



PRINCIPLE OF URINALYSIS



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Objective

- **Can explain : the abnormalities detected in urine**
- **Can perform : routine urinalysis**
- **Can interpret : the results of urinalysis**



Examination of urine

- **Screening**
- **Diagnosis and management**
- **Follow up and prognosis**



Collection of urine

- **Routine urinalysis**

- **Fresh**
- **First morning or random specimen**
- **Midstream**
- **Clean, dry & detergent free container**

- **Timed specimen**

- **Refrigerator**
- **Preservative**

- **Specimen for culture**

- **Clean-voided/clean-catch midstream**
- **Sterile container**







Routine urinalysis

- **Physical examination**
- **Chemical examination**
- **Microscopic examination**












Routine urinalysis : Physical examination

Normal

- **Colour**  **Pale yellow**
- **Clarity**  **Clear**
- **Volume**  **600-1,600 ml (adult)**
- **Specific gravity**  **1.003-1.035**

Abnormal

-  **Hematuria .. smoky urine**
-  **Hemoglobinuria**
-  **Etc.**
-  **Turbid .. Cells, Organisms, etc.**
-  **Polyuria .. >2,000 ml/day**
-  **Oliguria .. <500 ml/day**
-  **Anuria .. <100 ml/day**
-  **High .. Diabetes mellitus**
-  **Low .. Diabetes insipidus**



Routine urinalysis : Chemical examination

- Specific gravity
- pH
- Protein
- Sugar
- Blood, hemoglobin & myoglobin
- Bile (conjugated bilirubin)
- Urobilinogen
- Ketone
- Nitrite
- Leukocyte esterase

Conventional method

VS

Reagent strip



Specific gravity

- Indirect method
- Depends on ionic concentration of urine
- Not affected by high amount of glucose and protein



Routine urinalysis : Chemical examination

pH

- **Fresh urine**
- **Normal .. 4.6 - 8.0**
- **Acid urine**
- **Alkaline urine**



Routine urinalysis : Chemical examination

Protein

- Urine protein excretion > 150 mg/day = proteinuria
- Most filtered protein = albumin
- Reagent strip is sensitive to albumin

Proteinuria

Functional proteinuria

Organic proteinuria

- 📁 Pre-renal proteinuria
- 📁 Renal proteinuria
- 📁 Post-renal proteinuria

Vaginal discharge contamination



Routine urinalysis : Chemical examination

Glucose

- Reagent strip is specific for glucose
- Renal threshold = 160 mg/dl

Glucosuria

- Without hyperglycemia
- With hyperglycemia



Routine urinalysis : Chemical examination

Bile (conjugated bilirubin)

- **Obstructive jaundice**
- **Hepatocellular jaundice**



Routine urinalysis : Chemical examination

Urobilinogen

- Fresh urine
- A small amount is excreted in urine

Increased urobilinogen

- Hemolytic jaundice
- Hepatocellular disease



Routine urinalysis : Chemical examination

Blood, Hemoglobin, Myoglobin

- **Hematuria**
 - ☞ **Intact erythrocyte**
- **Hemoglobinuria**
 - ☞ **Hemoglobin from hemolysis**
- **Myoglobinuria**
 - ☞ **Myoglobin from rhabdomyolysis**



Routine urinalysis : Chemical examination

Nitrite

- Nitrite-forming bacteria

Leukocyte esterase

- Detects both lysed and intact leukocyte equivalent to 5 - 15 cells/HPF

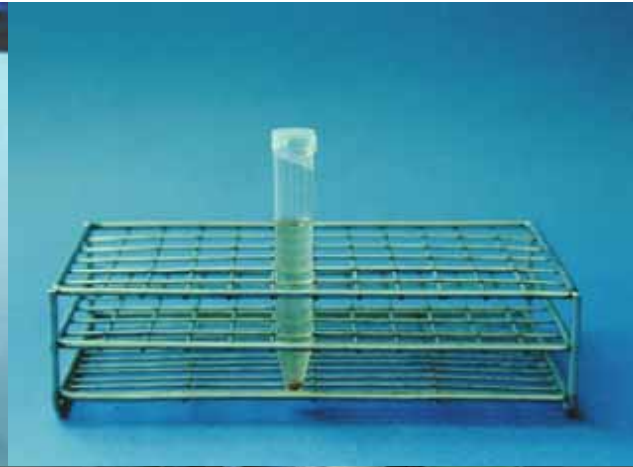


Routine urinalysis : Microscopic examination

- **Fresh urine**
- **No preservative**
- **Midstream collection**



Routine urinalysis : Microscopic examination



Preparation of urine sediments





Routine urinalysis : Microscopic examination

Formed element of urine

- **Cells**
- **Casts**
- **Crystals**
- **Organisms**
- **Contaminants and artifacts**



Routine urinalysis : Microscopic examination

Cells

- **Erythrocyte**
- **Leukocyte**
- **Epithelial cell**
 - 📁 **Tubular cell, Oval fat body**
 - 📁 **Transitional cell**
 - 📁 **Squamous cell**



Routine urinalysis : Microscopic examination

Erythrocyte (Red blood cell)

- Pale, biconcave disc, diameter ~ 7 micron
- Normal 0 - 2 cells/HPF

Increased erythrocyte

- Renal diseases
- Lower urinary tract disease
- Extrarenal diseases
- Toxic reaction
- Physiologic





Routine urinalysis : Microscopic examination

Dysmorphic erythrocyte

- Red blood cell with cellular protrusions or fragmentation
- Reflect glomerular origin
- Detected by phase contrast microscope





