using hemacytometer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Afternoon (2PM-4PM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urobilinogen (alkaline tide)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrite determination (1st morning)</td>
</tr>
<tr>
<td>NO₃ → NO₂ = (+) UTI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1st morning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnancy test (hCG)</td>
</tr>
<tr>
<td>Ideal specimen for routine UA</td>
</tr>
<tr>
<td>No concentrated and most acidic = preservation of cells and casts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fasting/2nd morning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose determination</td>
</tr>
<tr>
<td>2nd voided urine after a period of fasting</td>
</tr>
</tbody>
</table>

### Changes in Unpreserved Urine

<table>
<thead>
<tr>
<th>Decreased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarity</td>
</tr>
<tr>
<td>Bacterial multiplication</td>
</tr>
<tr>
<td>Precipitation of AU/AP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycolysis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ketones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatilization</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bilirubin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photooxidation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urobilinogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxidized to urobilin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RBC/WBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disintegrate in alkaline urine</td>
</tr>
</tbody>
</table>

### Increased

<table>
<thead>
<tr>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea ---(Urease)----&gt; NH₃</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplication</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Odor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea ---(Urease)----&gt; NH₃</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nitrite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial multiplication</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Differentiate contamination from true infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contamination: ↑ Bacteria</td>
</tr>
<tr>
<td>True infection: ↑ Bacteria and WBCs</td>
</tr>
</tbody>
</table>

### Preservation

<table>
<thead>
<tr>
<th>Refrigeration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-8°C</td>
</tr>
<tr>
<td>↑ SG (hydrometer/urinometer)</td>
</tr>
<tr>
<td>Precipitate AU/AP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Formalin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addis count</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Boric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine culture</td>
</tr>
</tbody>
</table>
Red/Purple/Burgundy red/purplish red/Portwine
Porphyria
(Lead poisoning: normal color)

Brown/black
Methemoglobin (acid urine)
Homogentisic acid: Alkaptonuria
-Urine darkens after a period of standing
-(-) Homogentisic acid oxidase

Urine Color Changes w/ Commonly Used Drugs

Cola-colored
Levodopa (Tx: Parkinsonism)
Red → Brown (alkaline)

Yellow
Mepacrine/Atabrine (Tx: Malaria, Giardiasis)

Red to brown
Metronidazole/Flagyl (Tx: Trichomoniasis, Amoebiasis, Giardiasis)
Methyldopa/Aldomet (Antihypertensive)

Orange-red (acid)
Phenazopyridine/pyridium (Tx: UTI)

Bright orange-red (acid)
Rifampin (Tx: TB) = all body fluids are red

Bright yellow
Riboflavin (Multivitamins)

Nubecula
Faint cloud in urine after a period of standing
WBCs, epithelial cells and mucus

Bilifuscin (Dipyrrole)
Hemoglobin Köln = unstable
Red-brown urine

Clarity/Transparency/Turbidity
Clear
Transparent, no visible particulates

Hazy
Few particulates, print easily seen through urine

Cloudy
Many particulates, print blurred through urine

Turbid
Print cannot be seen through urine

Milky
May precipitate or clot

Bacteria
Uniform turbidity ON cleared by acidification or filtration

Chyluria
Lymph fluid in urine

Squamous epithelial cells
↑ females

Radiographic contrast media
↑ SG by refractometer (>1.040)
Rgt strip: not affected by RCM

Vaginal cream
Tx: Candida
Pseudochyluria

Laboratory Correlations in Urine Turbidity

Acidic urine
AU
RCM

Alkaline urine
AP
Carbonates

Soluble w/ heat
AU
Uric acid

Soluble w/ dilute acetic acid
RBCs
AP
Carbonates

Insoluble in dilute acetic acid
WBCs
Yeasts
Spermatozoa
Bacteria

Soluble in ether
Lipids
Lymph fluid
Chyle
<table>
<thead>
<tr>
<th>Specific Gravity</th>
</tr>
</thead>
</table>
| SG | Density of solution compared w/ density of similar volume of distilled H₂O at a similar temperature  
| NV = 1.003-1.035 (random)  
| SG <1.003 = not a urine except DI |

