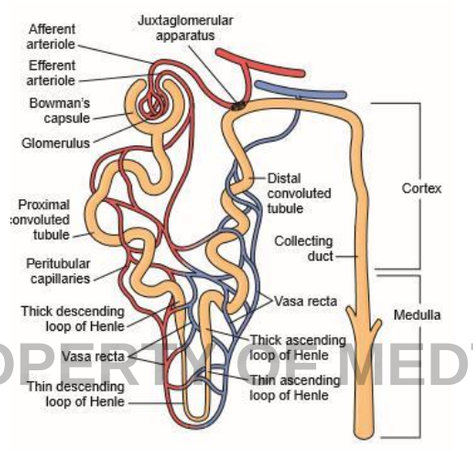
Clinical Microscopy

NEPHRON

- Functional unit of kidneys
- 1 – 1.5 million EACH kidney
- Composed of glomerulus and tubules
- 2 types of nephrons:
  1. _____:
     - 85% (majority)
     - For tubular reabsorption and removal of waste products,
  2. _____:
     - For the concentration of urine



RENAL FUNCTIONS:

- ✓ RENAL BLOOD FLOW
- ✓ GLOMERULAR FILTRATION
- ✓ TUBULAR REABSORPTION
- ✓ TUBULAR SECRETION

GLOMERULUS

- Consists of a coil approx. of 8 capillary lobes
- Within Bowman's capsule
- **NONSELECTIVE FILTER (substances _____ Da)**

URINE FORMATION

Glomerulus → PCT → Loop of Henle → DCT → CD → Calyx → Renal Pelvis

I. RENAL BLOOD FLOW

1. Renal artery	•Supplies 25% of blood to kidney (blood in)
2. Afferent arteriole	•Entry of blood (to the nephrons)
3. Glomerulus	•Glomerular filtration rate: 120 mL/min
4. Efferent arteriole	•Exit of blood (from the nephrons)
5. Peritubular capillaries	•Surrounds the PCT and DCT
6. Vasa Recta	•Maintains the osmotic gradient
7. Renal vein	•Blood out

RENAL BLOOD FLOW
- _____

RENAL PLASMA FLOW
- _____

FUNCTION TESTS: Dye Tests (PAH: p-aminohippuric acid and PSP: phenolsulfonphthalein)

II. GLOMERULAR FILTRATION

- Barrier cell layers:
  - ✓ capillary wall membrane – endothelial cells are fenestrated
  - ✓ basement membrane/basal lamina
  - ✓ visceral epithelium – with podocytes
- Additional structure: **SHIELD OF NEGATIVITY** ➡ Repels substances that are _____ _____
- **Glomerular Filtration Rate:** _____

FUNCTION TESTS: Clearance tests (used to measure filtering capacity of glomeruli

- Substances to be measured must NEITHER be reabsorbed nor secreted
- Substances:
  - ✓ Creatinine (most commonly used)
  - ✓ Inulin (reference method)
  - ✓ Urea (earliest, least accurate)
  - ✓ $Beta_2$-microglobulin
  - ✓ Cystatin C – produced by **nucleated cells**
  - ✓ Radioisotopes
- Calculated GFR: **Cockgroft and Gault** (variables: _____, _____ **and** _____)

Creatinine Clearance:

$$C = \frac{UV}{P} \times \frac{1.73}{A}$$

- **Modification of Diet in Renal Disease (MDRD)** system formula (variables: _____, _____, _____)

III. TUBULAR REABSORPTION (1st function affected in kidney disorders)

TUBULAR REABSORPTION			
Active Transport (with a carrier protein)		**Passive Transport (due to difference in physical/concentration gradient)**	
Substance	**Location**	**Substance**	**Location**
Glucose, AA, Salts	**PCT**	Water	PCT, DLH, CD
Chloride	ALH	Urea	PCT, ALH
Sodium	**PCT** and DCT	Sodium	ALH

Proximal Convoluted Tubule (PCT): Major site of reabsorption (65%)

Ascending Loop of Henle: impermeable to water

Renal threshold: plasma concentration at which ACTIVE transport stops.

