Gross Exam

- Color
- Appearance
- Odor

A complete urinalysis has 4 parts:

- Gross examination
- Specific Gravity
- Biochemical analysis
- Sediment Examination

Biochemical Testing

Biochemical Testing

- Ascorbic Acid (Vitamin C) can interfere with the glucose and blood reactions resulting in a false ***negative*** reading.
- Specific gravity indicator pads are of little use in animals.
- Nitrite and Leukocytes aren't reliable either.

Urine Tests

(a) Urinalysis
(b) Flow Cytometry
(c) Cytology
(d) Glomerular Filtration Rate
(e) Creatinine Clearance
(f) 24-Hour Urine for Urinary Protein Excretion
(g) 24-Hour Urine Analysis for Stone Formers
(h) Urinary Electrolytes
(i) Renal Tubular Acidosis
(j) Adrenal-Specifi c Urinary Tests
(k) Urinary Markers for TCC Detection
(l) Urinary Markers for Prostate Cancer Detection

Blood Tests TO THE RENAL FUNCTION

(a) Prostate-Specifi c Antigen (PSA)
(b) Electrolytes
(c) Testicular Tumor Markers
(d) Bone Disease Related to Urology
(e) Sex Hormone Profi le
(f) Serum Markers of Adrenal Function

Radiology

(a) Plain Abdominal Radiograph (KUB)
(b) Intravenous Urography (IVU)
(c) Ultrasound Scanning (USS)
(d) Computed Tomography (CT)
(e) Magnetic Resonance Imaging (MRI)
(f) Magnetic Resonance Spectroscopy
(g) Nephrostogram
(h) Retrograde Ureteropyelography (RPG)
(i) Doppler Studies
(j) Cystogram
(k) Urethography
(l) Cavernosography
(m) Fistulography

Nuclear Medicine Investigations

(a) MAG3 Renography
(b) DMSA Renography
(c) Obtaining a Glomerular Filtration Rate (GFR)
(d) Bone Scan
(e) Positron Emission Tomography (PET) Scan

Urodynamics

(a) Frequency Volume Charts
(b) Flow Rate Study
(c) Residual Bladder Urine Volume Estimation
(d) Pressure-fl ow Cystometry Studies
(e) Urethral Pressure Profi le
(f) Video Urodynamics
(g) Ambulatory Urodynamics
(h) Sphincter Electromyography (EMG)

Other TESTS
(a) Transrectal Ultrasound of the Prostate
(b) Urinary Stone Analysis
(c) Pad Test for Urinary Incontinence
(d) Laparoscopy for
Undescended Testis
(e) Aspiration of Renal Cysts
(f) Urethral Swabs
(g) Bladder Catheterization
(h) Standard Semen Analysis
(i) Cystoscopy

Some normal urine constituents excreted (in g/24 hours):

Urea 25-30 Uric acid 0.6-0.7 Creatinine 1.0-1.2
Hippuric acid 0.7 Ammonia 0.7 Amino acids 3
Sodium 1-5 (NaCl 15.0)
Potassium 2-4 Calcium 0.2-0.3 Magnesium 0.1
Chloride 7 Phosphate 1.7-2.5 Sulfate 1.8-2.5

Routine urinalysis is composed of two examinations:
1)Chemical tests for abnormal chemical constituents
2) Microscopic exam for abnormal insoluble constituents

Normal Urine

pH 4.5-8.0 (6.0 average)

Specific gravity 1.001 - 1.030

Solutes
- urea
- sodium
- potassium
- phosphate
- sulfate
- creatinine
- uric acid
- other ions

