Biochemical composition of normal urine

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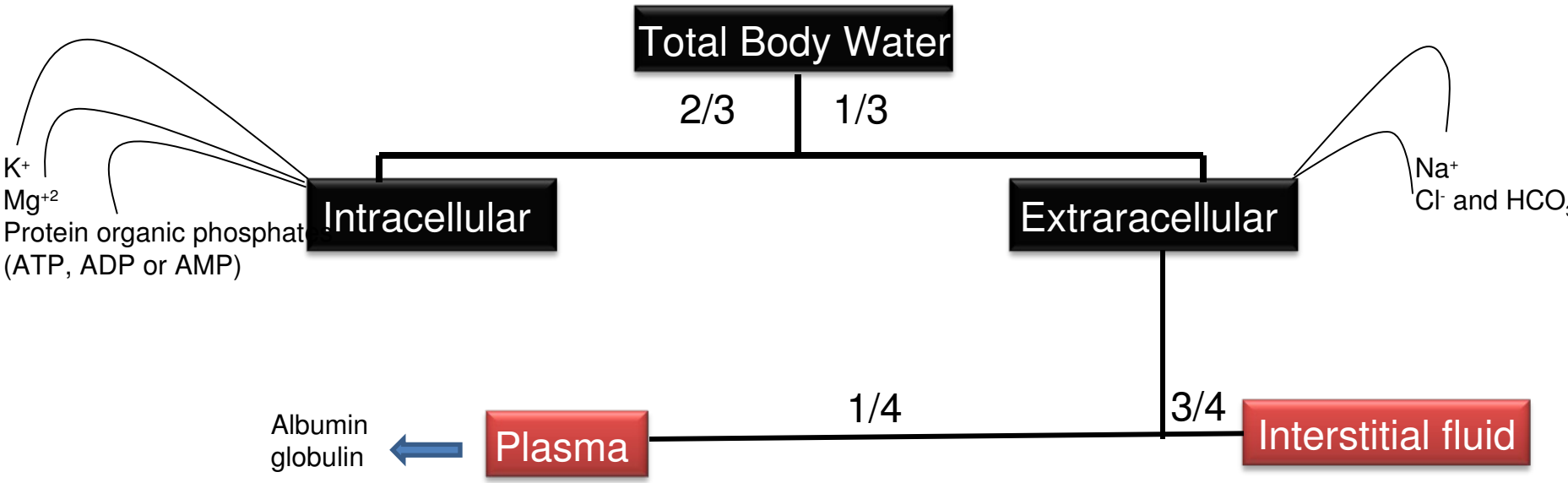
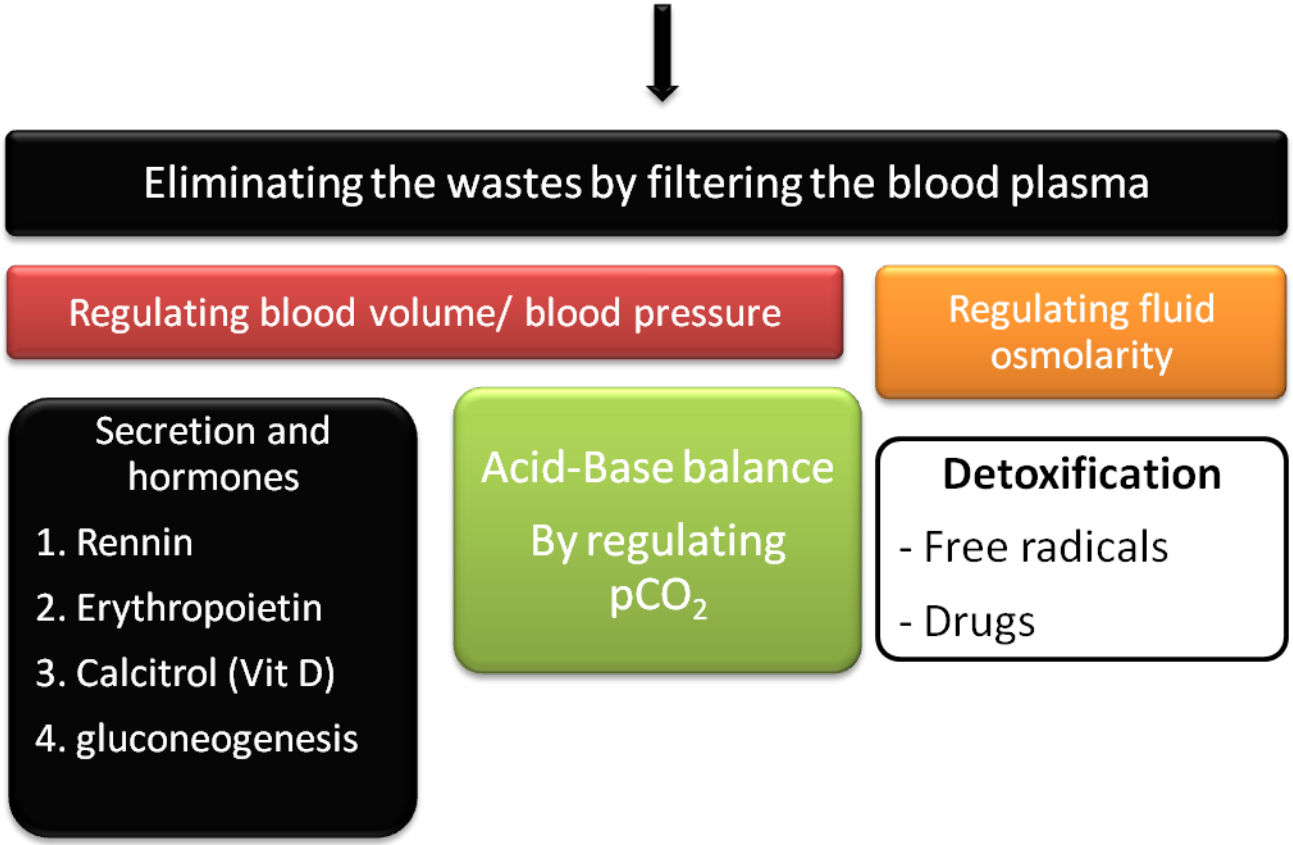
Total Body Water (TBW) = 60% of body weight

Highest in newborns and adult males
lowest in adult females and in adults with a large amount of adipose tissue