Adapted from the Lecture Handouts, 12th Edition of Mr. Errol E. Coderes RMT, IMLT, MLS (ASCPi)CM

RENIN – ANGIOTENSIN – ALDOSTERONE SYSTEM (RAAS)

TRIGGERING FACTOR(S): _____, _____

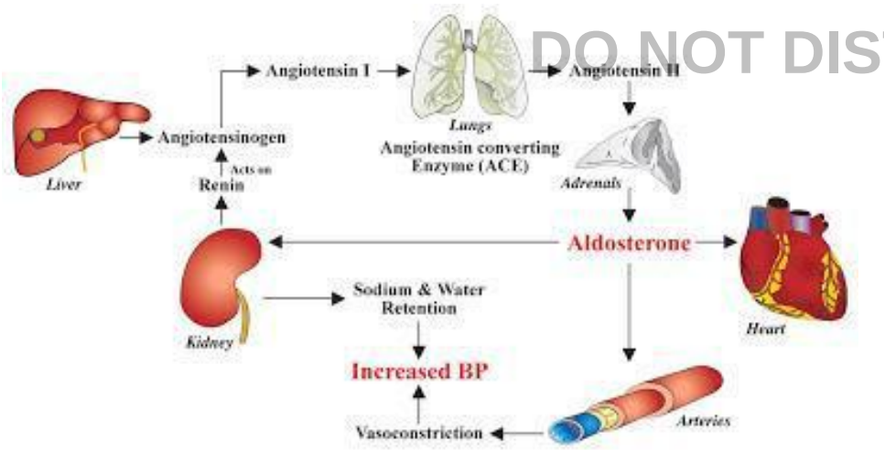


Photo Source: renalfellow.org

EFFECTS OF ANGIOTENSIN II:

- Aldosterone and ADH release (↑ Na+ & water retention)
- Vasoconstriction (↑ BP)
- Renal blood flow correction

RENAL THRESHOLD OF GLUCOSE: _____ mg/dL or 8.88 – 9.99 mmol/L)

ANTI-DIURETIC HORMONE

- Regulator of the reabsorption of water in DCT and CD
- Inversely proportional to body hydration and urine volume
- **ADH deficiency: Diabetes Insipidus**
  - ✓ _____: patient is not capable of producing ADH
  - ✓ _____: renal tubules lack receptors for ADH
- **ADH excess:** _____

COLLIGATIVE PROPERTIES:

↓ FREEZING POINT

↓ VAPOR PRESSURE

↑ BOILING POINT

↑ OSMOTIC PRESSURE

FUNCTION TESTS:

- Obsolete tests:
  - ✓ _____: fluid deprivation for 24 hrs
  - ✓ _____: comparison of day & night volume and SG
- Commonly used tests:
  - ✓ Specific Gravity (SG) – number & density of particles in solution
  - ✓ Osmolarity – number only of particles in solution

IV. TUBULAR SECRETION

- 2 major functions:
  - ✓ to remove waste products that were not filtered by glomerulus
  - ✓ Acid-Base Balance regulation (through secretion of H+ ions)
- Major site for removal of substances not filtered: PROXIMAL CONCOLUTED TUBULE
- **FUNCTION TESTS:** Dye Tests (PAH: p-aminohippuric acid and PSP: phenolsulfonphthalein)

RENAL TUBULAR ACIDOSIS: _____ URINE OUTPUT due to inability to excrete H+ ions.

URINE

- Composition: 95-97% water, 3-5% solids
- Sample should be delivered and tested in the laboratory **within** _____
- **As soon as urine is voided,** changes occur.

TOTAL SOLIDS IN 24 HOURS:

60 grams

MAJOR ORGANIC SUBS:

_____

MAJOR INORGANIC SUBS:

_____

CHANGES IN UNPRESERVED URINE		
INCREASED	**Mnemonic**	**REASON**
Odor	**O**ne	Urea → ammonia due to bacterial proliferation
Nitrite	**N**etwork	Nitrate-reducing bacteria multiplication
Bacteria	**B**ank pH	Multiplication
pH		Urea → ammonia due to bacterial proliferation/ CO_2 loss
DECREASED		
Glucose	*(insert your mnemonic here)*	Bacterial consumption/ Glycolysis
Ketones		Volatilization
Bilirubin		Photo oxidation
Urobilinogen		Oxidation to urobilin
Clarity		Bacterial proliferation and precipitation of amorphous materials
RBCs, WBCs and casts		Disintegration
Trichomonads		Loss of motility, death
MODIFIED/DARKENED		
Color		RedOx of metabolites

- ✓ Normal range (volume): _____ (avg: 1,200-1500mL)
- ✓ Urine output (night): _____ (Night:Day ratio = _____)
- ✓ Routine UA: _____ (avg: _____)
- ✓ Container capacity: _____
- ✓ Polyuria: Increased urine output (_____)
- ✓ Oliguria: decreased urine output (_____)
- ✓ _____: complete cessation of urine flow (<100mL/24 hrs)
- ✓ _____: increased urine output at night (>500mL/24 hrs)