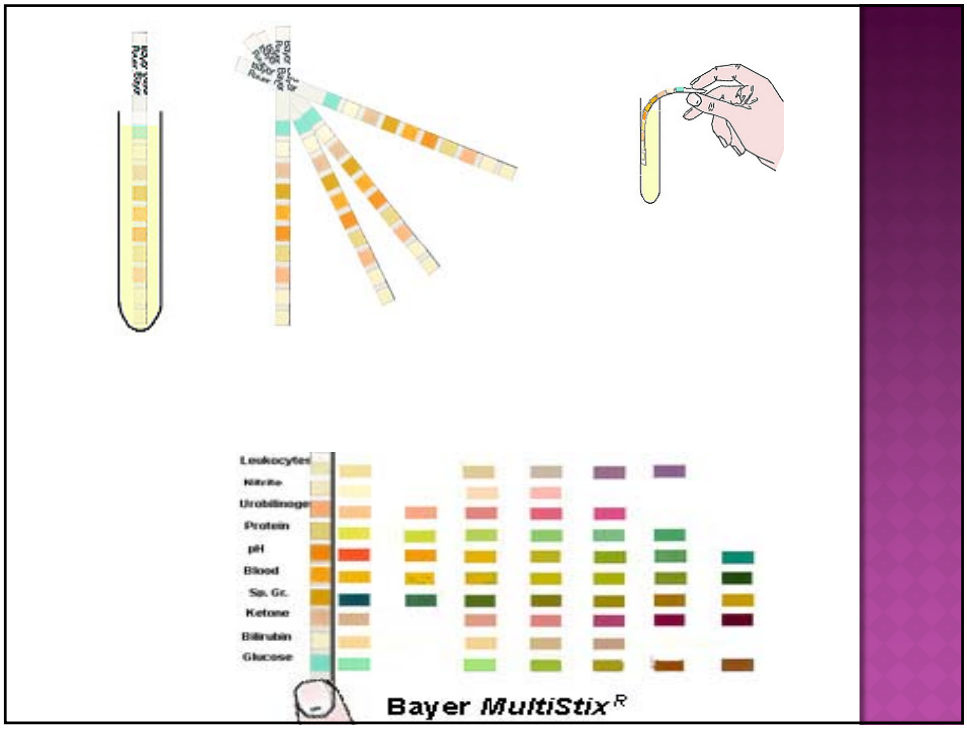
Clear, straw to amber in color

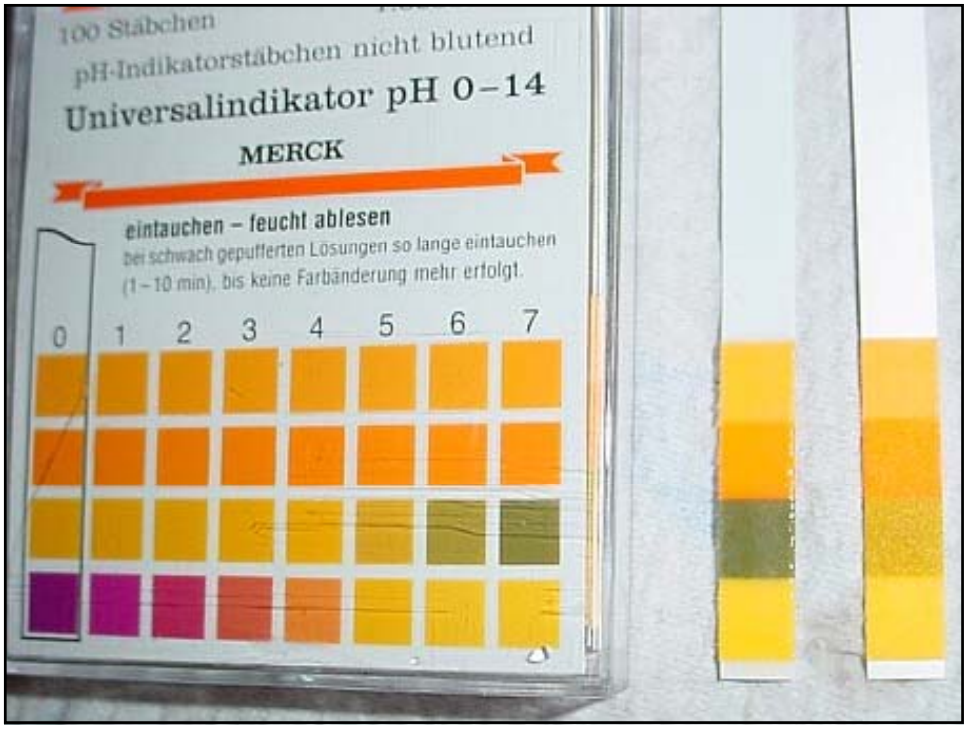
Abnormal Constituents of Urine

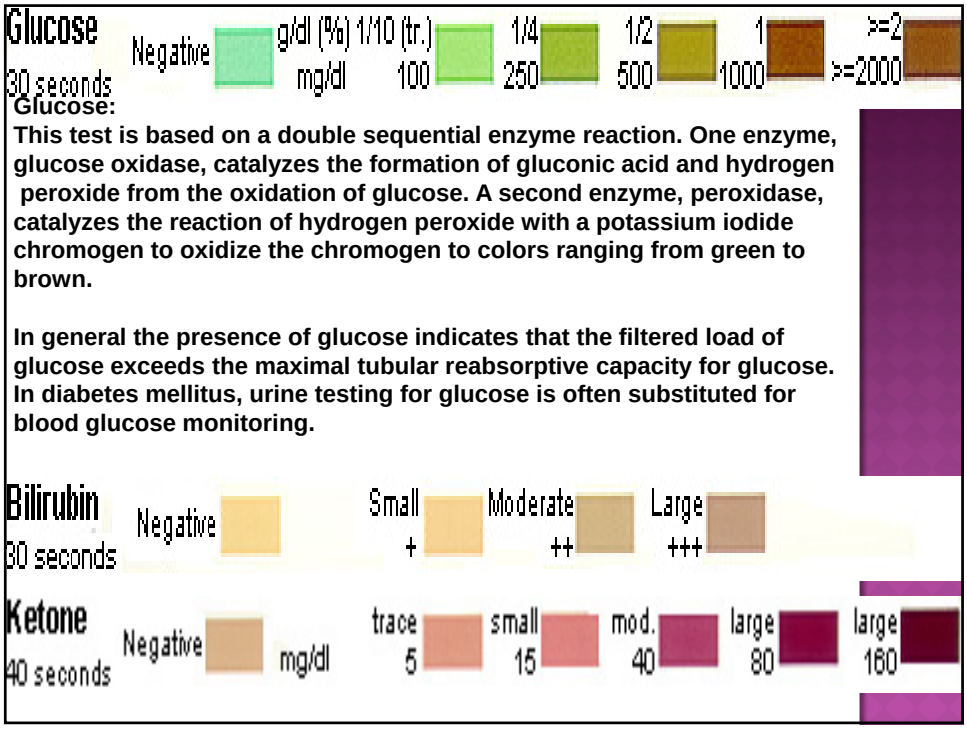
- glucose--glycosuria diabetes
- albumin--albuminuria
- protein—proteinuria glomerular damage
- ketones--ketonuria starvation, diabetes
- RBCs--hematuria renal calculi, infection, trauma

hemoglobin--hemoglobinuria
- bile pigments--bilirubinuria

transfusion rx, hemolytic anemia, burn liver problems
- WBCs--pyuria inflammation


Leukocytes
Nitrite
Urobilinogen
Protein
pH
Blood
Sp. Gr.
Ketone
Bilirubin
Glucose
Bayer MultiStix®

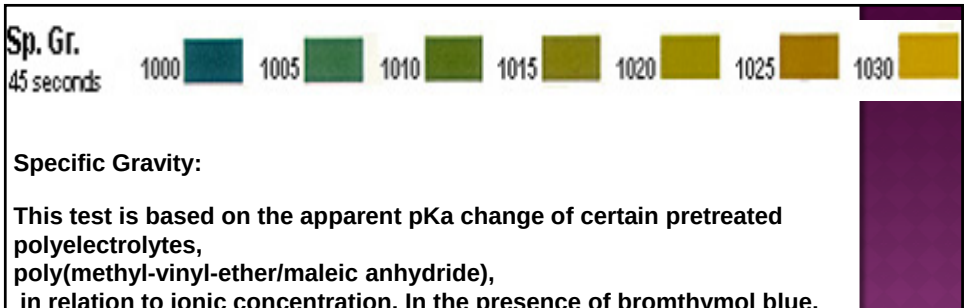

100 Stäbchen
pH-Indikatorstäbchen nicht blutend
Universalindikator pH 0–14
MERCK
eintauchen – feucht ablesen
bei schwach gepufferten Lösungen so lange eintauchen
(1–10 min), bis keine Farbänderung mehr erfolgt.
0 1 2 3 4 5 6 7



Glucose:

This test is based on a double sequential enzyme reaction. One enzyme, glucose oxidase, catalyzes the formation of gluconic acid and hydrogen peroxide from the oxidation of glucose. A second enzyme, peroxidase, catalyzes the reaction of hydrogen peroxide with a potassium iodide chromogen to oxidize the chromogen to colors ranging from green to brown.

In general the presence of glucose indicates that the filtered load of glucose exceeds the maximal tubular reabsorptive capacity for glucose. In diabetes mellitus, urine testing for glucose is often substituted for blood glucose monitoring.



Specific Gravity:

This test is based on the apparent pKa change of certain pretreated polyelectrolytes,
poly(methyl-vinyl-ether/maleic anhydride),
in relation to ionic concentration. In the presence of bromthymol blue, colors range
deep blue-green in urine of low ionic concentration through
green and yellow-green in urines of increasing ionic concentration.

The specific gravity is a convenient index of urine concentration.
It measures density and is only an approximate guide to true concentration.