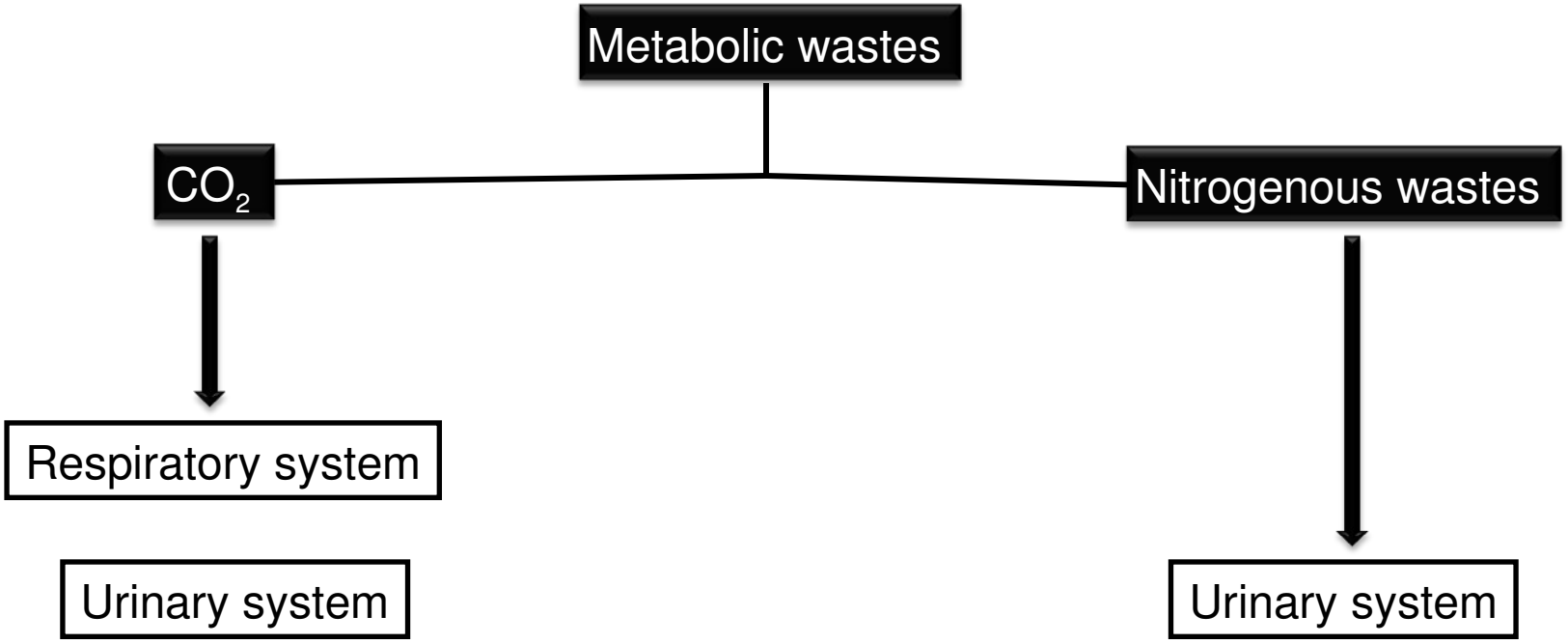
Function of kidney

Controlling the blood volume and composition

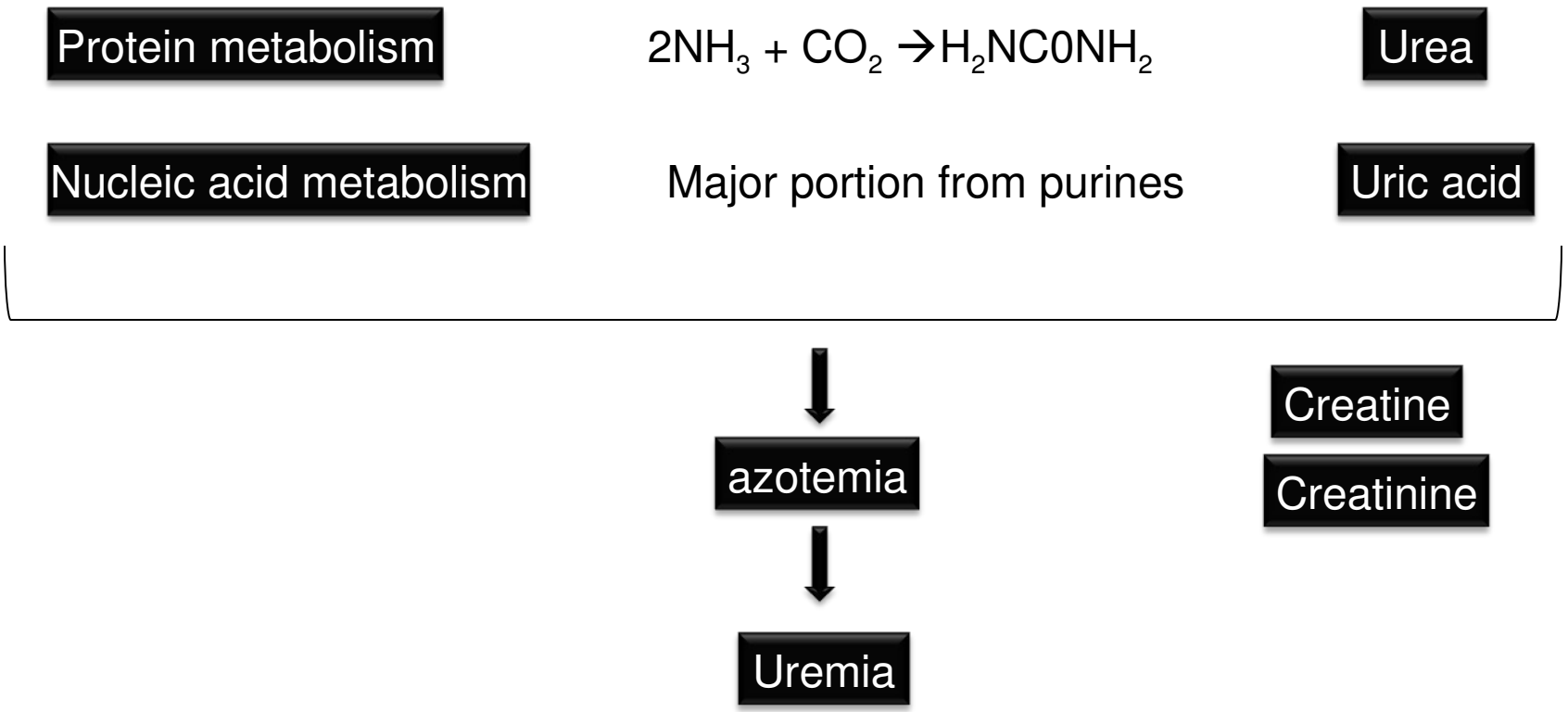


Human Metabolic Wastes

- The by product of all chemical reactions in the body that needs to be excrete or else the build up of these compounds will sicken and eventually kill the person.



Nitrogenous wastes



Urea comprised 50% of total nitrogenous wastes in the humans

Urine

- Definition

By definition “urine is a **?**”

A liquid containing multiple waste products of metabolism, especially urea and other nitrogenous compounds, that are filtered from the blood by the kidneys. Urine is stored in the urinary bladder and is excreted from the body through the urethra.

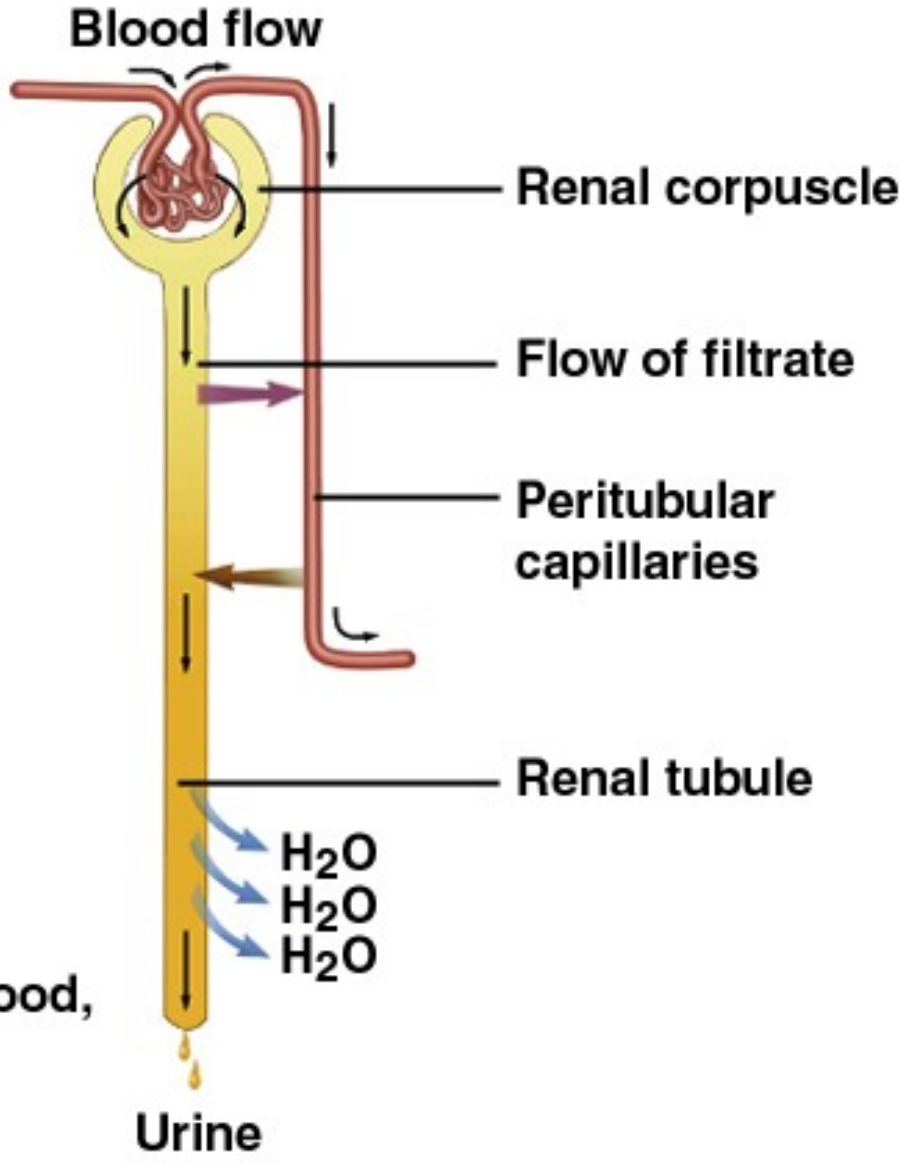
Urine Formation

① **Glomerular filtration**
Creates a plasmalike filtrate of the blood

② **Tubular reabsorption**
Removes useful solutes from the filtrate, returns them to the blood

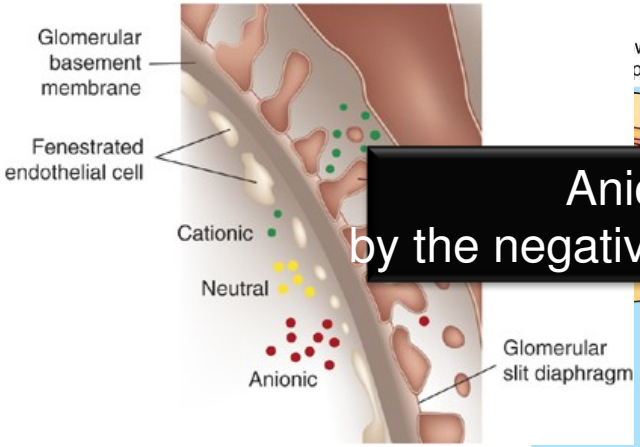
③ **Tubular secretion**
Removes additional wastes from the blood, adds them to the filtrate

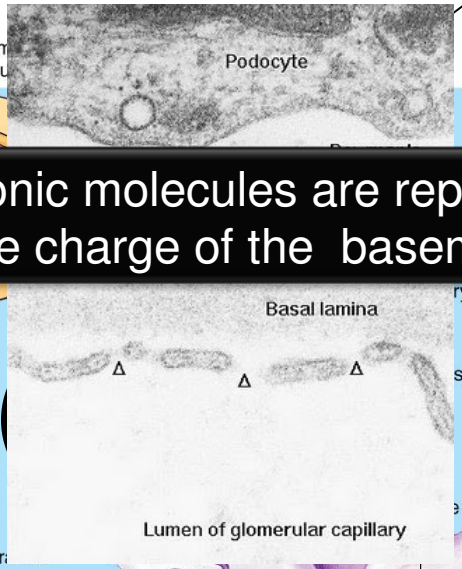
④ **Water conservation**
Removes water from the urine and returns it to blood, concentrates wastes

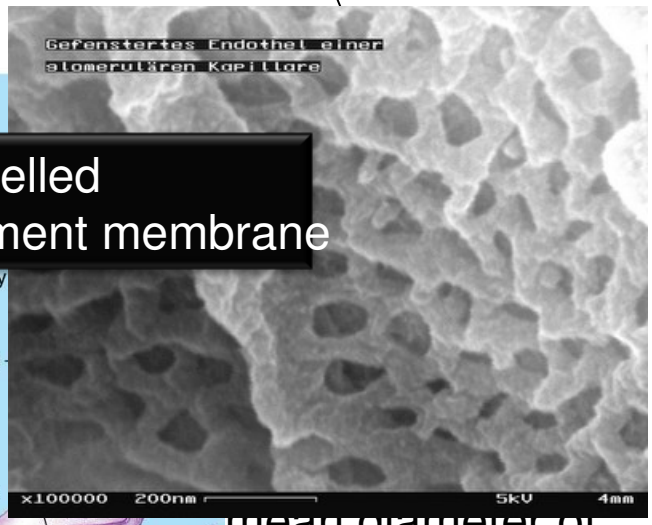


Ultrafiltration of plasma

- Ultrafiltration occurs through glomerulus giving rise to primary urine
- The primary urine is isotonic with plasma.