TYPES OF SPECIMEN		
Random/ Occasional/ Single	For routine screening	Most commonly received specimen
	Routine screening, pregnancy tests, detection of orthostatic proteinuria	Ideal specimen Concentrated specimen
24-hour (timed)	Quantitative tests	For measuring exact amount of a urine chemical ***Patient must begin and end collection with an empty bladder!***
	For Addis count	NV: RBCs: 0-500,000 WBCs & ECs: 0-1,800,000 Hyaline casts: 0-5,000
	For nitrite testing	
	For urobilinogen detection	Due to alkaline tide
Catheterized	For bacterial culture	
	For routine screening, bacterial culture	More representative of actual urine (than random spx)
Suprapubic aspirate	Bladder urine (for bacterial culture), Cytology	Free of extraneous contamination
Three-glass collection	Prostatic infection	
		Urine volume: 30-45mL Container capacity: 60mL Temperature (within 4hrs): 32.5 – 37.7°

Color (hydration's rough estimate)	Cause
	Recent intake of fluids
Pale yellow	Dilute random spx, Polyuria (DI or DM)
Dark Yellow	Concentrated spx, Dehydration Medications: B complex vitamins, Acriflavine, Nitrofurantoin)
Orange	Bilirubin (w/ yellow foam) Medications: Phenazopyridine, Phenindione
Yellow-green	Bilirubin → Biliverdin (oxidation)
	Pseudomonas infxn
	Phenol, Indican, Clorets, Amitriptyline, Methocarbamol, Methylene blue
Pink/ Red	RBCs (hematuria: cloudy/ smoky red), hemoglobin (hemoglobinuria: clear red), myoglobin (myoglobinuria: clear red/cola-colored)
	Porphyria
Red-brown, Black	Homogentisic acid: Alkaptonuria (alkaline urine) Methemoglobin: acidic urine Melanuria: upon air exposure Phenol derivatives, Argyrol, Methyldopa, Metronidazole

_____: yellow pigment (major pigment)

_____: pink pigment (in refrigerated spx)

_____: orange-brown pigment (unfresh specimen)

URINE COLOR DETERMINATION

- ✓ Under a good light source
- ✓ Looking down through container against a _____

URINE CLARITY	
	No visible particulates, transparent
	Few particulates, print easily seen through urine
	Many particulates, print blurred through urine
	Print cannot be seen through urine
	May precipitate or be clotted

URINE CLARITY DETERMINATION

- ✓ Sample is thoroughly mixed
- ✓ Under a good light source
- ✓ View through a newspaper print

✓	✓
✓	✓
✓	✓

Clarity refers to transparency or turbidity of a urine specimen

NONPATHOLOGIC CAUSES OF TURBIDITY	PATHOLOGIC CAUSES OF TURBIDITY
Squamous epithelial cells	RBCs
Mucus	WBCs
Amorphous phosphates, carbonates, urates	Bacteria
Semen, spermatozoa	Yeast
Fecal contamination	Non squamous epithelial cells
Radiographic contrast media	Abnormal crystals
Talcum powder	Lymph fluid
Vaginal creams	Lipids

URINE ODOR	
Odor	**Cause**
Aromatic	Normal
Foul, ammonia-like	UTI
	DM, starvation, vomiting
Maple syrup	MSUD
	PKU
	Tyrosinemia
Rotting fish (galunggong)	Trimethylaminuria
	Isovaleric academia
	Methionine Malabsorption
Bleach	Contamination
Sulfur	Cystinosis/Cystinuria
	Acute Tubular Necrosis
Pungent	Ingestion of asparagus, egg & garlic
	Hawkinsinuria
	3-hydroxy-3-methylglutaric aciduria

•	Multiple carboxylase deficiency
•	Recto-vesical fistula

SPECIFIC GRAVITY MEASUREMENT		
Method		**Notes**
Indirect	**Reagent strip**	*To be discussed in the preceeding section*
	Refractometer Principle: Refractive Index	No temperature correction Temperature compensated between 15-38°C Calibration: ☻ Distilled water: _____ ☻ 3% NaCl: _____ ± 0.001 ☻ 5% NaCl: _____ ± 0.001 ☻ 9% sucrose: _____ ± 0.001
Direct	**Urinometer** Principle: Buoyancy	Less accurate Calibration temperature: ____ ☻ For every ___ above _____: add 0.001 ☻ For every ___below _____: subtract 0.001
For both Refractometer and Urinometer: ☻ Subtract _____ for each gram of Protein ☻ Subtract _____ for each gram of Glucose		
Harmonic oscillation densitometry ☻ Based on frequency of sound waves ☻ Eg. Yellow IRIS ✓ Required volume: ____ ✓ ____ = IRIS slideless microscope ✓ ____ = IRIS mass gravity meter		

- ☻ Normal urine SG: _____ (random); _____ (24-hr)
- ☻ SG < 1.010 = _____
- ☻ SG = 1.010 = _____
- ☻ SG > 1.010 = _____
- ☻ SG > 1.035 = _____