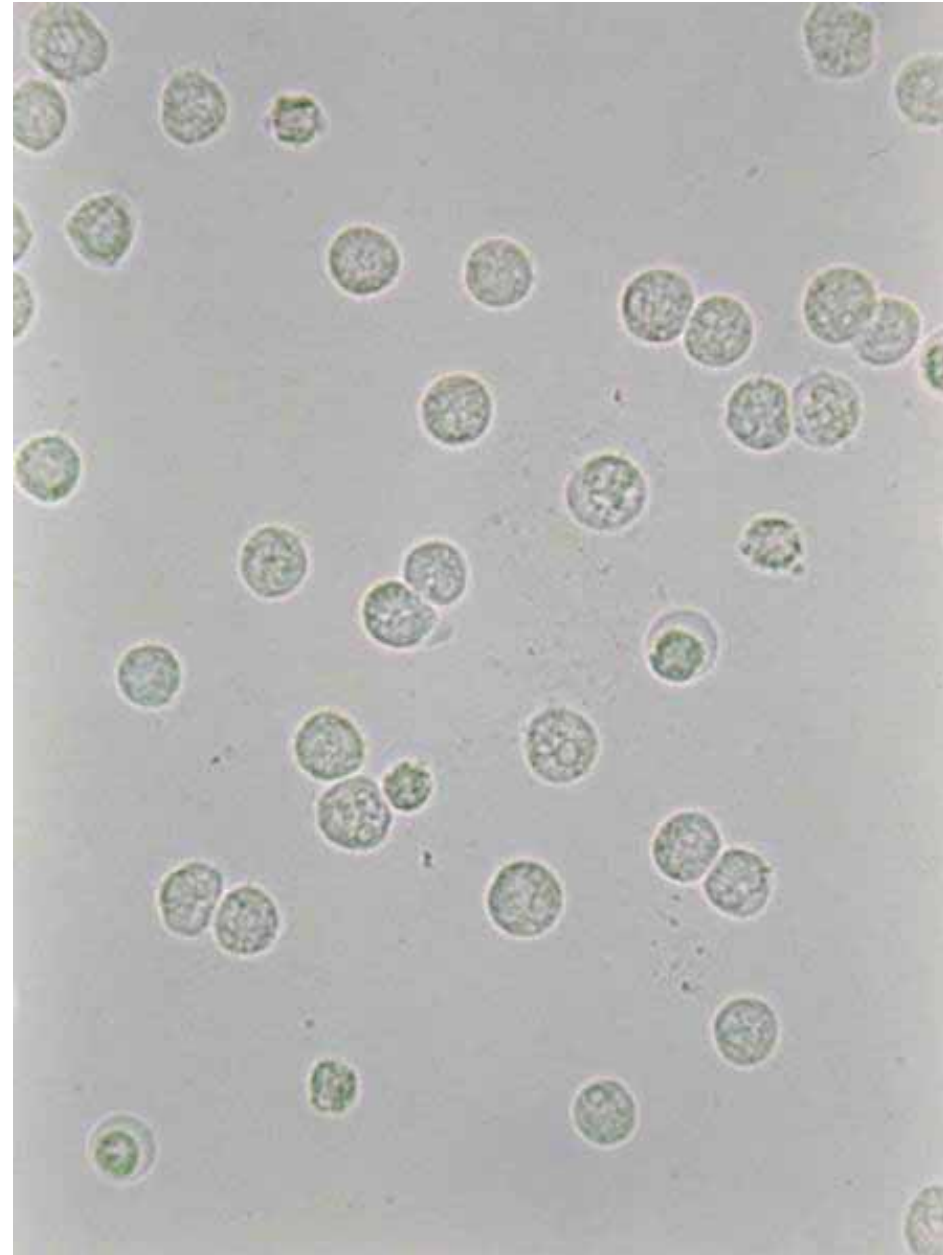
Routine urinalysis : Microscopic examination

Leukocyte (White blood cell)

- Granular spheres, diameter ~ 12 micron, multilobated nuclei
- Normal 0 - 5 cells/HPF

Increased leukocyte

- Infection, inflammation, fever, strenuous exercise





Routine urinalysis : Microscopic examination

Renal tubular cell

- Line the tubule
- Slightly larger than leukocyte
- Round or polygonal shape
- Large nucleus

Increased renal tubular cell

- Acute tubular damage





Routine urinalysis : Microscopic examination

Oval fat body

- Tubular cell that absorbed lipoprotein with cholesterol and triglyceride leaked from nephrotic glomeruli
- Characteristic of the nephrotic syndrome





Routine urinalysis : Microscopic examination

Transitional epithelial cell

- Line the urinary tract from the renal pelvis to the proximal third of the urethra
- Round, oval, fusiform shape
- Round centrally located nucleus
- Increased : infection, CA