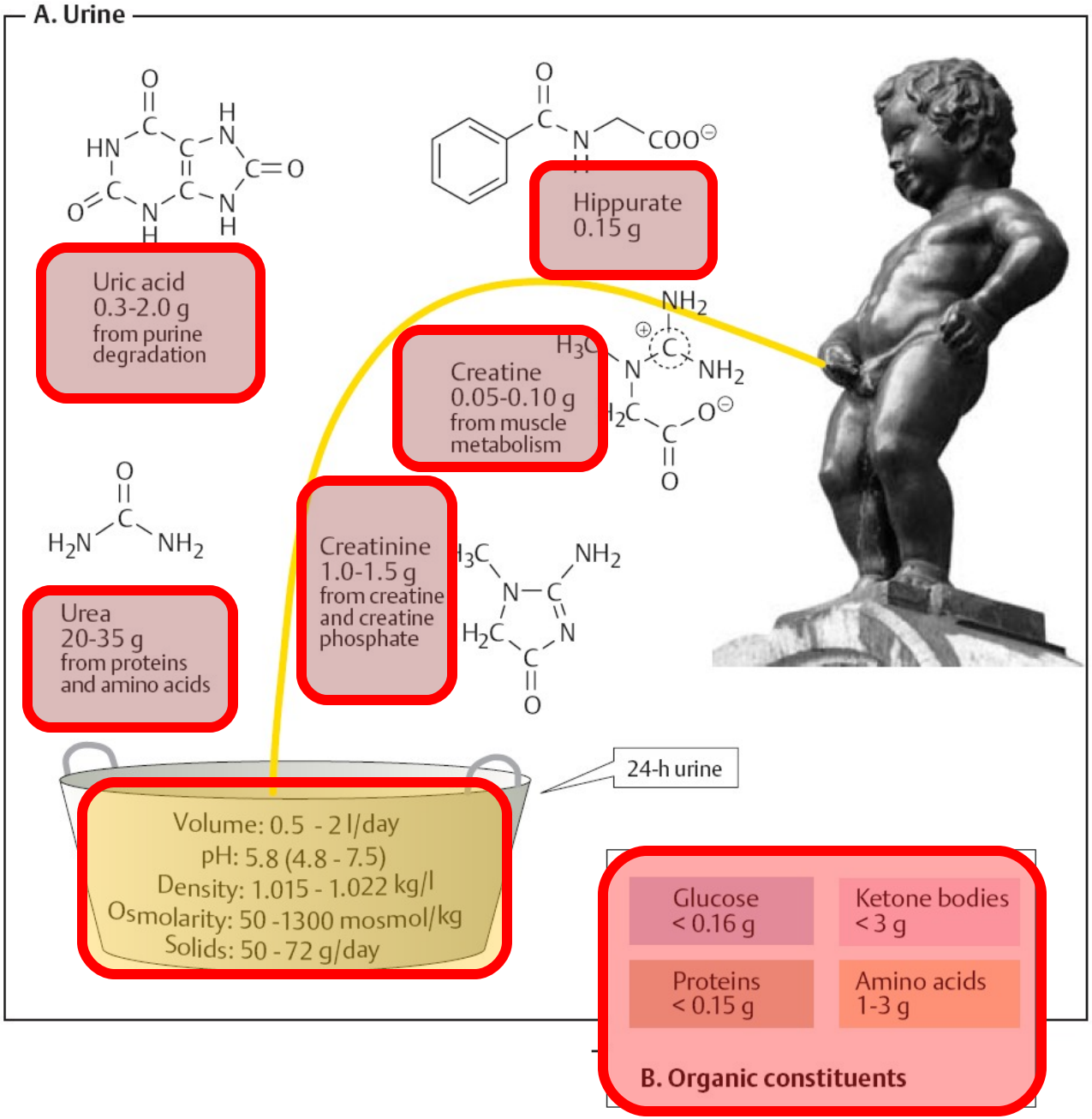


Anionic molecules are repelled by the negative charge of the basement membrane

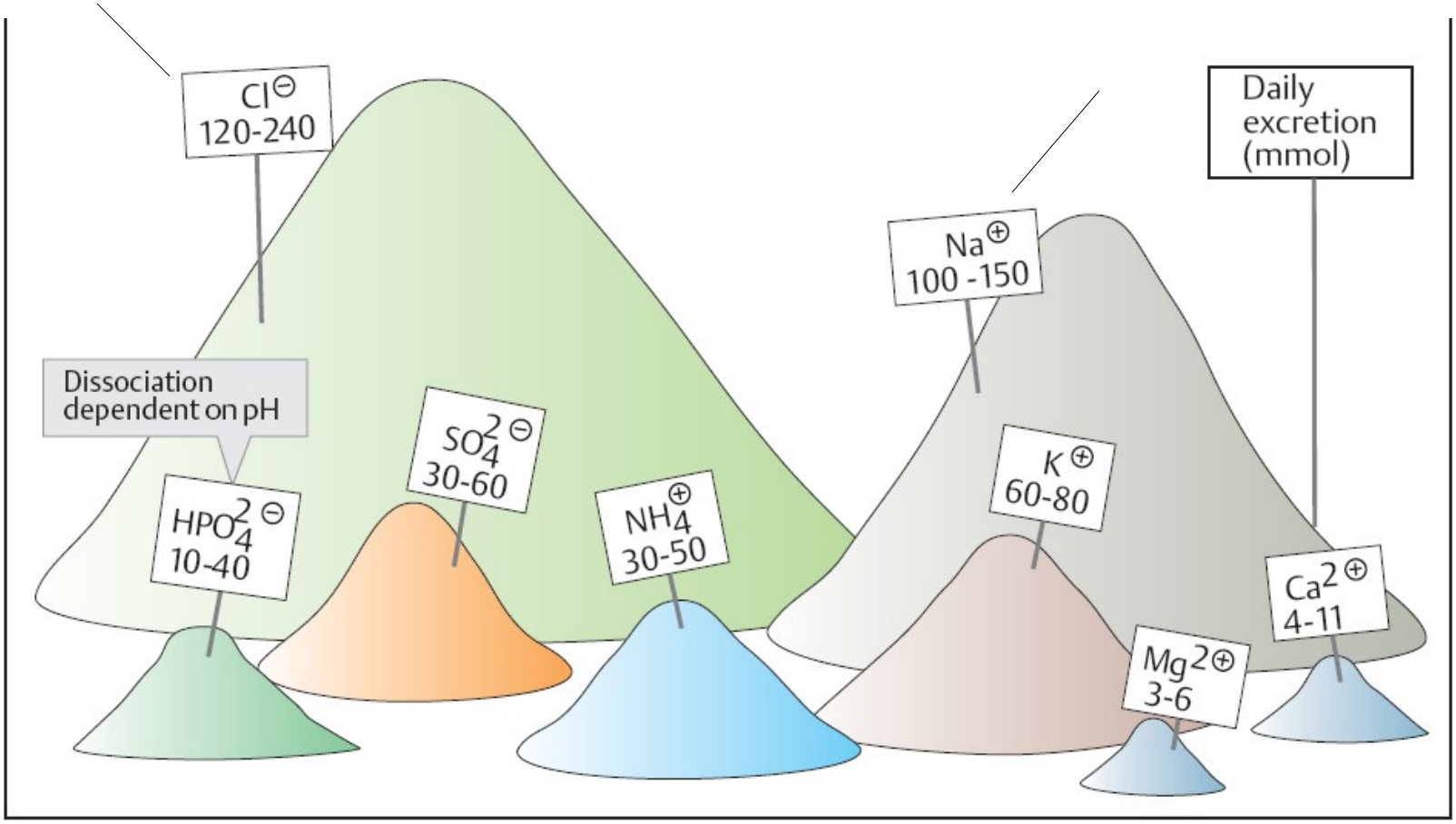
mean diameter of 2.9nm

Plasma component more than 64KDa are totally blocked

Plasma component lesser than 15 KDa



C. Inorganic constituents



Urinalysis

- The routine urine examination.
- Most useful tool for the clinicians as an indicator or health or disease.
- Particularly, used in renal metabolic disorders.
- Often done for patients admitted to the hospital.

- The routine urine analysis is divided into four main groups:

1. Physico-Chemical properties.
2. Chemical examination.
3. Microscopic examination.
4. Bacterial screening

1. Physico-Chemical properties
Color
Appearance
Volume
Specific gravity
Odor

2. Chemical examination
pH
Sugar
Protein
Ketone bodies
Bilirubin
Urobilinogen
Occult blood
Nitrite
Ascorbic acid

3. Microscopic examination
WBCs
Epithelial cells
RBCs
Casts
Crystals
Bacteria
Yeasts
Nonbacterial organisms

4. Bacterial screening
Gram staining
Colony count

Urine collection

- Urine must be collected in a sterile bottle.
- The routine urine examination must be conducted within 30 min.
- In case of delay, urine must be refrigerated

- Delay in sample examination will result in:
- Decreased pH by the utilization of glucose by bacteria.
- Increased pH by the conversion of urea to ammonia by bacteria.
- In increased pH, the tendency of phosphates to precipitate will increase.
- Oxidation of urobilinogen to urobilin. It may give false negative result for jaundice.