Chemical Examination

- ☻ Reagent strip should be stored in an opaque, tightly closed container
- ☻ Stored below 30°C (room temperature)
- ☻ Do not freeze
- ☻ Automated reagent strip reader principle: _____

Parameter	Reading time	Principle	Positive Color
Glucose	30 secs		Green to brown (if potassium iodide)
Bilirubin			Tan or pink to violet
Ketones	40 secs		Purple
SG	45 secs		Blue (SG 1.000) Yellow (SG 1.030)
Protein	60 secs		Blue
pH			Orange (pH 5.0) Blue (pH 9.0)
Blood			Uniform green/blue (Hgb or Mb) Speckled/spotted (intact RBCs)
Urobilinogen			Red
Nitrite			Uniform pink
Leukocytes	120 secs		Purple

Adapted from the Lecture Handouts, 12th Edition of Mr. Errol E. Coderes RMT, IMLT, MLS (ASCPi)CM

GLUCOSE

- ☻ Most frequently tested in urine
- ☻ Enzymes: glucose oxidase and peroxidase
- ☻ Sensitivity: 100 mg/dl
- ☻ False reactions
  - ✓ (+) oxidizing agents, detergents

- ✓ (-) high levels of ascorbic acid, low temp, high SG, improperly preserved spx

Clinitest/Benedict's test

- ☻ **Principle: copper reduction**
- ☻ False reactions:
  - ✓ (+) reducing agents
  - ✓ (-) oxidizing agents

✓

Clinitest procedure

- ☻ Components of tablet
  - ✓ _____ = main reacting agent
  - ✓ _____ = eliminates interfering O_2
  - ✓ _____ = heat production
- ☻ ___ gtts urine
- ☻ (+) blue to orange/red
- ☻ Pass through phenomenon (>2 g/dl sugar is present)
  - ☻ To prevent: use ___ gtts urine

BLOOD

HEMOGLOBIN VS. MYOGLOBIN		
Test	**Hemoglobin**	**Myoglobin**
Plasma examination	Red/ pink plasma	Pale yellow plasma
Blondheim's test (2.8% ammonium sulfate)	* (-) for reagent strip	* (+) for reagent strip

- ☻ False reactions
  - ✓ (+) strong oxidizing agents, bacterial peroxidases, menstrual contamination
  - ✓ (-) ascorbic acid (>25 mg/dl), unmixed specimens, high SG, crenated cells, formalin, captopril

SPECIFIC GRAVITY

- ☻ False reactions:
  - ✓ (+) High concentration of protein
  - ✓ (-) highly alkaline urine (>6.5)

Ph

- ☻ Plays a role in the identification of crystals
- ☻ Random = _____
- ☻ 1st morning = _____
- ☻ Unpreserved = _____
- ☻ Only interference: runover from adjacent (protein) pad

Acid urine	Alkaline urine
Diabetes Mellitus	Vegetarian diet
Starvation	After meal (alkaline tide)
High protein diet	Vomiting
Cranberry juice	Renal tubular acidosis

PROTEIN

- ☻ Most indicative of renal disease
- ☻ White foam when shaken
- ☻ False reactions:
  - ✓ (+) highly buffered urine, high SG, pigmented specimen
  - ✓ (-) proteins other than albumin, microalbuminuria
- ☻ **PRE-RENAL**
  - ✓ Caused by disorders that occur before it reaches the kidney
  - ✓ Eg. Intravascular hemolysis, muscle injury, severe infection & inflammation
  - ✓ _____
    - ✓ Proliferation of Ig-producing plasma cells
    - ✓ BJP = coagulates @ 40-60°C and dissolves @ 100°C
    - ✓ Test: Immunofixation electrophoresis
- ☻ **RENAL**

  a. Glomerular proteinuria – most common type of proteinuria
    - ✓ Diabetic nephropathy
      - Decreased glomerular filtration

- Indicator: microalbuminuria (_____ test)
- Normal Albumin excretion rate (AER) = 0-20 ug/min
- Microalbuminuria = _____ or _____
- Clinical albuminuria = _____

✓ Orthostatic proteinuria
- Aka Cadet or postural proteinuria
- (-) protein strip for first morning urine but positive for 2 hrs after standing sample

b. Tubular proteinuria
✓ Normally filtered albumin can no longer be reabsorbed
✓ Fanconi syndrome

- **POST-RENAL**
  - ✓ UTI
  - ✓ Injury/trauma
  - ✓ Menstrual contam
  - ✓ Prostatic fluid
  - ✓ Vaginal secretions

SULFOSALICYLIC ACID PRECIPITATION TEST – detects all forms of protein Reagent: 3ml of 3% SSA		
Grade	**Turbidity**	**Protein range (mg/dl)**
Negative	No increase in turbidity	
Trace	Noticeable turbidity	
1+	Distinct turbidity with no granulation	
2+	Turbidity with granulation with no flocculation	
3+	Turbidity with granulation and flocculation	
4+	Clumps of protein	