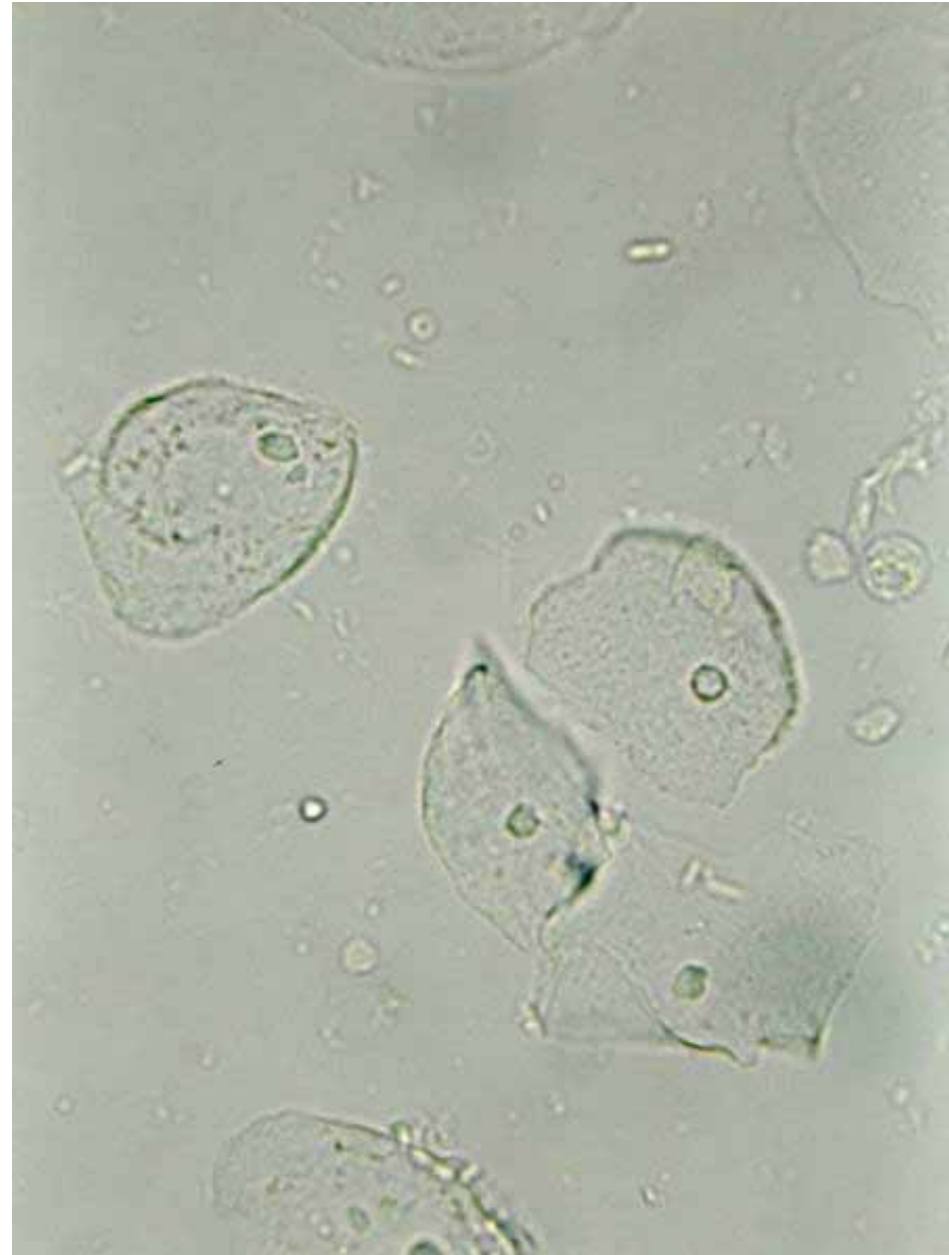


Routine urinalysis : Microscopic examination

Squamous epithelial cell

- Line the distal third of the urethra
- Large and flat with abundant cytoplasm, fold margin
- Small round central nucleus

Vaginal discharge contamination





Routine urinalysis : Microscopic examination

Casts

***Tamm-Horsfall protein* .. the glycoprotein secreted by the ascending loop of Henle .. forming the matrix of all casts**

- **Hyaline casts**
- **Red blood cell casts**
- **White blood cell casts**
- **Renal tubular epithelial casts**
- **Granular casts**
- **Fatty casts**
- **Waxy casts**
- **Broad casts**



Routine urinalysis : Microscopic examination

Hyaline casts

- Transparent, homogenous and colourless
- Can be seen 0-2/LPF in normal

Increased in

- Various renal diseases
- Transiently in exercise, dehydration, fever, etc.





Routine urinalysis : Microscopic examination

Erythrocyte (RBC) casts

- Prolonged stasis leading to hemoglobin (blood) cast
- Indication of bleeding in nephron : acute GN, lupus nephritis, nephrosclerosis, etc.