A specific gravity of <1.010 is consistent with a concentrating defect.
A specific gravity of >1.025, in the absence of protein, glucose and other large molecular weight substances such as contrast media, usually indicates normal renal concentration and makes chronic renal insufficiency unlikely.

pH:

The test is based on the double indicator (methyl red/bromthymol blue) principle that gives a broad range of colors covering the entire urinary pH range. Colors range from orange through yellow and green to blue.

The urine pH should be recorded, although it is seldom of diagnostic value. Phosphates will precipitate in an alkaline urine, and uric acid will precipitate in an acidic urine.

Protein:

This test is based on the protein-error-of-indicators (tetrabromphenol blue) principle. At a constant pH, the development of any green color is due to the presence of protein. Colors range from yellow for negative through yellow-green and green to green-blue for positive reactions.

Heavy proteinuria usually represents an abnormality in the glomerular filtration barrier. The test is more sensitive for albumin than for globulins or hemoglobin.

Urobilinogen:

This test is based on the modified Ehrlich reaction, in which para-diethylaminobenzaldehyde in conjunction with a color enhancer reacts with urobilinogen in a strongly acid medium to produce a pink-red color.

Urine urobilinogen is increased in any condition that causes an increase in production or retention of bilirubin.

Nitrite:

This test depends upon the conversion of nitrate (derived from the diet) to nitrite by the action of Gram negative bacteria in the urine. At the acid pH of the reagent area, nitrite in the urine reacts with para-arsanilic acid to form a diazonium compound. This diazonium compound in turn couples with 1,2,3,4-tetrahydrobenzo(h)quinoline-3-ol to produce a pink color.

Bacteriuria caused by some Gram negative bacteria which produce the nitrate reductase enzyme give a positive test.

Leukocytes:

Granulocytic leukocytes contain esterases that catalize the hydrolysis of the derivatized pyrrole amino acid ester to liberate 3-hydroxy-5-phenyl pyrrole.

This pyrrole then reacts with a diazonium salt to produce a purple product.

A positive leukocyte esterase test provides indirect evidence for the presence of bacteriuria.

Blood:

This test is based on the peroxidase-like activity of hemoglobin, which catalyzes the reaction of diisopropylbenzene dihydroperoxide and 3,3',5,5'-tetramethylbenzidine.

The resulting color ranges from orange through green; very high levels of blood may cause the color development to continue to blue.

The presence of large numbers of RBCs in the urine sediment establishes the diagnosis of hematuria.

If the dipstick is more strongly positive than would be expected from the number of RBCs, then the possibility of hemoglobinuria or myoglobinuria should be considered.

URINALYSIS

- Physical properties
  - Color and clarity
  - pH
  - Specific volume
- Chemical constituents
  - Protein
  - Glucose,etc.
- Microscopic exam of sediment

PHYSICAL PROPERTIES

- Color: yellow
- Yellow – due to urochrome
- Affected by:
  - Concentration
  - Food
  - Dyes
  - Blood

Clarity

normal is clear/transparent

Alkaline: cloudy (precipitation of crystals)

UTI: WBC and alkalinity

Pink "dust": amorphous urates

Odor: volatile acids
Ammoniacal: old specimen
Fruity: ketones
Foul: urinary tract infection

SPECIFIC GRAVITY

- Degree of concentration
- Normal: 1.003-1.030, usually 1.010-1.025
- Urinometer: weighted bulb
  - Floats "high" in conc. spec, "low" in dilute
  - Calibrate to read 1.000 in distilled water
    - Correct for protein or glucose
- Refractometer:
  - Ratio of velocity of light in air to velocity through
  - solution
  - Correlates well with specific gravity

- Low specific gravity: hypostenuria
  - Diabetes insipidus: impaired ADH
  - Loss of concentrating ability
- High specific gravity: hypersthenuria
  - Adrenal insufficiency
  - Hepatic disease
  - Congestive heart failure
- Fixed specific gravity: isosthenuria
  - Loss of both concentrating and diluting function

VOLUME

- Normal volume: 700-2000 mL/24 hours
- Polyuria:
  - Increased fluid intake
  - Diuretics
  - Nervousness/anxiety
  - Oliguria:
- Decreased fluid intake or excess fluid loss
  - Increased salt ingestion
  - Renal shutdown
  - Obstruction to urine flow
  - Anuria

PH

- Normal: 4-8 (usually 6)
  - Reagent strips use 2 acid-base indicators
  - Methyl red
  - Bromthymol blue

pH: usually ~6
Regulation of blood pH
Acid urine:
High protein diet
Acidosis/uncontrolled diabetes mellitus
Alkaline urine
After meals- alkaline tide
High vegetable diets
UTI
Renal tubular acidosis