| Refractometer (TS meter) | Based on refractive index:  
| RI = _light velocity in air_  
| _light velocity in soln_  
| Compensated to temperature (15-38°C)  
| Corrections:  
| a. 1g/dL glucose: (-0.004)  
| b. 1g/dL protein: (-0.003)  
| Calibrations:  
| a. Distilled H₂O = 1.000  
| b. 5% NaCl = 1.022 ± 0.001  
| c. 9% Sucrose = 1.034 ± 0.001 |

| Urinometer | Requires temperature correction  
| a. ↑ 3°C calibration temperature (20°C) = (+0.001)  
| b. ↓ 3°C calibration temperature (20°C) = (-0.001)  
| Requires correction for glucose and protein (RF/U)  
| RF < U by 0.002 | Refractometer reading is lower than the urinometer reading by 0.002  
| Urinometer calibration | K₂SO₄ solution: 1L H₂O + 20.29g K₂SO₄  
| SG = 1.015 |

| Isosthenuria | SG = 1.010 (Glomerular filtrate)  
| Hyposthenuria | SG < 1.010  
| Hypersthenuria | SG > 1.010  
| Urine Odor |  
| Aromatic/Odorless | Normal  
| Ammoniacal | Urea --> (Urea cyclase) NH₃  
| Ex. UTI (↑ productive) urease  
| Fruity, sweet | DM (Ketones)  
| Rotten fish/Galunggong | Trimethylaminuria  
| Sweaty feet | Isovaleric acidemia  
| Mousy | Phenylketonuria  
| Cabbage | Methionine malabsorption  
| Caramelized sugar, curry | MSUD  
| Bleach | Contamination  
| Sulfur | Cystine disorder |

### Chemical Examination of Urine

#### Specific Gravity

| Principle (Rgt Strip) | pKa dissociation constant  
| ↑ concentration = ↑ H⁺  
| Indicator: Bromthymol blue = (↓) Blue → Green → Yellow (↑)  
| Other info. | Not affected by glucose, protein and RCM  
| Harmonic Oscillation Densitometry | Frequency of soundwave entering a solution will change in proportion to the density (SG) of the solution  
| -Yellow IRIS (Automated): International Remote Imaging System |

| pH |  
| Normal | Random = 4.5-8.0  
| 1st morning = 5.0-6.0  
| pH 9.0 = Unpreserved urine |
### Sediment Constituents