Erythrocyte (RBC) casts



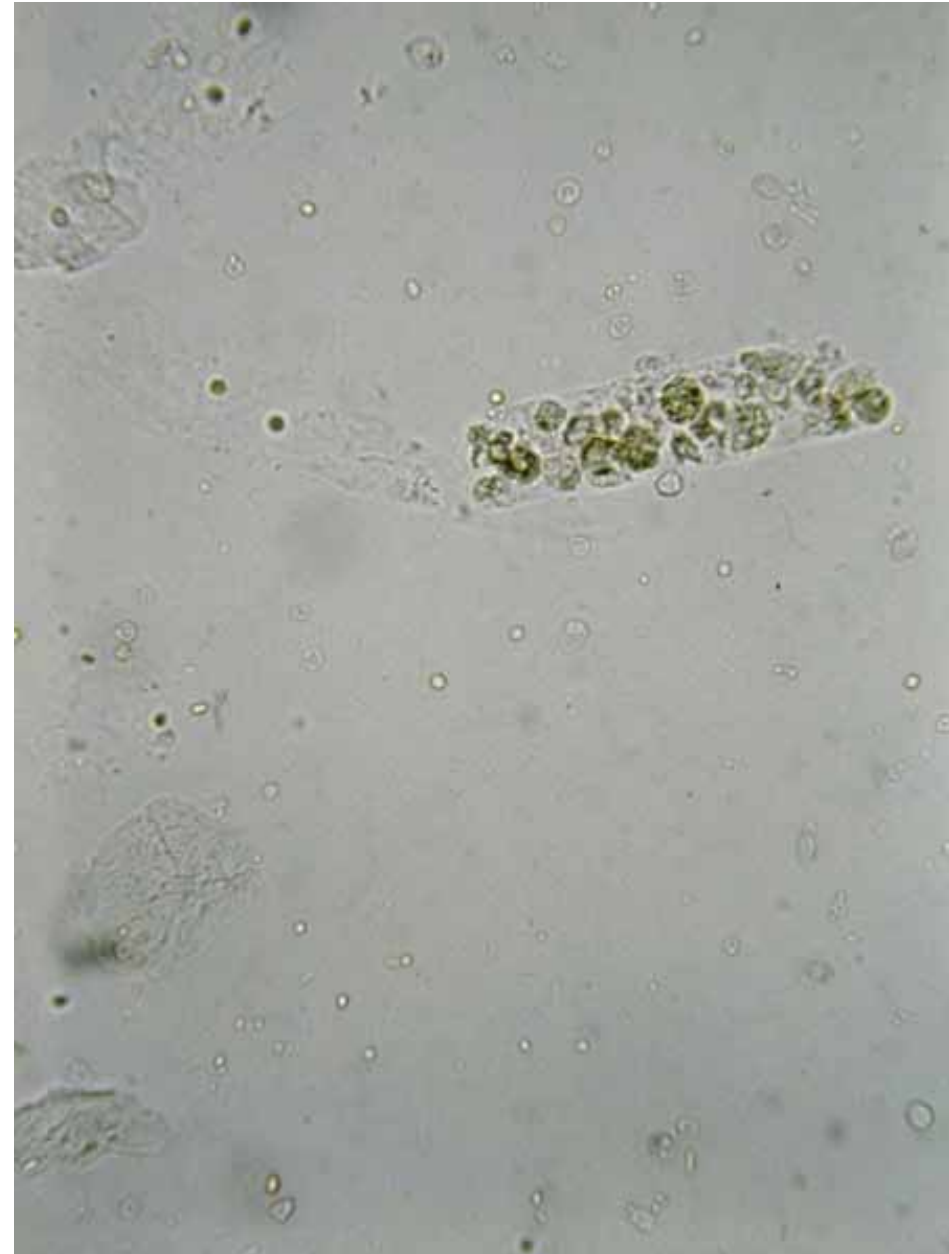
Hemoglobin casts



Routine urinalysis : Microscopic examination

Leukocyte (WBC) casts

- Tubular and/or tubulointerstitial diseases eg. acute & chronic pyelonephritis, interstitial nephritis, acute GN





Routine urinalysis : Microscopic examination

Renal tubular epithelial casts

- Reflect tubular damage, e.g. acute tubular necrosis, acute allograft rejection, etc.





Routine urinalysis : Microscopic examination

Granular casts

- Granules may originate from plasma protein aggregates as well as from cellular remnants
- Appear with both pathologic and non-pathologic conditions

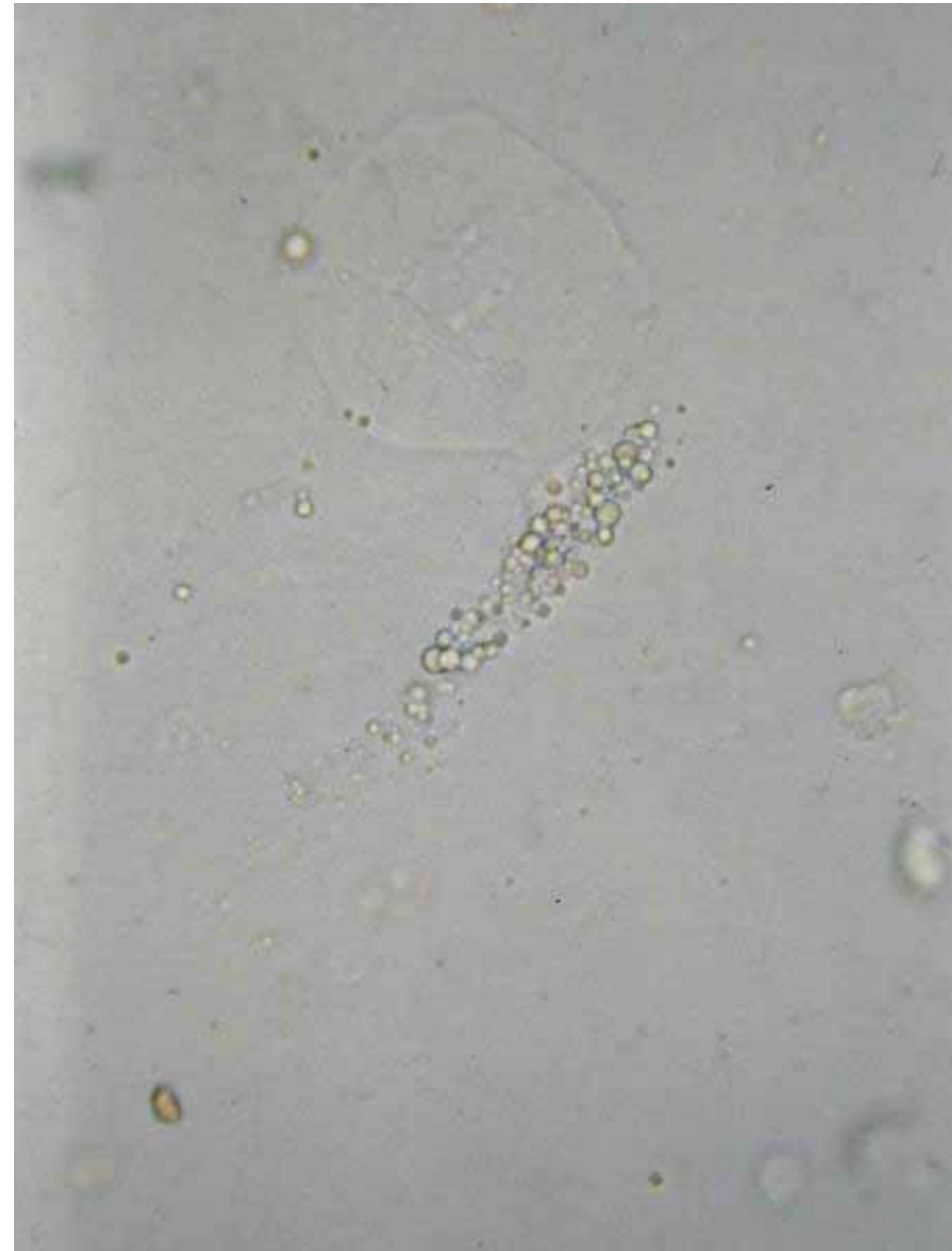




Routine urinalysis : Microscopic examination

Fatty casts

- Commonly seen with heavy proteinuria
- Feature of nephrotic syndrome





Routine urinalysis : Microscopic examination

Waxy casts

- Homogeneously smooth with sharp margins, blunted ends and cracks along the lateral margins
- Extreme stasis of urine flow
- Advanced renal disease