Types of specimen

Random	First morning	Afternoon	24 hours
Chemical & microscopic examination Taken any time after first morning urine	Specimen of choice Most concentrated Microscopic and	**Taken between 2 → 4 pm** **Best for detecting urobilinogen**	**Used for clearance test of kidney** **Samples are collected for 24 hours (for eg, 8am to next day 8 am).** **It is to avoid any changes in the dilution of various suspended constituents of urine**
Night	Day	Postprandial	
All urine samples are collected in 12 hour of night (for eg, 8pm to 8am)	All urine samples are collected in 12 hour of day (for eg, 8am to 8pm)	Taken after 2 hours of meal	

Physico-Chemical properties

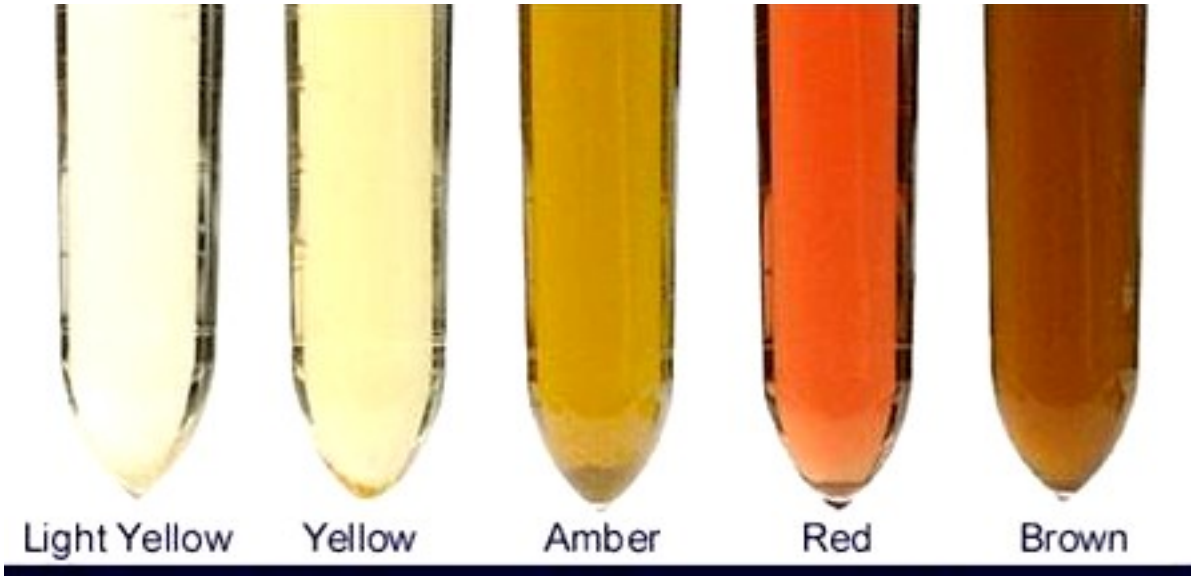
- **Color of normal urine**
- Normal urine color ranges from pale yellow to deep amber.
- it is the result of a pigment called urochrome .

B vitamins turn urine an eye-popping neon yellow BUT may also indicate liver disease.

porphyria, a disease that affects your skin and nervous system, turns urine the color of port wine.

Color of normal urine

- Most changes in urine color are harmless and temporary and may be due to:
  - Certain foods – beets may turn urine red
  - Dyes in foods/drinks
  - Supplements – vitamins
  - Prescription drugs
- Unusual urine color can indicate an infection or serious illness .

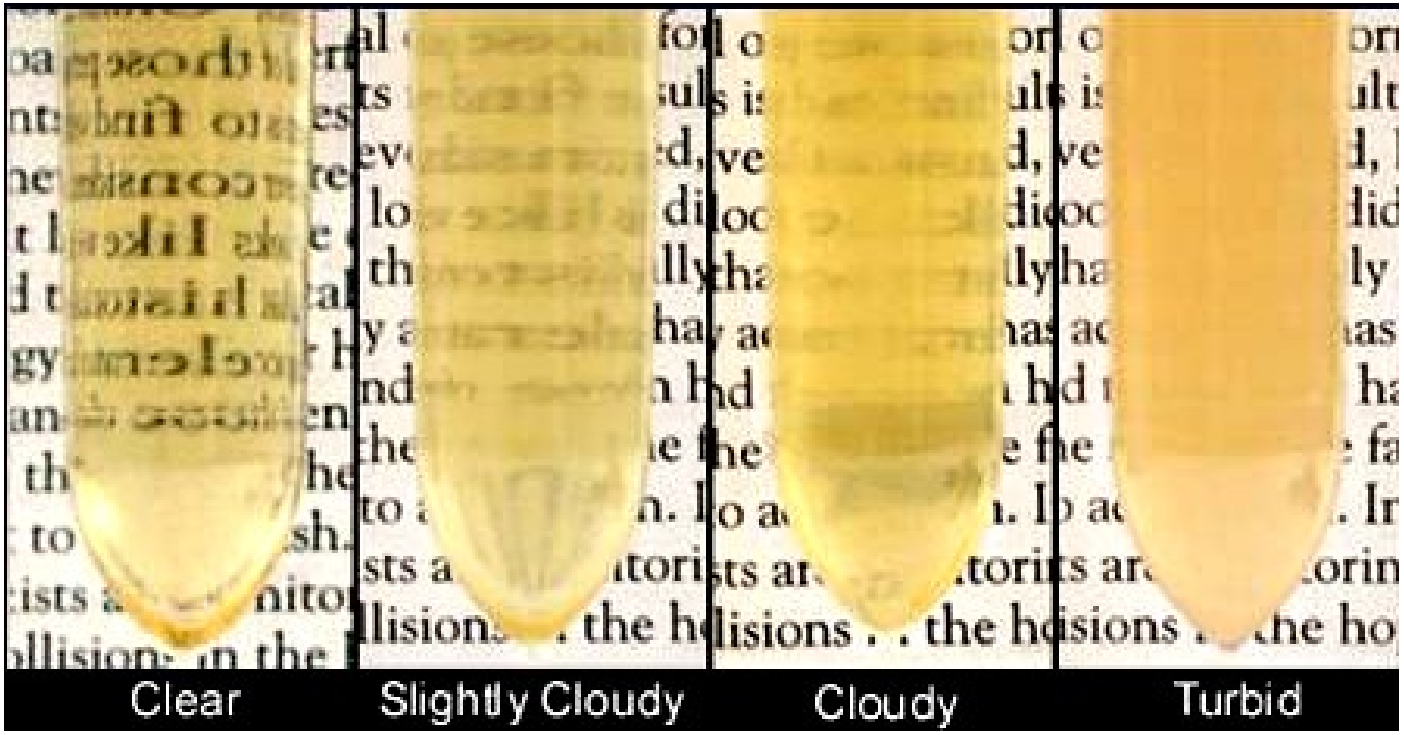


Different colors of urine

pale yellow (straw)
light yellow
yellow
green-yellow (olive)
red-yellow
red
red-brown
brown-black
black
milky

Appearance of normal urine

- Clarity of urine



Appearance of urine

- Substances that cause cloudiness but that are not considered unhealthy include:
  - mucous,
  - sperm and prostatic fluid,
  - cells from the skin,
  - normal urine crystals, and
  - contaminants (like body lotions and powders).
- Other substances that can make urine cloudy (such as red blood cells, white blood cells, or bacteria) indicate a condition that requires attention.

Volume of urine

- Normal volume is 750 –2000ml/24H
- Under 750 ml (oligouria) - dehydration, infection, obstruction, renal stones, kidney, failure, etc).
- Over 2000ml (polyuria) - diabetes insipidus, hypertension, nephroticsyndrome, ingestion of alcohol or drugs, endocrinal disorders.
- Absent of urine (anuria) - obstruction, kidney failure, stenosis.

Odor of urine

- Healthy urine may have a mild smell but generally does not have a foul odor.

- In some cases, an unusual or strong urine odor may be due to benign conditions that are not harmful, such as eating certain foods or taking certain medications and volatile acids.

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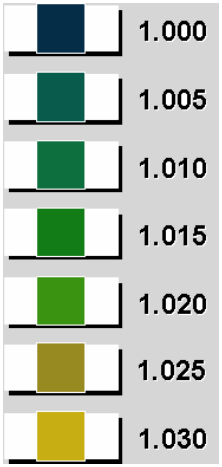
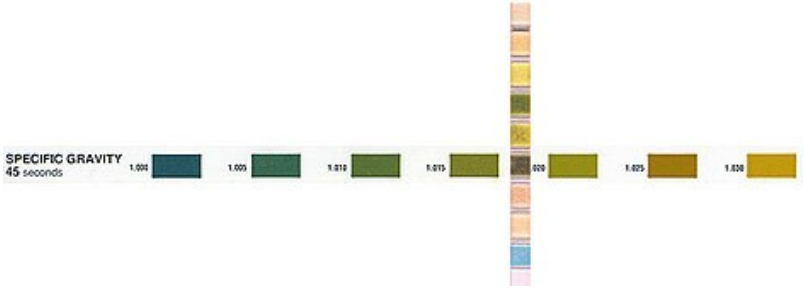
Specific gravity





- Specific gravity reflects kidney's ability to concentrate.
- Want concentrated urine for accurate testing, best is first morning sample.
- Low – specimen not concentrated, kidney disease.
- High – first morning, certain drugs
- Random specimen (1.003 to 1.032)
- 24 hours specimen (1.015 to 1.025)
- Severe renal tubular damage, sp. Gravity is fixed at 1.010 → isothenuric

Osmolality of urine

- Determination of urinary osmolality is more important than specific gravity because it gives more accurate reflection of the concentration of dissolved substances.