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KETONES

- Product of increased fat metabolism (unable to metabolize carbohydrates)
  - ✓ 78% beta hydroxybutyric acid (not detected in rgt strip)
  - ✓ 22% acetoacetic acid/diacetic acid (parent ketone)
  - ✓ 2% acetone (detected with the addition of glycine)
- False reactions:
  - ✓ (+) Highly pigmented urine, levodopa, pthalein dyes, medications wiith sulfhydryl groups
  - ✓ (-) improperly preserved specimens
- _____ tablet components
  - ✓ Sodium nitroprusside
  - ✓ Disodium phosphate
  - ✓ Glycine
  - ✓ _____ (better color differentiation)

BILIRUBIN

- Measured: _____ (water soluble/B2)
- Yellow foam
- False reactions:
  - ✓ (+) Highly pigmented urine, metabolites of iodine, indican, phenazopyridine
  - ✓ (-) exposure to light (spx), high conc. of nitrite, ascorbic acid
- Ictotest tablet components:
  - ✓ P-nitrobenzene-diazonium p-toluenesulfonate
  - ✓ SSA
  - ✓ Sodium carbonate
  - ✓ Boric acid
  - ✓ (+) blue to purple

UROBILINOGEN

- False reactions:
  - ✓ (+) Ehrlich reactive substances, pigmented urine
  - ✓ (-) old spx, high conc of nitrite, formalin-preserved urine
- _____ test
  - ✓ Urobilinogen – soluble in Chloroform and Butanol; red portions for C&B
  - ✓ Porphobilinogen – insoluble in Chloroform and Butanol; red portions for urine layer
  - ✓ Other Ehrlich-reactive substances – soluble in butanol, insoluble in chloroform; red portions in urine and butanol
- _____ test

- ✓ Rapid screening test for porphobilinogen
- ✓ Reagent: ____ Hoesch reagent (Ehrlich's rgt in 6M or 6N HCl)
- ✓ (+) red

Condition	Blood	Urine Bilirubin	Urine Urobilinogen
Extravascular hemolytic disease (pre-hepatic jaundice)	↑ UB	(-)	(+++)
Liver damage (hepatic jaundice)	↑ UB/CB	(-)/(+)	(++)
Bile duct obstruction (post-hepatic or obstructive jaundice)	↑ CB	(+++)	(-)/↓

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NITRITE

- Rapid screening test for UTI or bacteriuria
- False reactions:
  - ✓ (+) improperly preserved specimen, highly pigmented urine
  - ✓ (-) non-reductase containing bacteria, insufficient contact time between bacteria & urinary nitrate, lack of urinary nitrate, large quantities of bacteria that converts nitrite to nitrogen, antibiotics, high SG, ascorbic acid
- (+) nitrite corresponds to 100,000 organisms/ml

LEUKOCYTES

- False reactions:
  - ✓ (+) strong oxidizing agents, formalin, highly pigmented urine, nitrofurantoin
  - ✓ (-) high conc of proteins, ascorbic acid, gentamicin, cephalosporins, tetracyclines, inaccurate timing
- Strip can detect lysed WBCs
- With esterase: granulocytes, monocyte, histiocyte and Trichomonas
- Without esterase: _____

Microscopic Examination

- Urine volume requirement = _____ (avg of _____)
- Centrifuge at ____ RCF for __ mins
- Volume after decanting = _____
- Amount to be smeared on slide = ___ ul (____ ml)

MICROSCOPIC TECHNIQUE	
Bright-field	Routine UA
	Enhances visualization of translucent elements (eg. Hyaline cast)
	Identification of cholesterol in oval fat bodies, fatty casts and crystals
	Identification of T. pallidum
Fluorescence	Visualization of fluorescent microorganisms
	3-D microscopy image& layer by layer imaging of a specimen Bright-field microscopes can be adapted ● Nomarski (differential) ● Hoffman (modulation)

SEDIMENT STAINS		
Stain	**Action**	**Function**
(crystal violet + safranin O)	Delineates structure & contrasting colors of the nucleus and cytoplasm	Identifies WBCs, epithelial cells and casts
	Enhances nuclear detail; supravital stain	Differentiates WBCs and RTE Cells
	Lyses RBCs, enhances nuclei of WBCs	Distinguishes RBCs from WBCs, yeast, oil droplets and crystals
Lipid stains (Oil Red O and Sudan III)	Stains TAG and neutral fats orange-red	Identifies free fat droplets and lipid containing cells and casts
Gram stain	Differentiates gram (+) and gram (-)	Identifies bacterial casts
Hansel stain (_____ + _____)	Stains eosinophilic granules	Identifies urinary eosinophils