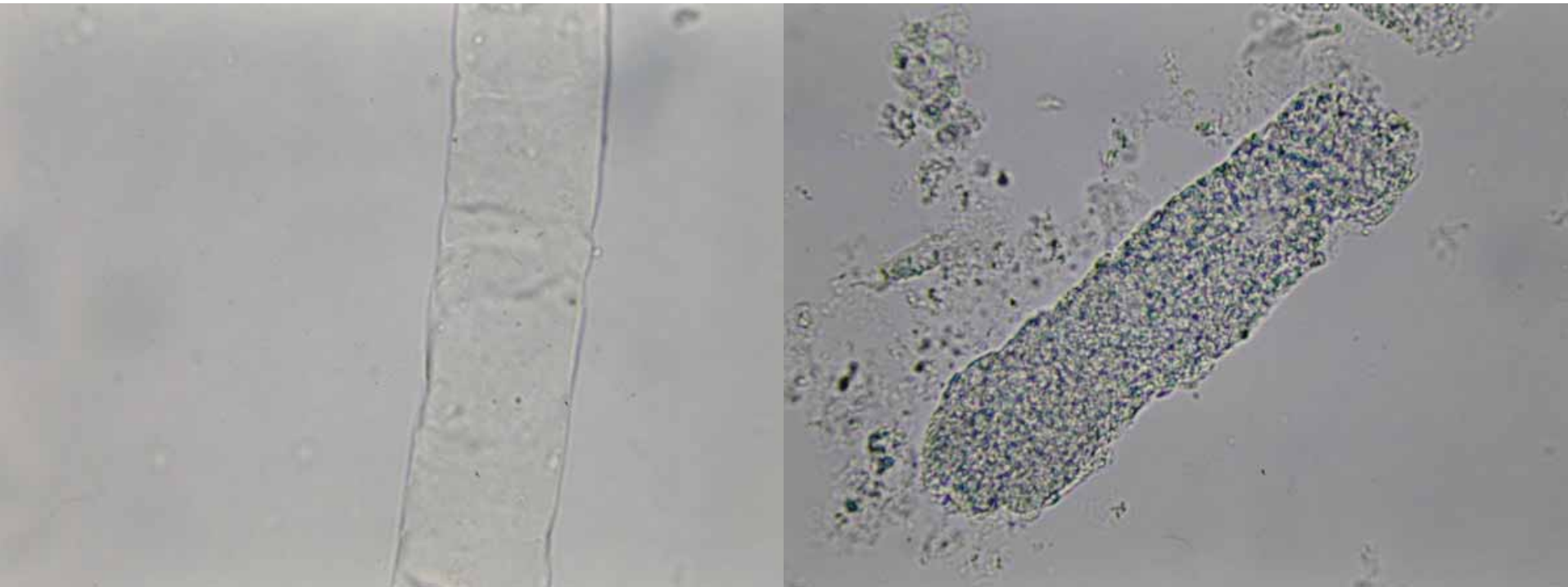




Routine urinalysis : Microscopic examination

Broad casts

- Diameter 2-6 times that of normal casts
- Indicate tubular dilatation and/or stasis in the distal collecting duct
- Found in chronic renal failure / Poor prognosis





Routine urinalysis : Microscopic examination

Telescoped sediment

- **Element of glomerulonephritis & nephrotic syndrome in the same urine specimen**
- **Rbc, rbc casts, wbc, wbc casts, broad waxy casts, oval fat bodies, fatty cast**
- **Advanced renal disease eg. Lupus nephritis**



Routine urinalysis : Microscopic examination

Crystals

- Less significant, except pathologic crystals
- Normal acidic urine : Calcium oxalate, uric acid, etc.
- Normal alkaline urine : Calcium carbonate, triple phosphate, etc.

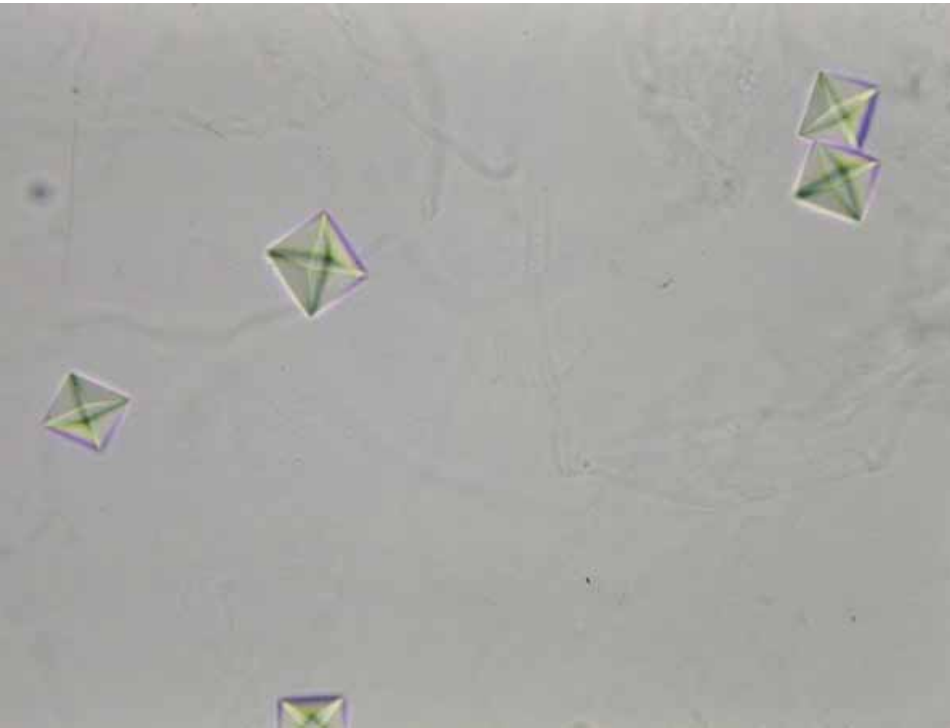
Abnormal crystals

- Cystine, acetyl sulfadiazine, cholesterol, bilirubin
- Amorphous – granular precipitates :
amorphous urate,
amorphous phosphate