- It is the measure of the moles of dissolved particles (un dissociated molecules and ions) contained in a kilogram (Kg) of a solvent.

- **The normal osmolality of random urine specimen varies from 40-1350 m,osmol/kg.**
- **The normal osmolality of 24 hours urine specimen varies from 500-800 m,osmol/kg.**

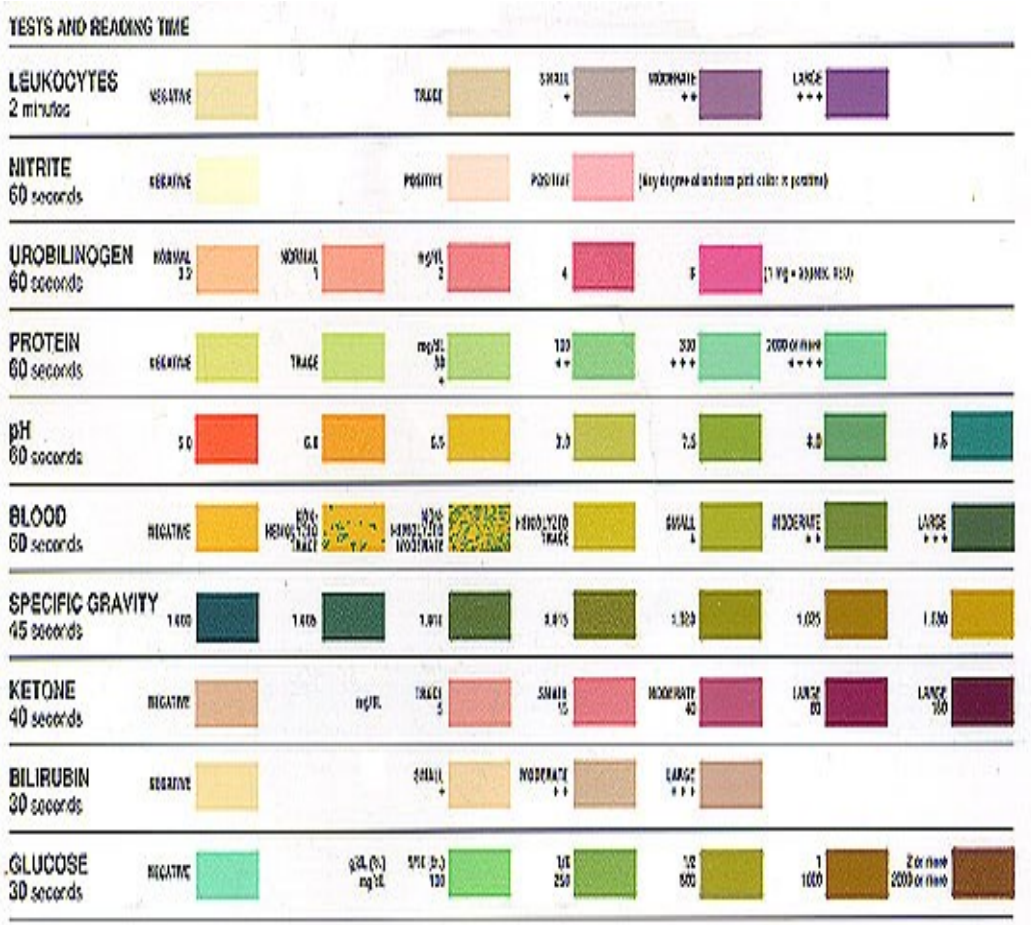
Chemical Examination

- Reagent strips are used only once and discarded.
- Testing
  - Perform within 1 hour after collection
  - Allow refrigerated specimens to return to room temperature.
  - Dip strip in fresh urine and compare color of pads to the color chart after appropriate time period.
  - Instruments are available which detect color changes electronically

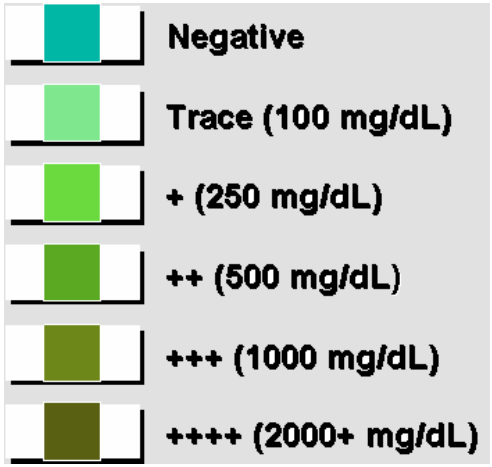
Using Reagent Strips

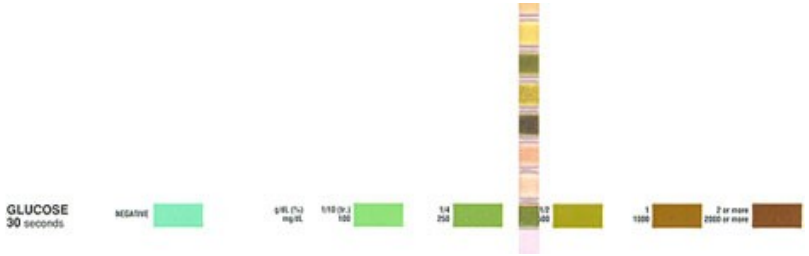
- BRIEFLY dip the strip in urine.
- Colors are matched to those on the bottle label at the appropriate times.
- **Timing is critical for accurate results.**

Reagent Strips



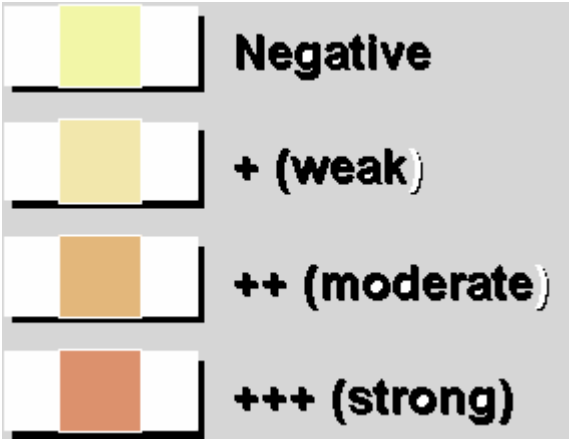
Glucose

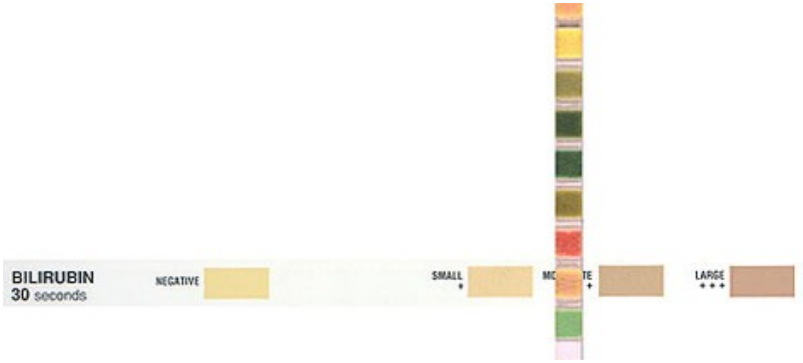




- Presence of glucose (glycosuria) indicates that the blood glucose level has exceeded the renal threshold.
- Useful to screen for diabetes.

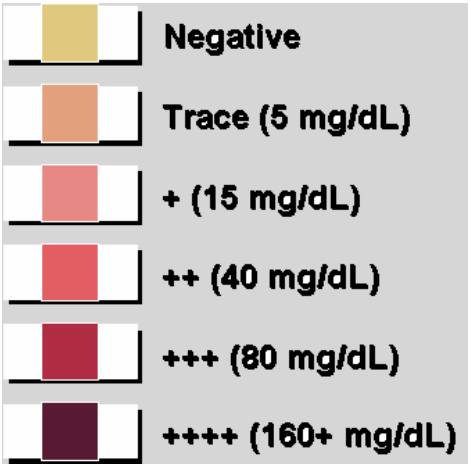
Bilirubin

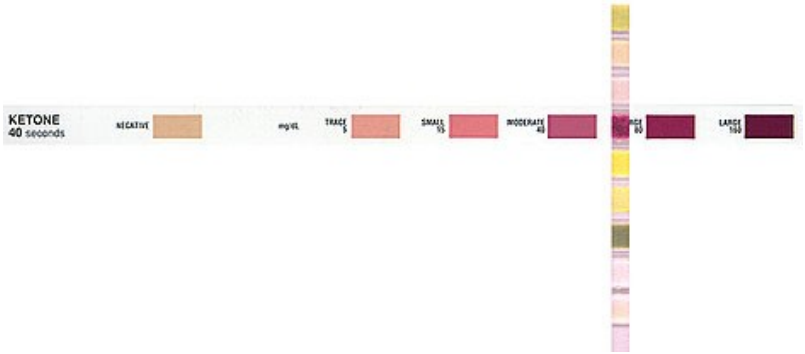




- Bilirubin is a byproduct of the breakdown of hemoglobin.
- Normally contains no bilirubin.
- Presence may be an indication of liver disease, bile duct obstruction or hepatitis.
- Since the bilirubin in samples is sensitive to light, exposure of the urine samples to light for a long period of time may result in a false negative test result.