	Stains structures containing iron	Identifies hemosiderin granules in cells and casts
• _____ (orange)	Stains DNA	Both are used by Sysmex UF-100 Urine Cell Analyzer
• _____ (green)	Stains nuclear membranes, mitochondria and cell membranes	

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Sediments

ERYTHROCYTES

- Normal: _____
- Shadow cells – faint, colorless circles due to dissolved hemoglobin
- _____ – found in hypertonic urine; with wrinkled edges
- _____ – found in hypotonic urine; swells
- Dysmorphic RBCs – with cellular protrusions; renal glomerular bleeding
- _____ – doughnut shape cells; more specific than dysmorphic RBCs in glomerular hematuria
- Mistaken with – yeast, oil droplets and air bubbles

PUS CELLS

- Normal: _____
- _____ – increased WBCs in urine
- Neutrophils – most predominant
  - ✓ _____ – sparkling appearance due to Brownian movement
- Eosinophils – not normally present in urine; >1% is already significant
  - ✓ Drug-induced interstitial nephritis
- Lymphocytes and mononuclear cells – assoc. with renal transplant rejection

YEAST CELLS

- Small, oval, refractile with buds
- Mistaken as RBCs
- Growth is favored by an acidic, glucose containing urine
- Primarily Candida albicans – found in diabetes mellitus, immunocompromised patients and patients with vaginal moniliasis

MUCUS THREADS

- Made up of _____ protein

PARASITES

- S. haematobium, T. vaginalis (ping-pong disease), E. granulosus, W. bancrofti
- _____– most common fecal contaminant

EPITHELIAL CELLS

- _____
  - ✓ Point of reference
  - ✓ Largest cells in normal urine
  - ✓ Variation of SEC: Clue cells (Gardnerella vaginalis) – honeymoon cystitis
- Urothelial/Transitional EC
  - ✓ Commonly seen in patients with catheterization
  - ✓ _____ – can signify transitional cell carcinoma
- Renal Tubular EC
  - ✓ Product of necrosis of renal tubules
  - ✓ _____ = tubular injury
  - ✓ _____ - RTE cells with absorbed lipoproteins

BACTERIA

- Small, spherical and rod-shaped

CASTS

Order of cast degeneration: hyaline → cellular → coarsely granular → fine granular → waxy

	Wider than normal cast matrix Renal failure cast
	Highly refractile cast with jagged ends and notches Chroic renal failure cast
Hyaline cast	Colorless, homogenous matrix Congestve Heart Failure cast
Bacterial cast	Bacilli bound to matrix
RBC cast	Orange-red color matrix with embedded RBCs Blood cast: greater stasis of urine flow
WBC cast	Cast matrix that consists WBCs
	Coarse and fine granules in a matrix Muddy Gray Cast
	RTE cells attached to matrix

CRYSTALS

NORMAL CRYSTALS			
pH	**Crystal**	**Details**	**Solubility**
Acid		☻ Yellow-brown ☻ Most pleomorphic – rhombic, lemon-shaped, hexagonal, four sided ☻ Product of purine metabolism ☻ Lesch Nyhan Syndrome, Chemotherapy	Alkali
		☻ Brick dust/yellow brown precipitates ☻ Pink sediment (after refrigeration)	Alkali & heat
	Calcium oxalate	☻ _____ (_____) – oval/dumbbell; ethylene glycol poisoning	Dilute Hcl
		☻ _____ (_____) – envelope; increased intake of ascorbate rich foods	
Alkaline		☻ Granular in appearance ☻ White precipitate	Dilute acetic acid
	Calcium phosphate	☻ Aka _____ ☻ Flat plates, thin prisms in rosette forms ☻ May resemble sulfonamides	Dilute acetic acid
		☻ Prism shaped/ "coffin lid" ☻ Feathery when disintegrate	Dilute acetic acid
		☻ "thorny apples" ☻ Convert to UA crytals when added with GlAcetic acid	Acetic acid with heat
		☻ Forms effervescence after addition of acetic acid	Gas from acetic acid
ABNORMAL CRYSTALS			
Acid	Cystine	☻ Colorless, hexagonal plates ☻ Mistaken as UA crystals ☻ Cystinuria ☻ Cystinosis	Ammonia, dilute HCl
		☻ Rectangular plates with a notch in one or more corners ☻ Staircase pattern ☻ Resemble radiographic dye crystals	Chloroform
		☻ Yellow-brown spheres with concentric circles and radial striation ☻ "sofa pillow" ☻ Precipitated with tyrosine after addition of alcohol	Hot alkali or alcohol
		☻ Fine, delicate colorless to yellow needles ☻ More common than leucine	Alkali or heat
	Bilirubin	☻ Clumped needles or granules with bright yellow color	Acetic acid, Hcl, NaOH, ether, chloroform
		☻ Sheaves of wheat, petals ☻ (+) Lignin test – urine + 25% HCl → yellow color	Acetone