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Description</th>
</tr>
</thead>
</table>
| RBCs | NV = 0-2 or 0-3/hpf  
Hypertonic: crenated, shrink  
Hypotonic: Ghost cells, swell, hemolyzed  
Dysmorphic: glomerular membrane damage, w/ projections, fragmented  
Sources of error:  
-Yeasts  
-Oil droplets  
-Air bubbles  
-CaOx crystals  
♫ Remedy: add 2% acetic acid  
-RBCs: lysed  
-Other cells: intact |
| WBCs | NV = 0-5 or 0-8/hpf  
Glitter cells (Hypotonic urine)  
-Granules swell  
-Brownian movement  
>1% eosinophils: significant  
-↑ Drug-induced allergic reaction  
-↑ Inflammation of renal interstitium |
| Addis count | Quantitative measure of formed elements of urine using hemacytometer  
Specimen: 12 hr urine  
Preservative: Formalin  
NV:  
a. RBCs: 0-500,000/12 hr urine  
b. WBCs: 0-1,800,000/12 hr urine  
c. Hyaline Casts: 0-1000/12 hr urine |
| Squamous epithelial cells | Largest cell in the urine sediment  
From linings of vagina, female urethra and lower male urethra  
♫ Variation: Clue cells:  
-EC w/c are studded w/ bacteria (bacterial vaginosis)  
-Whiff/Sniff test: vaginal discharge + 10% KOH → Fishy amine-like odor  
-Culture: *G. vaginalis* = HBT medium |
| Transitional epithelial cells (Urothelial cells) | Spherical, polyhedral, or caudate w/ centrally located nucleus  
Derived from the linings of the renal pelvis, ureter, urinary bladder, male urethra (upper portion)  
Not clinically significant in small numbers |
| Renal tubular epithelial cells | Rectangular, polyhedral, cuboidal or columnar w/ an eccentric nucleus, possibly bilirubin stained or hemosiderin laden  
From nephron:  
-PCT: rectangular, columnar/convoluted  
-DCT: round/oval  
>2 RTE/hpf: tubular injury |
| Oval fat body | Lipid containing RTE cells  
Lipiduria (Ex. nephrotic syndrome)  
Cholesterol: Maltese cross |
| Bubble cells | RTE cells w/ nonlipid containing vacuoles  
Acute tubular necrosis |
| Yeast | *C. albicans* (DM, vaginal moniliasis) |
| *T. vaginalis* | Flagellate w/ jerky motility |
| Hartnup disease: “Blue diaper syndrome”  
Obermayer’s test: FeCl₃ → (+) Violet w/ chloroform |
|---------------------------------------------------------------|
| **Argentaffinoma**  
Carcinoid tumor involving argentaffin cells  
↑ 5-HIAA: metabolite of serotonin  
FeCl₃ → (+) Blue-green (PKU)  
Nitrosonaphthol → (+) Violet w/ HNO₃  
Be sure patient should avoid banana, pineapple, tomatoes (serotonin-rich) |
| **Cystine Disorders** |
| **Cystinuria (Renal type)**  
Defect in renal tubular transport of:  
-Cystine (least soluble → urine)  
-Ornithine  
-Lysine  
-Arginine |
| **Cystinosis**  
Inborn error of metabolism  
Cystine deposits in many areas of the body  
Cyanide-nitroprusside → (+) Red-purple |
| **Homocystinuria**  
Defect in the metabolism of homocystine  
Silver nitroprusside → (+) Red-purple |
| **Brand’s modification of Legal’s nitroprusside**  
Rxn: Cyanide-nitroprusside → (+) Red-purple |
| **Mucopolysaccharide Disorders** |
| **MPS**  
Dermatan SO₄  
Keratan SO₄  
Heparan SO₄ |
| **Clinical significance**  
Alder-Reilly syndrome  
Hurler syndrome = MPS → cornea of the eye  
Hunter’s = cornea, cartilage = Sex-linked recessive  
Sandip syndrome = Mental retardation only |
| **CTAB**  
(+) White turbidity |
| **Urine Disorders** |
| **Lesch-Nyhan disease**  
↑ Urinary uric acid crystals |
| **Porphyrias** |
| **D-ALA**  
Glycine + Succinyl CoA ----(ALA synthetase)----> D-ALA |
| **Porphobilinogen**  
D-ALA ----(ALA synthetase)----> Porphobilinogen  
Lead poisoning: inhibits ALA synthase |
| **Uroporphyrinogen**  
Porphobilinogen -----(Uroporphyrinogen synthase/  
Uroporphyrinogen cosynthase)----> Uroporphyrinogen  
Acute intermittent porphyria: (-) Uroporphyrinogen synthase  
Congenital erythropoietic porphyria: (-) Uroporphyrinogen cosynthase |
| **Coproporphyrinogen**  
Uroporphyrinogen ---------(Uroporphyrinogen  
decarboxylase)---------> Coproporphyrinogen  
Porphyria cutanea tarda: (-) Uroporphyrinogen decarboxylase |
| **Protoporphyrinogen**  
Coproporphyrinogen ---------(Coproporphyrinogen  
oxidase)---------> Protoporphyrinogen  
Hereditary coproporphyria: (-) Coproporphyrinogen oxidase |
| **Protoporphyrin IX**  
Protoporphyrinogen ---(Protoporphyrinogen oxidase)--> Protoporphyrin IX  
Variegate porphyria: (-) Protoporphyrinogen oxidase |
| **Heme**  
Protoporphyrin IX + Fe²⁺ ----(Ferrocheletase)--------> Heme  
Lead poisoning: inhibits Ferrocheletase |
| **Porphyrias**  
Vampire disease  
Disorders of porphyrin metabolism |
### Access to procedure manuals
Competency of personnel performing the tests