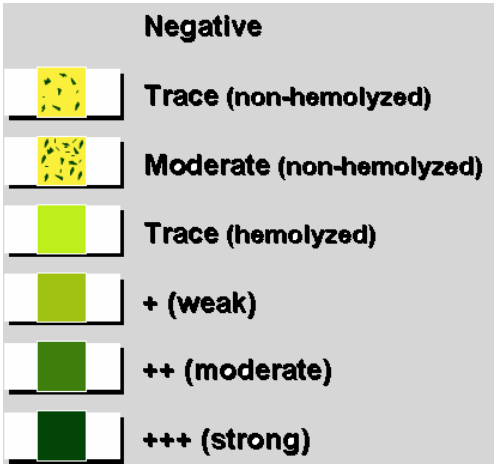
Ketones





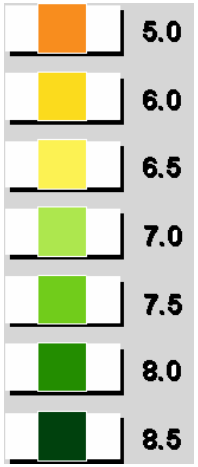
- Ketones are excreted when the body metabolizes fats incompletely (ketonuria)

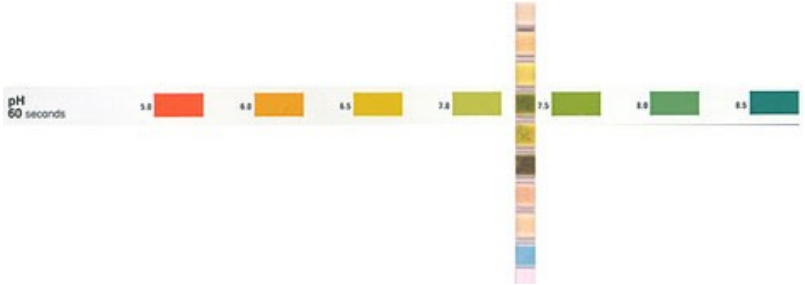
Blood



- Presence of blood may indicate infection, trauma to the urinary tract or bleeding in the kidneys.
- False positive readings most often due to contamination with menstrual blood.

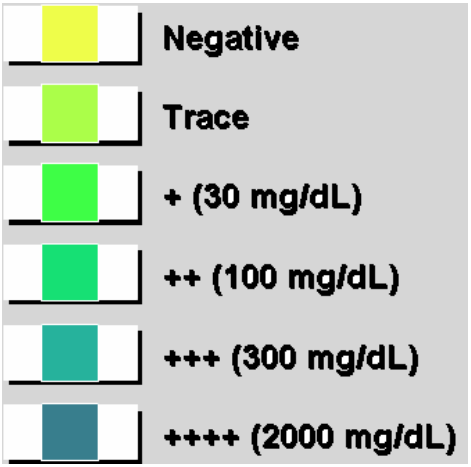
Ph





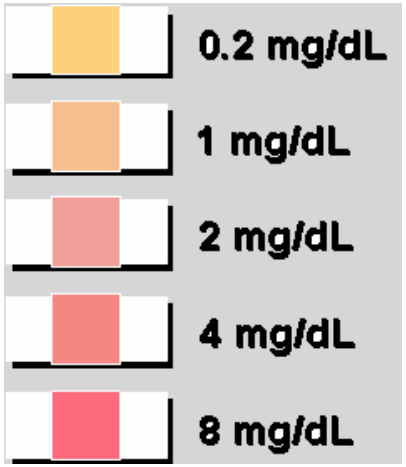
- pH measures degree of acidity or alkalinity of urine

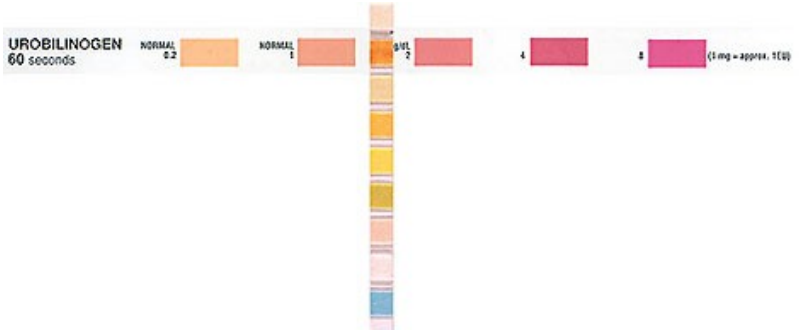
Protein



- Presence of protein (proteinuria) is an important indicator of renal disease.
- False negatives can occur in alkaline or dilute urine or when primary protein is not albumin.

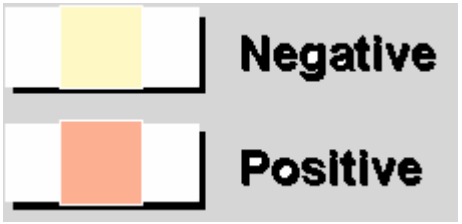
Urobilinogen





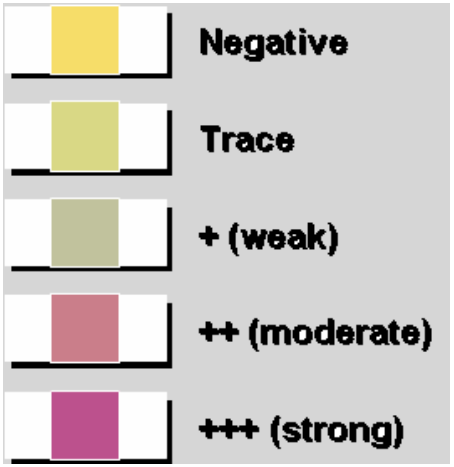
- Urobilinogen is a degradation product of bilirubin formed by intestinal bacteria.
- It may be increased in hepatic disease or hemolytic disease

Nitrite



- Nitrite formed by gram negative bacteria converting urinary nitrate to nitrite

Leukocytes



- Leukocytes (white blood cells) usually indicate infection.
- Leucocyte esterase activity is due to presence of WBCs in urine while nitrites strongly suggest bacteriuria.

Normal Values

- Negative results for glucose, ketones, bilirubin, nitrites, leukocyte esterase and blood.
- Protein negative or trace.
- pH 5.5-8.0
- Urobilinogen 0.2-1.0 Ehrlich units

Handling and Storage of Strips

- Handling and Storage
  - Keep strips in original container
  - Do not touch reagent pad areas
  - Reagents and strips must be stored properly to retain activity
    - Protect from moisture and volatile fumes
    - Stored at room temperature
  - Use before expiration date

Procedure

- Dip strip briefly, but completely into well mixed, room temperature urine sample.
- Withdraw strip.
- Blot briefly on its side.
- Keep the strip flat, read results at the appropriate times by comparing the color to the appropriate color on the chart provided.

Sources of Error

- **Timing** - Failure to observe color changes at appropriate time intervals may cause inaccurate results.
- **Lighting** - Observe color changes and color charts under good lighting.
- **QC** - Reagent strips should be tested with positive controls on each day of use to ensure proper reactivity.
- **Sample** - Proper collection and storage of urine is necessary to insure preservation of chemical.

Sources of Error

- **Testing cold specimens** - would result in a slowing down of reactions; test specimens when fresh or bring them to RT before testing

- **Inadequate mixing of specimen** - could result in false reduced or negative reactions to blood and leukocyte tests; mix specimens well before dipping

- **Over-dipping of reagent strip** - will result in leaching of reagents out of pads; briefly, but completely dip the reagent strip into the urine

Parameter	Normal	Abnormal
Colour	Yellow straw, amber, transparent	•Dark amber - concentrated urine insufficient of fluid intake •Cloudy - infectious process •Dark orange – drug, eg: pyridium •Red or dark brown - disease process causing blood in
Consistency	Clear liquid	Mucous plug, viscid, thick - infectious process
Odor	Faint aromatic	Offensive - infectious process
Sterility	No microorganism present	Microorganism present - infectious of UT
pH	4.5-8.0	•Over than 8.0 - UT infection •Under 4.5 - uncontrolled diabetes, starvation, dehydration
Specific gravity	1.010 to 1.025	•Over 1.025 – diabetes mellitus, under hydration •Under 1.01 – diabetes insipidus, kidney disease, over hydration
Urine glucose	Not present	Present – diabetes mellitus
Urine ketone bodies (eg: acetone)	Not present	Present – diabetic coma, starvation, prolonged vomiting
Urine blood	Not present	Occult –kidney disease Bright red - hemorrhage

Urine microscopy

- **White blood cells**
- Pyuria refers to the presence of elevated number of leukocytes (granulocytes) :
  - Upper or lower UT infection
  - Glomerulonephrotis
  - Vaginal & cervical infections
  - External urethral meatus (men & women)

Normal range:

0-2 /HPF (5+ indicates an infection and 10+ indicates more severe conditions).

Urine microscopy

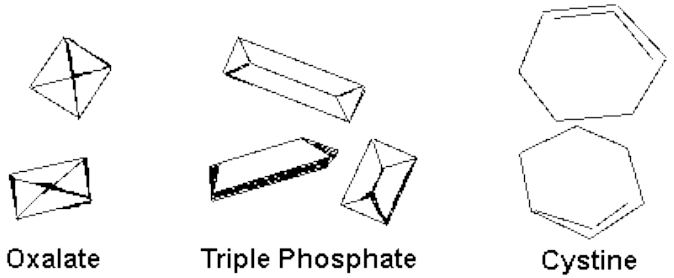
Epithelial cells

- Normal urine – not present/unquantified
- Renal tubular epithelial cells, usually larger than granulocytes, contain a large round or oval nucleus are normally slough into the urine in small amounts.
- Positive – nephrotic syndrome, condition leading to tubular degeneration.

Urine microscopy

Urinary crystals

- Normal urine – present but unquantified.
- Type of crystals:
  - Calcium oxalate
  - Triple phosphate
  - Amorphous phosphates
  - Uric acids
- Uric acid crystals (hyoeruricemia)
  - Cyctine
  - Tyrosine
  - Leusine



- Elevated numbers of crystal may indicates:
  - Hipercalcemia
  - Cystine crystal –cystinuria

- May due to renal failure or other renal disease.