	Radiographic dye	● Resembles cholesterol crystals ● SG = >1.040 using Rf	10% NaOH
	Ampicillin	● Colorless needles following refrigeration	Refrigeration forms bundles

RENAL DISORDERS

GLOMERULAR DISORDERS		
Disorder	**Etiology**	**Findings**
	Deposition of immune complex, formed in conjunction with group A Streptococcus infection, on the glomerular membranes	Macroscopic hematuria Dysmorphic RBCs RBC casts Proteinuria Granular casts (+)ASO titer
Rapidly Progressive (Cresentic) Glomerulonephritis	Deposition of immune complexes from systemic immune disorders (ex. SLE) on the glomerular membrane Cellular proliferation of epithelial cells inside the Bowman's capsule form "crescents"	Macroscopic hematuria Proteinuria RBC casts
	Deposition of antiglomerular basement membrane antibody to glomerular and alveolar basement membranes	Macroscopic hematuria Proteinuria RBC casts
	Anti-neutrophilic cytoplasmic auto-antibody (ANCA) binds to neutrophils in vascular walls producing damage to small vessels in the lungs and glomerulus	Macroscopic hematuria Proteinuria RBC casts
	Occurs in children ff. viral respiratory infections Decrease in platelets disrupts vascular integrity	Macroscopic hematuria Proteinuria RBC casts
Membranous glomerulonephritis	Thickening of glomerular membrane following IgG immune complex deposition associated with systemic disorders	Macroscopic hematuria Proteinuria
Membranoproliferative glomerulonephritis	Cellular proliferation affecting the capillary walls of the glomerular basement membrane, possibly immune mediated	Hematuria Proteinuria
Chronic glomerulonephritis	Marked decrease in renal function resulting from glomerular damage precipitated by other renal disorders Progression to renal failure	Hematuria Proteinuria Glucosuria Cellular and granular casts Waxy and broad casts
	Deposition of IgA on the glomerular membrane resulting from increased levels of IgA	Early stages: hematuria Late stages: see chronic GN
	Disruption of the electric charges that produces the tightly fitting podocyte barrier resulting in massive loss of proteins and lipids	Hypoalbuminemia Proteinuria Lipiduria
	Little cellular changes in the glomerulus Disruption of podocytes primarily in children following allergic reaction & immunizations	Heavy proteinuria Transient hematuria Fat droplets
Focal Segmental Glomerulosclerosis (FSGS)	Disruption of podocytes in certin numbers and areas of glomeruli, others remain normal	Proteinuria Hematuria
	Most common cause of ESRD Deposition of glycosylated proteins on the glomerular basement membranes caused by poorly controlled blood glucose levels	Microalbuminuria (+) MIcral test
	Genetic disorder showing lamellated and thinning of glomerular basement membrane	See nephrotic syndrome

TUBULAR DISORDERS		
Disorder	**Etiology**	**Findings**
	Damage to renal tubular cells caused by ischemia or toxic agents	Microscopic hematuria Proteinuria RTE cells and casts Hyaline, granular, waxy and broad casts

	Inherited defect in the production of normal uromodulin by the renal tubules and increased uric acid causing gout Normal uromodulin is replaced by abnormal forms that destroy the RTE cells	RTE cells Hyperuricemia
	Generalized failure of tubular reabsorption in the PCT	Glucosuria Possible cysteine crystals
Diabetes insipidus	Either Neurogenic or Nephrogenic	Low SG Polyuria (>15L/day)
	Normal blood glucose, increased urine glucose Defective tubular reabsorption of glucose	Glucosuria
INTERSTITIAL DISORDERS		
• _____ (Lower UTI)	Ascending bacterial infection of the urinary bladder	WBCs, bacteria Microscopic hematuria Mild proteinuria Increased pH NO CAST
• _____ (Upper UTI)	Infection of the renal tubules and interstitium related to interference of urine flow to the bladder, reflux of urine from the bladder (vesiculoureteral reflux) & untreated cystitis	WBCs, Bacteria WBC casts Bacterial casts Microscopic hematuria Proteinuria
Chronic pyelonephritis	Recurrent infection of the renal tubules and interstitium caused by the structural abnormalities affecting the flow of urine	WBCs, Bacteria WBC casts Bacterial, granular, waxy and broad casts Hematuria Proteinuria
	Allergic inflammation of the renal interstitium in response to certain medications	Hematuria Proteinuria WBCs (↑ eosinophils) WBC casts NO BACTERIA

Adapted from the Lecture Handouts, 12th Edition of Mr. Errol E. Coderes RMT, IMLT, MLS (ASCPi)CM