Glucose: glucosuria or glycosuria

- Blood levels of glucose exceed renal threshold (160 mg/dL)
  - Renal glucosuria
    - Diabetes mellitus- also increased volume with
    - high specific gravity as an attempt to rid
    - blood of excess glucose

Non-glucose reducing sugars:

• Lactose: lactating women
• Galactose: "galactosemia", leading to severe mental and physical deterioration and death
• Fructose: sometimes in hepatic disorders
• Pentoses: inherited benign condition

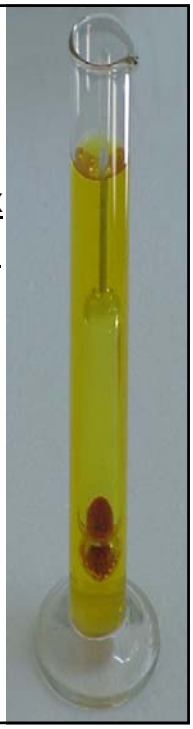
KETONES

- Inadequate carbohydrates in diet or defect
- in carbohydrate metabolism
- Increased fat metabolism, formation of
- ketone bodies (Acetone, acetoacetic acid,
- b-hydroxybutryic acid)
- Diabetes mellitus, anorexia, starvation
- Children more prone to ketosis and
- ketonuria

URINOMETER

- **Specific gravity of fluid x** = density of fluid x / density of water

urinometer for routine urinalyses. The hydrometer reads from 1.000 to 1.040 specific gravity



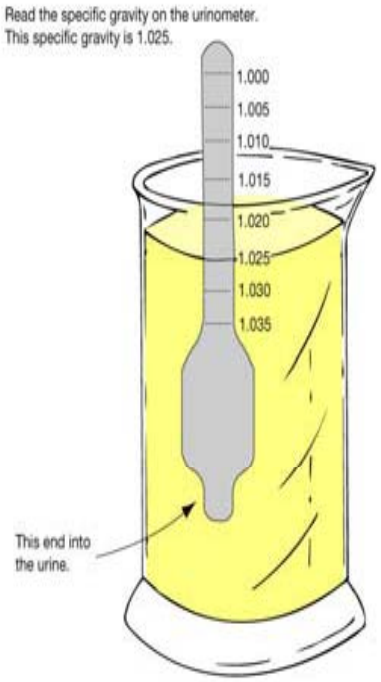
SPECIFIC GRAVITY

- is defined as the ratio of the density of a given solid or liquid substance to the density of water at a specific temperature and pressure, typically at 4°C (39°F) and 1 atm (760.00 mmHg) , making it a dimensionless quantity
- Substances with a specific gravity greater than one are denser than water, and so (ignoring surface tension effects) will sink in it, and those with a specific gravity of less than one are less dense than water, and so will float in it.
- Specific gravity is a special case of, or in some usages synonymous with, **relative density**, with the latter term often preferred in modern scientific writing.
- The use of specific gravity is discouraged in technical use in scientific fields requiring high precision — actual density (in dimensions of mass per unit volume) is preferred.
- Specific gravity, *SG*, is expressed mathematically as:

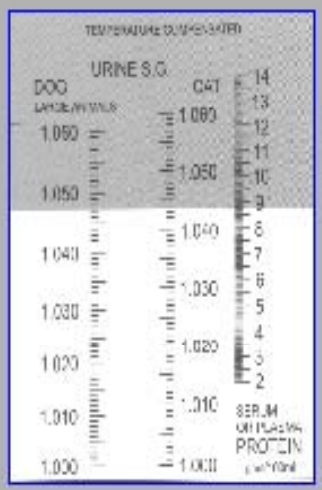
$$\mathrm{SG} = \frac{\rho_{\mathrm{substance}}}{\rho_{\mathrm{H_2O}}}$$

SPECIFIC GRAVITY IS

- a measure of urine concentration
- Excessively concentrated urine can crystallize over time forming kidney stones



Specific Gravity



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- 180L/day filtrate 1.8L/day urine
- Sterile
- Contains:
- – Water (~ 95%)
- – Urea (from amino acids)
- – Creatinine (from muscle creatine phosphate)
- – Uric acid (From nucleic acids)
- – Urobilins (urochrome)
- – Electrolytes

NITROGENOUS WASTES

- **Urea:** breakdown of amino acids in the
- liver and other cells leads to the production of ammonium ion $NH_4^+ + CO_2 \longrightarrow$ urea

- **Uric Acid:** breakdown product of nucleic acids

- **Creatinine:** from muscle metabolism of creatine phosphate