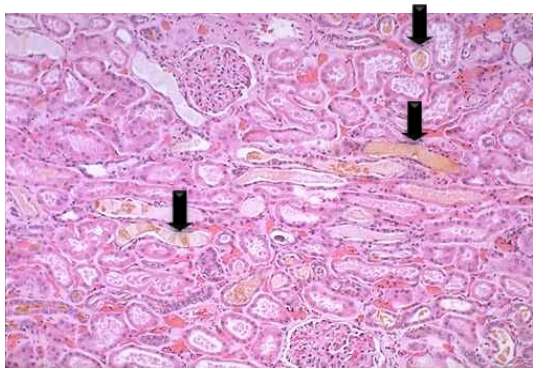
Urine microscopy

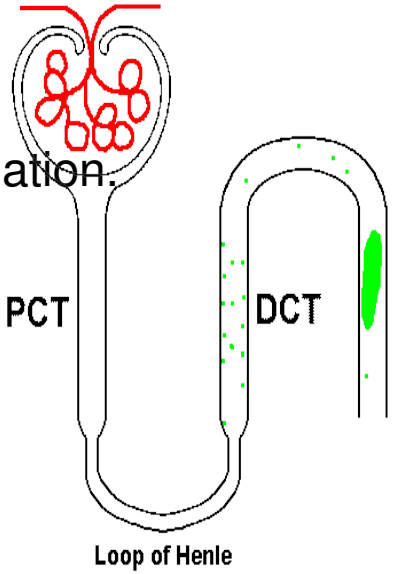
Casts

- Formed at the distal convoluted tubule or the collecting duct (distal nephron).
- Protein based cylindrical molds of the renal tubule
- Result of damage to the renal tubule
- Can contain cells and other material
- Dehydration and acidic urine especially predisposes to cast formation.

Types of casts

- Protein
- RBC
- WBC
- Other





Urine microscopy

Urinary bacteria

- Abundant normal microbial flora of the vagina or external urethral meatus.
- Ability to rapidly multiply in urine standing room temperature.
- However, it should be interpret in view of clinical symptoms.
- Bacterial culture must be done in case of bacteriuria

Urine microscopy

Urinary Yeast

- Yeast cells may be contaminants or represent a true yeast infection.
- Often difficult to distinguish from red cells and amorphous crystals but can be distinguished by their tendency to bud.
- Most often they are candida, which may colonize bladder, urethra or vagina.

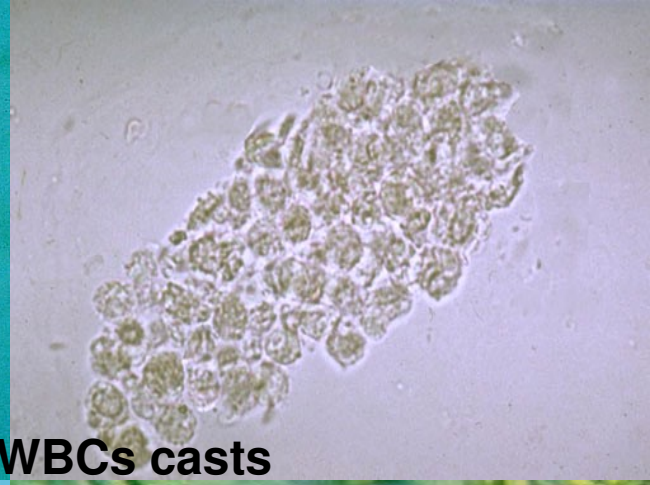
Urine microscopy

- **Non bacterial organisms**

- General "crud" or unidentifiable objects may find their way into a specimen, particularly those that patients bring from home.
- Spermatozoa can sometimes be seen.
- Rarely, pinworm ova may contaminate the urine.
- ova from bladder infestations with schistosomiasis may be seen.