Routine urinalysis : Microscopic examination

Normal crystals



Calcium oxalate

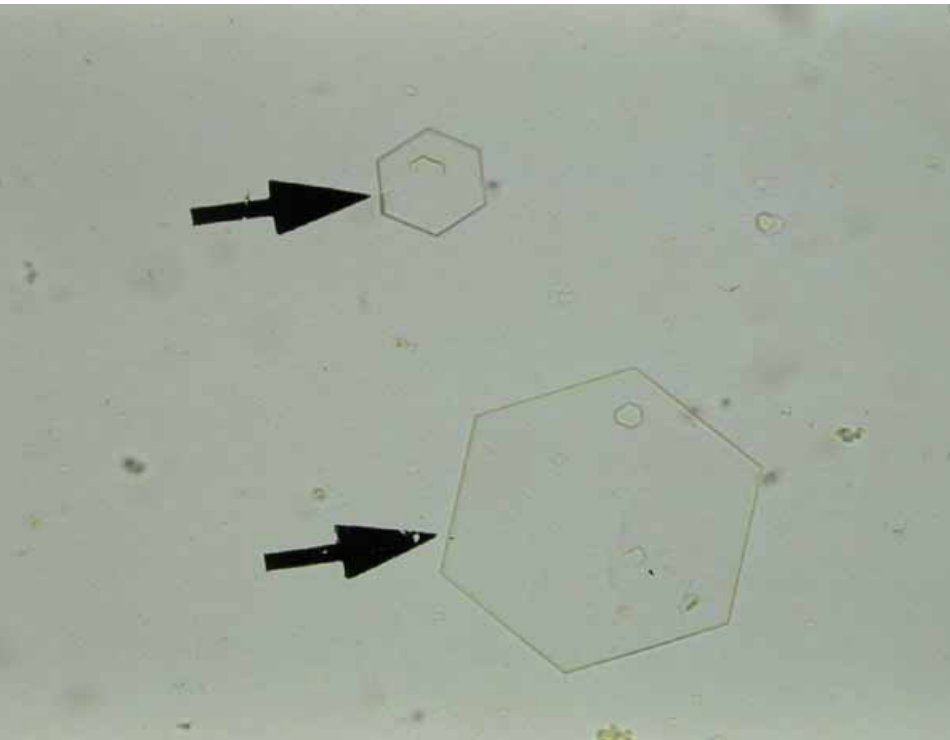


Uric acid

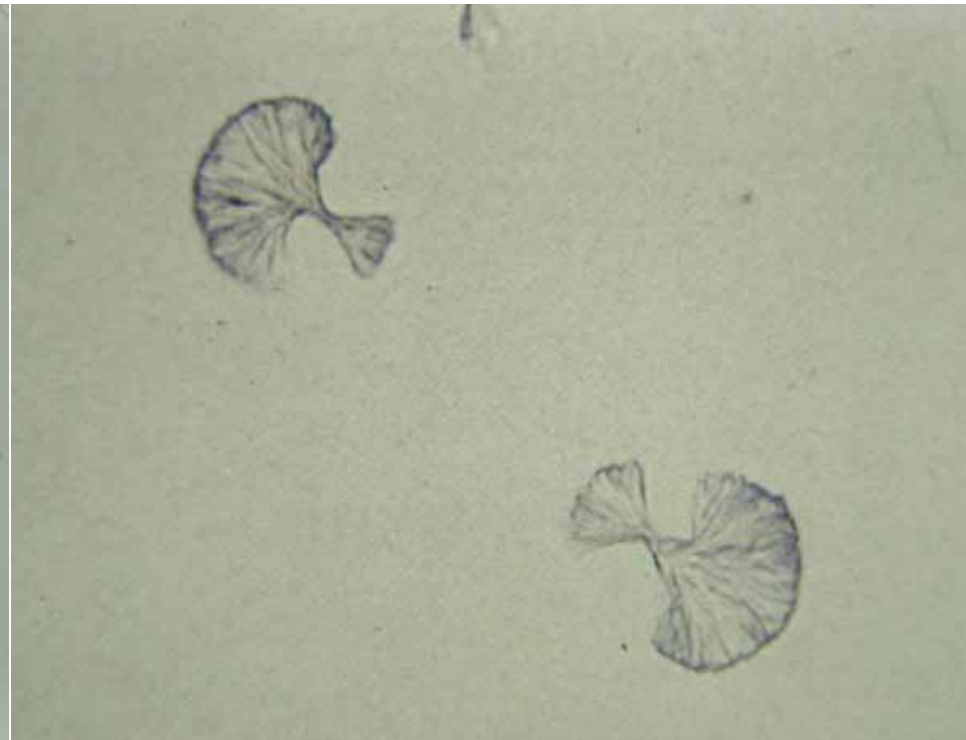


Routine urinalysis : Microscopic examination

Abnormal crystals



Cystine



Acetyl sulfadiazine

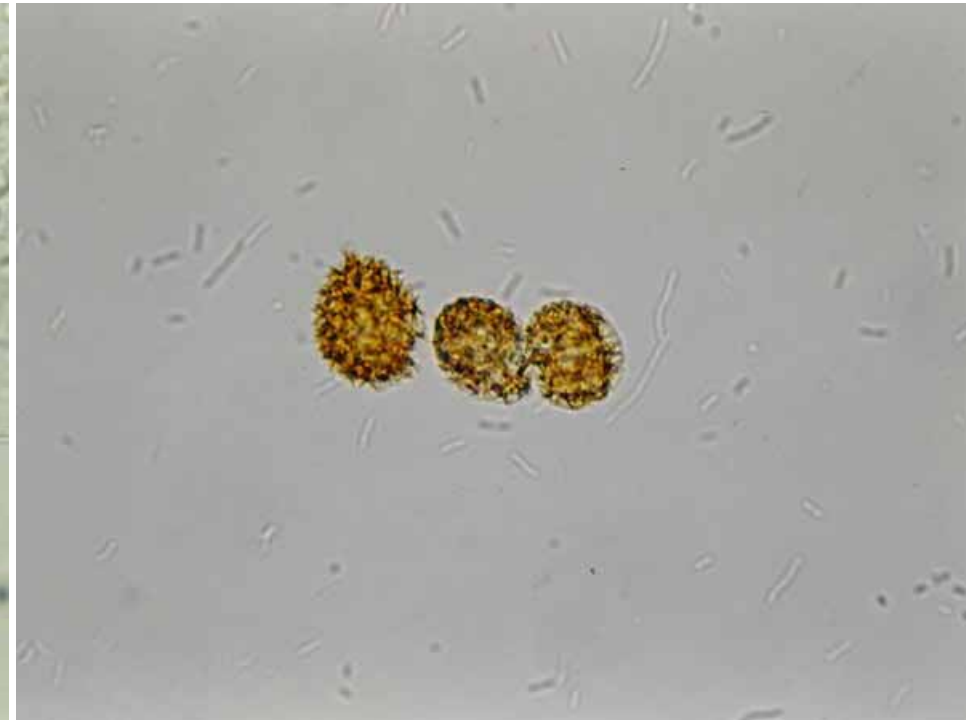


Routine urinalysis : Microscopic examination

Abnormal crystals



Cholesterol



Bilirubin



Routine urinalysis : Microscopic examination

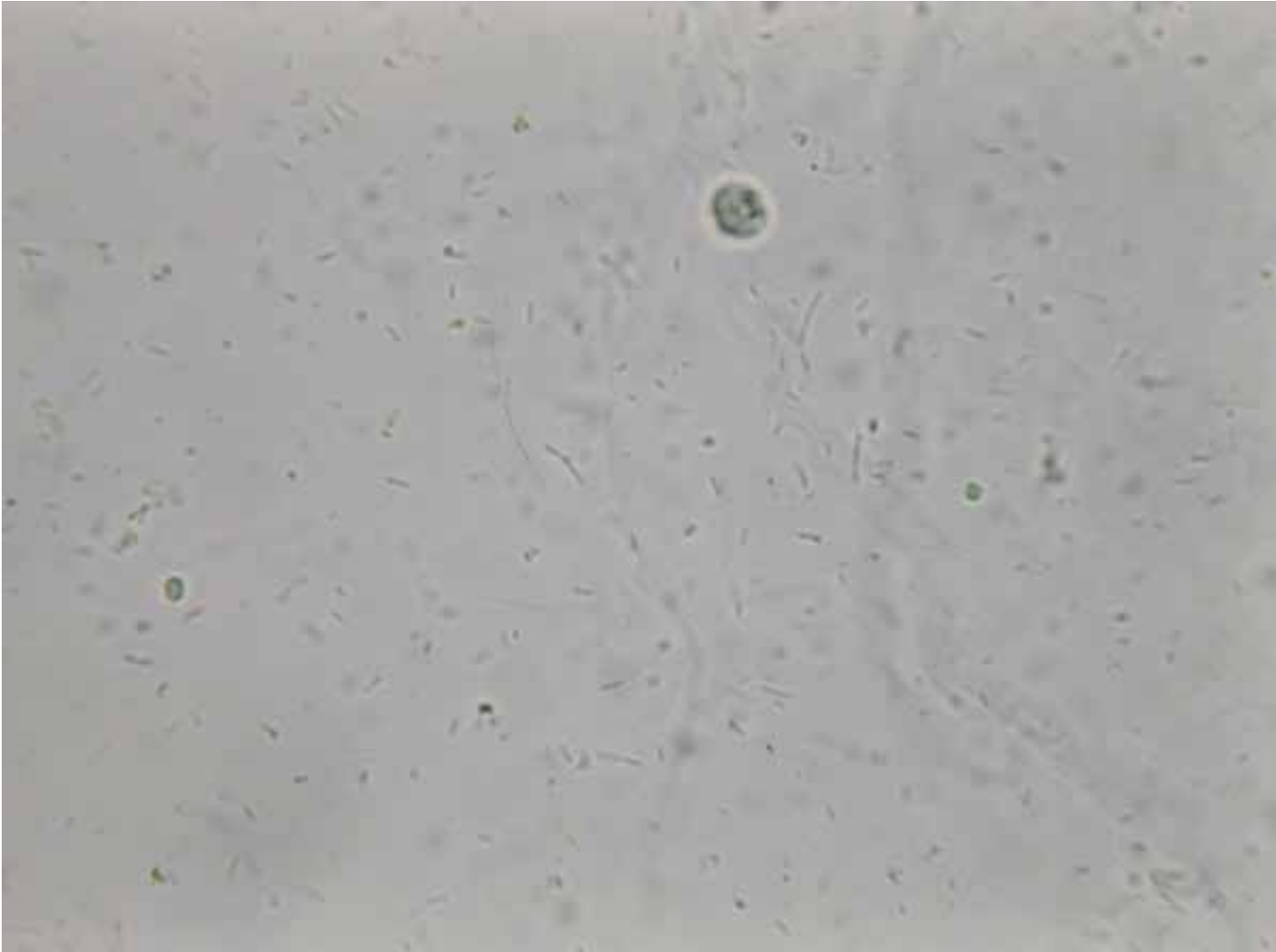
Organisms