<table>
<thead>
<tr>
<th>Microscopic Quantitations</th>
<th>EC (lpf)</th>
<th>Crystals (hpf)</th>
<th>Bacteria (hpf)</th>
<th>Mucous threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Rare</td>
<td>0-5</td>
<td>0-2</td>
<td>0-10</td>
<td>0-1</td>
</tr>
<tr>
<td>Few</td>
<td>5-20</td>
<td>2-5</td>
<td>10-50</td>
<td>1-3</td>
</tr>
<tr>
<td>Moderate</td>
<td>20-100</td>
<td>5-20</td>
<td>50-200</td>
<td>3-10</td>
</tr>
<tr>
<td>Many</td>
<td>&gt;100</td>
<td>&gt;20</td>
<td>&gt;200</td>
<td>&gt;10</td>
</tr>
</tbody>
</table>

| Casts (lpf) | None = 0 | Numerical ranges = 0-2/2-5/5-10/>10 |
| RBCs (hpf)  | None = 0 | Numerical ranges = 0-2/2-5/5-10/>10-25/25-50/50-100/>100 |
| WBCs (hpf)  | None = 0 | Numerical ranges = 0-2/2-5/5-10/>10-25/25-50/50-100/>100 |

### Quality Assurance Errors

#### Preanalytical
- Patient misidentification
- Wrong test ordered
- Incorrect urine specimen type collected
- Insufficient urine volume
- Delayed transport of urine to the laboratory
- Incorrect storage or preservation of urine

#### Analytical
- Sample misidentification
- Erroneous instrument calibration
- Reagent deterioration
- Poor testing technique
- Instrument malfunction
- Interfering substances present
- Misinterpretation of quality control data

#### Postanalytical
- Patient misidentification
- Poor handwriting
- Transcription error
- Poor quality of instrument printer
- Failure to send report
- Failure to call critical values
- Inability to identify interfering substances

### TQM
Based on a team concept involving personnel at all levels working together to achieve a final outcome of customer satisfaction through implementation

### CQI
Improving patient outcomes by providing continual quality care in a constantly changing health-care environment

### PDCA
Plan-Do-Check-Act

### PDSA
Plan-Do-Study-Act
| **Diarrhea** | **Acute**: <4 weeks  
**Chronic**: >4 weeks |
| --- | --- |
| **Secretory diarrhea** | ↑ solute secreted by the intestine  
Endotoxins |
| **Osmotic diarrhea** | ↑ amounts of osmotically active solutes in the lumen (maldigestion)  
↑ CHO in stool |
| **Intestinal hypermotility** | Secretory and osmotic diarrhea  
Laxatives  
Emotions/stress  
Cardiovascular drugs |
| **Fecal enzymes** | 1. Trypsin  
= X-ray paper  
= Trypsin deficiency (CF): inability to digest gelatin on the X-ray paper  
2. Chymotrypsin  
3. Elastase I = pancreas specificity |
| **Fecal CHO** | Stool pH = 7.0-8.0  
pH 5.5 = CHO disorders (lactose intolerance)  
Clinitest: >0.5 g/dL = CHO intolerance  
Follow up tests:  
a. D-xylose: malabsorption  
b. Lactose intolerance test: maldigestion |
| **Fecal Leukocytes** | Primarily neutrophils  
↑ Neutrophils:  
*Salmonella*  
*Shigella*  
*Campylobacter*  
*Yersinia*  
*EIEC*  
(-) Fecal leukocytes:  
Parasites  
Viruses  
*S. aureus*  
*Vibrio* spp |
| **Methylene blue** | For wet preparation  
Faster procedure than Wright’s and GS (for dry smears) but may be more difficult to interpret |
| **Lactoferrin Latex agglutination test** | Sensitive in refrigerated and frozen specimens |
| **↑ amounts of striated fibers** | Biliary obstruction  
Gastrocolic fistulas |
| **Fecal fats** | NV = 1-6 g/day |
| **Qualitative Fecal fat test** | Sudan III = most routinely used  
Sudan IV  
Oil red O |
| **Split fat stain** | Free fatty acids and fatty acids from hydrolysis of soaps and neutral fats  
NV = 100 droplets (<4 μm)  
Slightly increased = 100 droplets (1-8 μm)  
Increased = 100 droplets (6-75 μm) |
| **Quantitative Fecal fat test** | Confirmative test for steatorrhea  
3 day specimen |