WBCs in urine

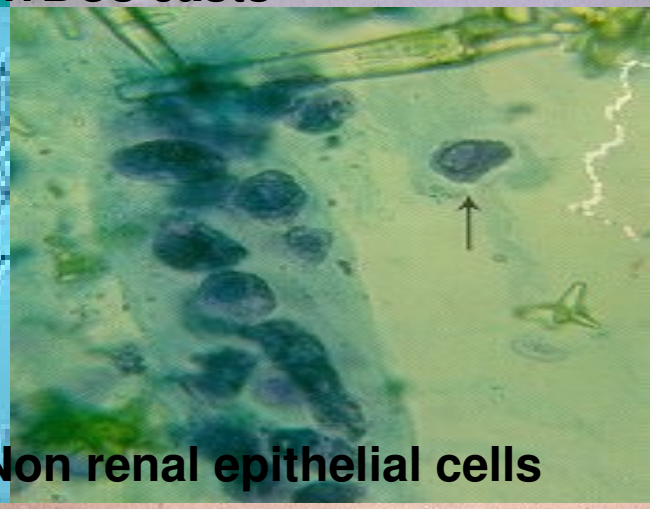
WBCs casts



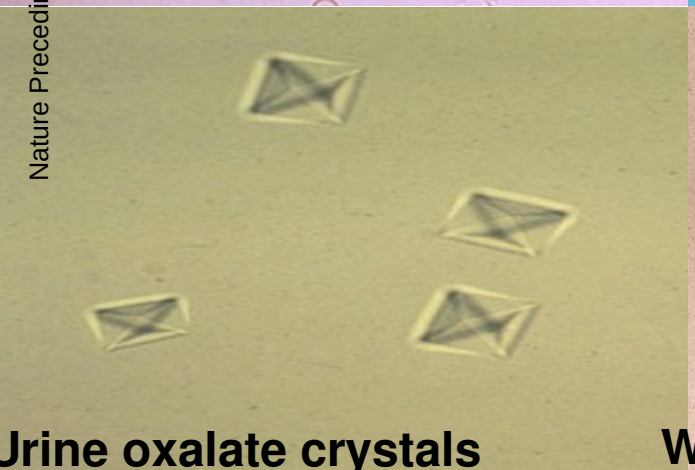
WBCs casts

Mixed cast urine

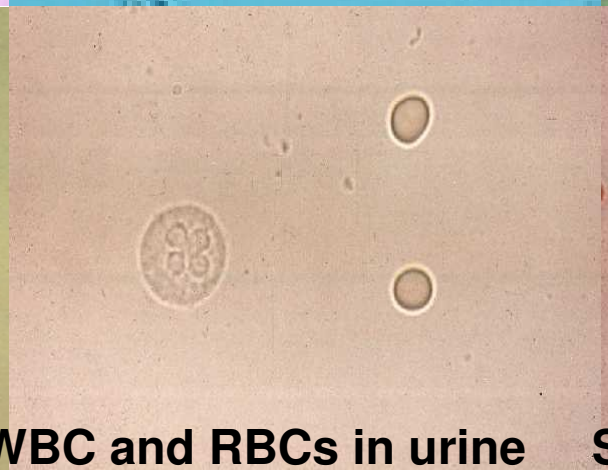
Cellular casts



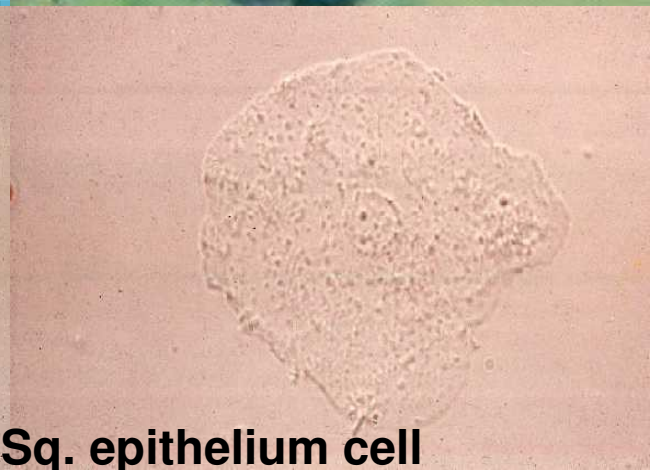
Non renal epithelial cells



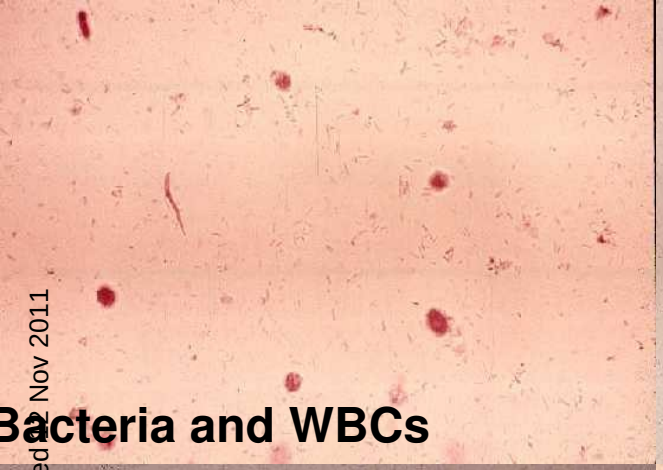
Urine oxalate crystals



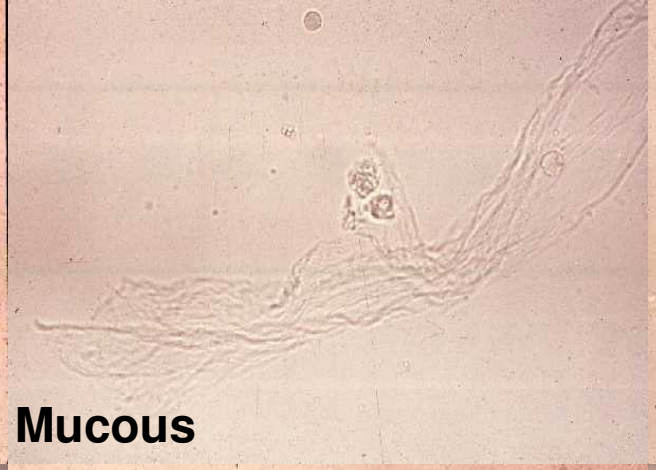
WBC and RBCs in urine



Sq. epithelium cell

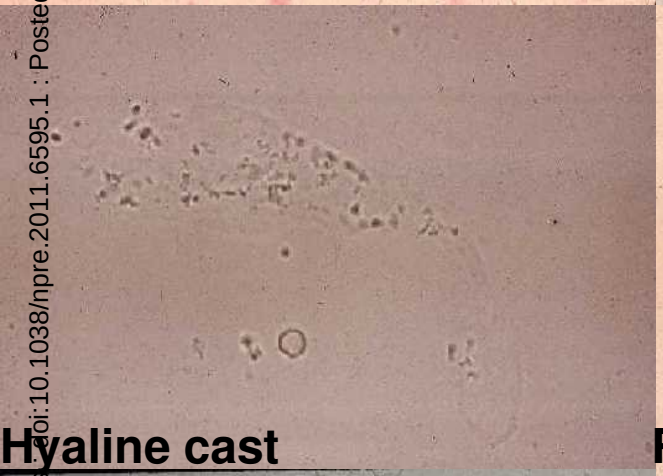


Bacteria and WBCs

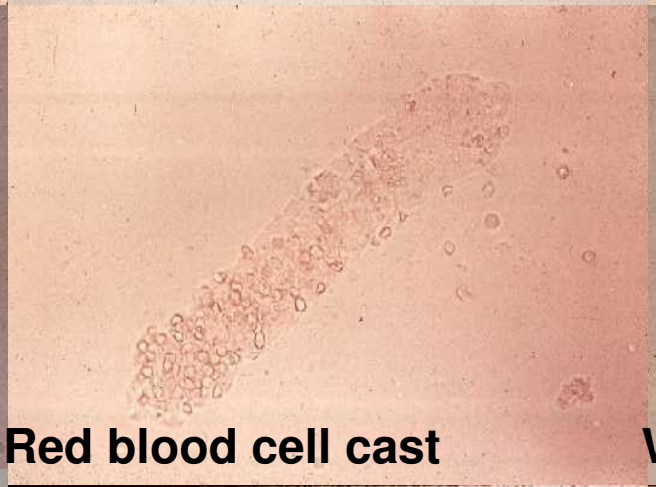


Mucous

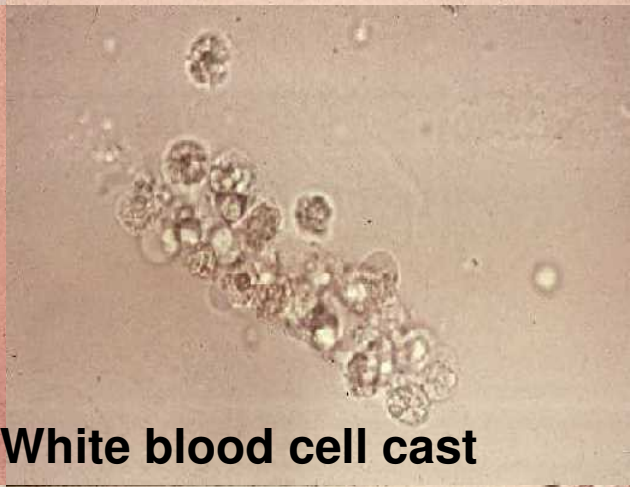
Budding yeast



Hyaline cast



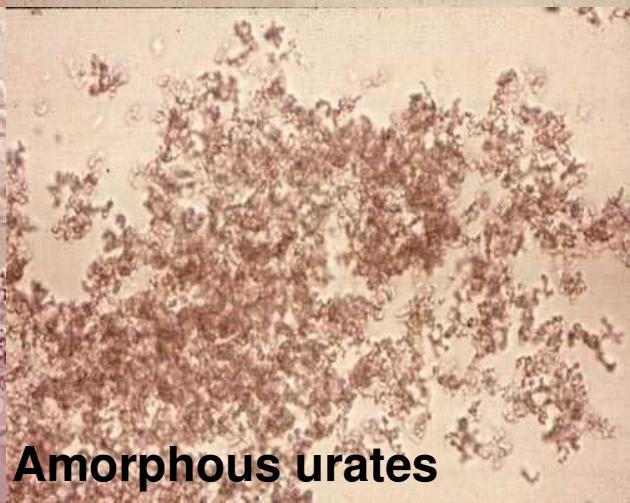
Red blood cell cast



White blood cell cast

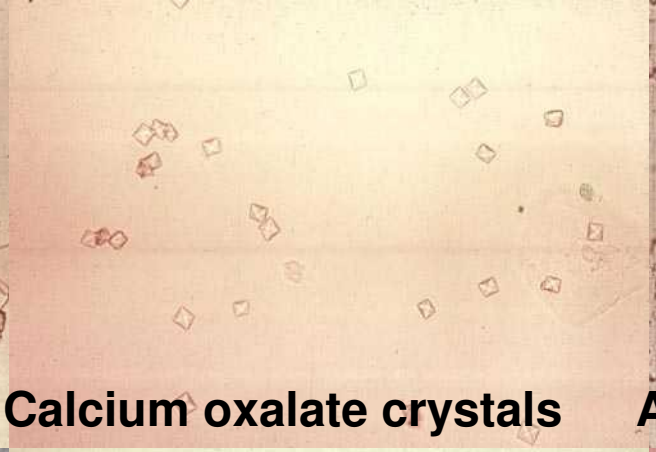
coarsely granular cast

waxycast



Amorphous urates

Uric acid crystals

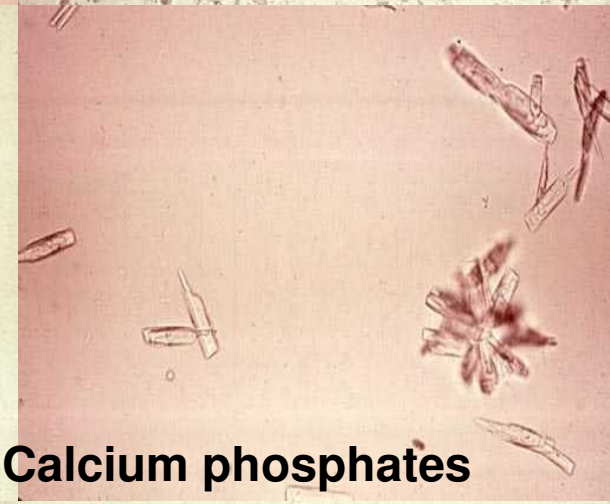


Calcium oxalate crystals

Amorphous phosphates

Triple phosphate crystals

Ammonium urate crystals



Calcium phosphates

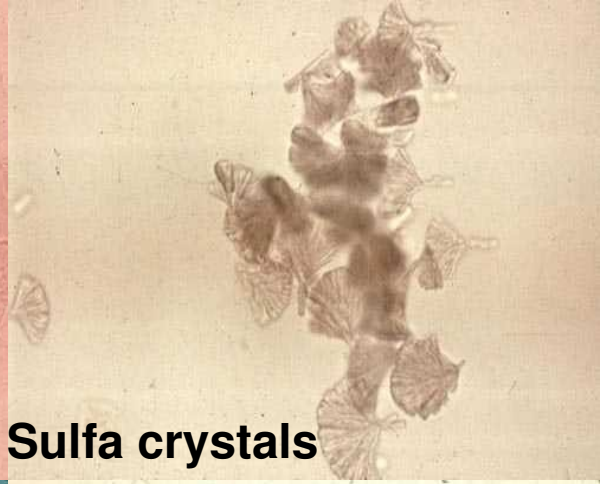
Calcium carbonate crystals

Tyrosine crystals

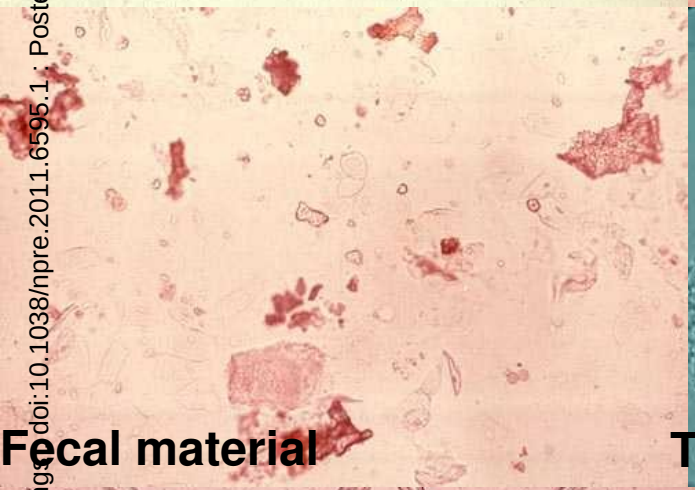
Cystine crystals

Leucine crystals

Cholesterol crystals



Sulfa crystals



Fecal material

Talc in urine

Startch in urine

Cotton fibers in urine

Cotton fibers in urine

Epithelial cells in urine

Requesting a urinalysis

Signs and symptoms

- Burning urination, difficulty in urination & painful urination – infectious and obstruction.
- Semen in urine with great exhaustion (semonorrhoea) – prostate problem.
- Backache early in the morning – infection, renal stones (fullnes of kidney, pelvis).
- UTI (leucorrhoea in females) – spread of infection into UT (honeymoon cystitis).
- Fatigue and exhaustion – renal problems.
- Lower abdominal pain or supra pubic pain – due to infection or stones.

Thank you