- **Bacteria**
- **Fungus**
- **Parasite**
- **Etc.**



Routine urinalysis : Microscopic examination

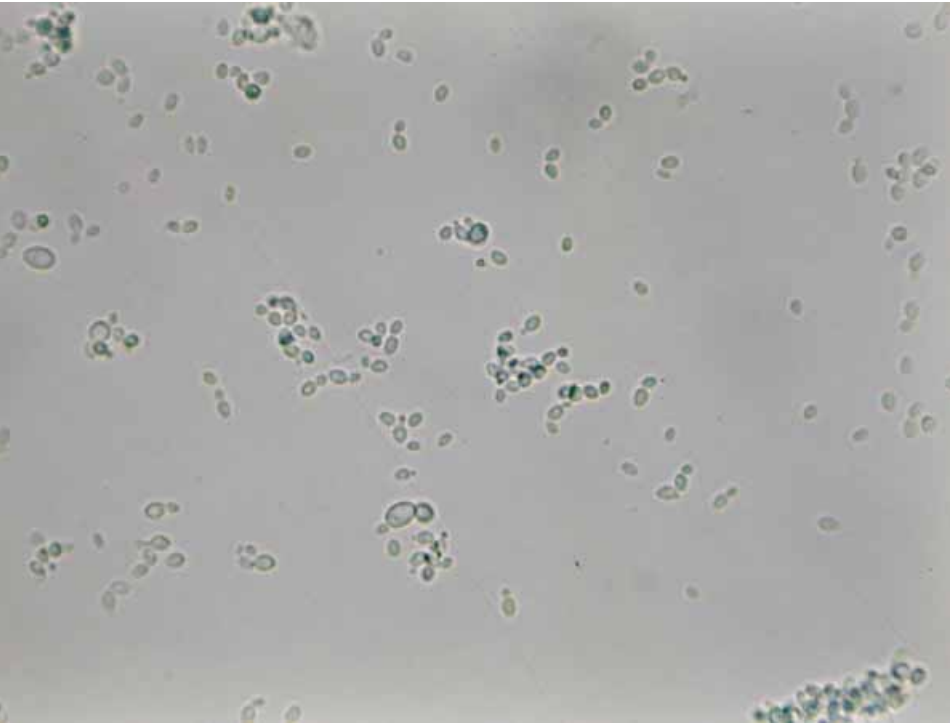
Bacteria





Routine urinalysis : Microscopic examination

Fungus



Yeast



Hyphae



Trichomonas vaginalis

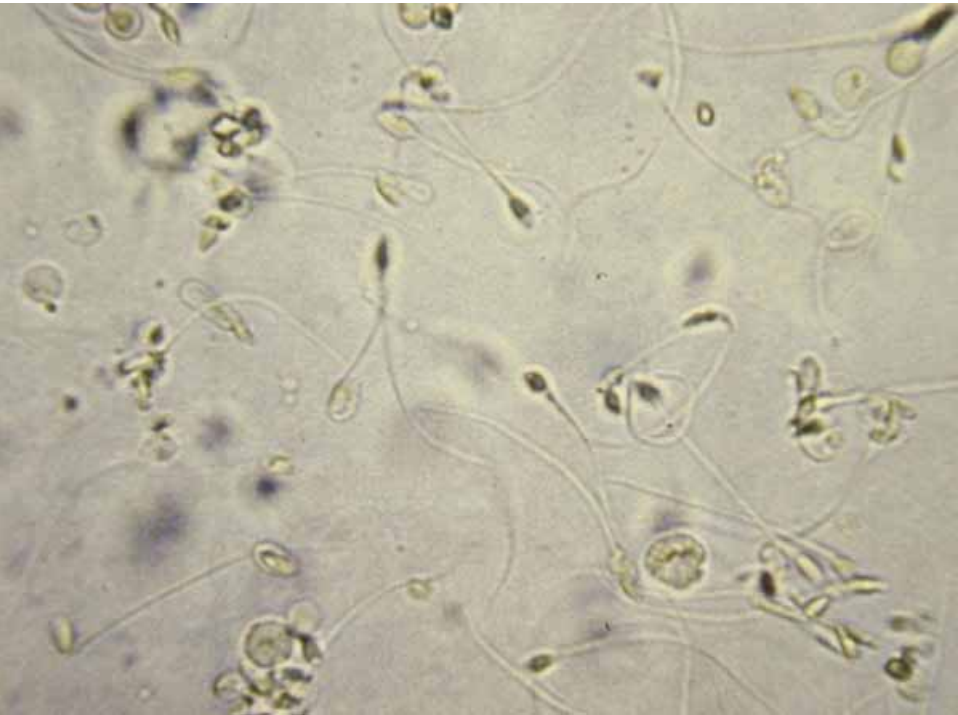


Advancing Excellence



Routine urinalysis : Microscopic examination

Contaminants and artifacts



Spermatozoa



Starch granule



REPORT

- **CELL (10-15 high power field)**
0-1, 1-2, 2-3, 3-5, 5-10, 10-20,.../ HPF
or numerous
- **CAST (10-15 low power field)**
0-1, 1-2, 2-3,.../ LPF
- **BACTERIA & CRYSTAL**
1+, 2+, 3+
or few, moderate, numerous



Reference Values for Urine Sediment

- Red blood cells 0-2/ HPF
- White blood cells 0-5 / HPF
- Renal epithelial cells few/HPF
- Transitional epithelial cells few/HPF
- Squamous epithelial cells few/HPF



Reference Values for Urine Sediment

- Casts 0-2 hyaline cast /LPF
- Abnormal crystals Negative
- Bacteria Negative
- Yeast Negative



THANK YOU FOR YOUR ATTENTION