Cerebrospinal fluid

CSF Production	**70% = choroid plexuses** **30% = ventricular ependymal lining of cerebral and subarachnoid spaces**
Rate of CSF production	_____ mL/min of CSF is produced _____ , 500 mL/day of CSF if produced Total CSF is replaced every _____
Total Volume	Adult: _____ Neonates: _____ ☻ Up to _____ can be collected; 3 tubes ✓ Chemistry and serology (freeze) ✓ Microbiology (room temperature) ✓ Hematology (refrigerated) ☻ If only 1 tube: _____ → _____ → _____ and _____
Collection	_____ **puncture** Ventricular puncture (used in infants with open fontanels) Cisternal puncture (collected in the sub-occipital region Lateral cervical puncture
pH	_____ (average)
SG	_____
Opening pressure	90 -180 mm H_2O
Appearance	Crystal clear

	Traumatic Tap	**Intracranial hemorrhage**
Distribution		
Formation of clot		
Supernatant		
Erythrophages		
D- dimer		

WBC **differential**	Adult: 0-5 WBCs per Ul ✓ ____% lymphocytes ✓ ____% monocytes Neonates: 0-30 WBCs per uL

	✓ Inversed; monocytes predominate	
CSF dilution	Appearance	Dilution
	Clear	
	Slightly hazy	
	Hazy	
	Slightly cloudy	
	Cloudy/Slightly bloody	
	Bloody/Turbid	
	WBC diluting fluid: 3% acetic acid with methylene blue Pleocytosis: increased number of normal cells (ABNORMAL CONDITION)	
Glucose	NV: ____% of plasma glucose (collected 2 hrs prior to spinal tap) **Increased:** due to increased plasma glucose **Decreased:** Bacterial, tubercular and fungal meningitis **Normal:** Viral meningitis	
Protein	NV: _____ (less than 1% that of plasma protein) **Increased:** Damage to BBB, Production of immunoglobulins within CNS, Decreased normal protein clearance and neural tissue degeneration **Decreased:** CSF leakage/ trauma. Recent puncture, rapid CSF production, water intoxication	
	Major protein	
	2nd most predominant	
	Protein unique to CSF	(CHO-deficient transferrin)
	Other proteins	Haptoglobin Ceruloplasmin IgG Some IgA
	Not found in normal CSF	IgM Fibrinogen Lipids
	Protein determination	Turbidimetric: ✓ 3% TCA = precipitates both alb and glob ✓ 3% SSA = precipitates alb only. (+ sodium sulfate to precipitate globulins) Dye binding: Coomassie Brilliant Blue Electrophoresis: detection of oligoclonal bands ✓ Presence of oligoclonal bands in CSF but **not** in serum: **Multiple sclerosis,** neurosyphilis, encephalitis, neoplastic disorders, Guillain-Barre Syndrome
	- Assessment of conditions that have increased IgG production within CNS NV: <0.77	
	- Assessment of blood brain barrier integrity NV: <9 Slight impairment: 9-14 Moderate impairment: 15-30 Severe impairment: >30 Complete damage: 100	
	NV: <25mg/dL **Increased:** bacterial meningitis (>35 mg/dL), tubercular and fungal meningitis (25 mg/dL) **Normal:** Viral meningitis	
	NV: 8-18 mg/Dl It is a product of ammonia and alpha-ketoglutarate. An indirect test/ indication for presence of excess ammonia in CSF **Increased:** Coma, Reye's syndrome	
Bilirubin	Negative >0/007 is indicative of subarachnoid hemorrhage	
LDH	Viral meningitis: increased LD2 and LD3 Bacterial meningitis: increased in LD4 and LD5	
CK-BB	NV: <6% of serum CK	

Adenosine deaminase	>15 U/L = suggestive of TB

Seminal fluid

Reasons for seminal fluid analysis	1. **Fertility testing** 2. **Postvasectomy semenalysis** 3. **Forensic analysis (rape cases)** 4. **Evaluation of sperm donors** 5. **Paternity cases**
Composition of seminal fluid	**TESTES AND EPIDIDYMIS** ✓ **TESTES:** main site of spermatogenesis (seminiferous tubules) ✓ _____ **(5%):** main and final site of sperm maturation ✓ _____**:** nurse cells/resident cells. Secretes **inhibin** that inhibits synthesis of FSH ✓ _____**:** secretes **testosterone**
	_____ **(60-70%)** ✓ First site where mature sperms are motile ✓ Contains fructose (for motility) and Flavin (for the grayish to pearly white color of semen)
	_____ **(20-30%)** ✓ Proteolytic enzymes secretion
	Substance / **Normal value** **Acid phosphatase** / >200 units/ejaculate **Citric acid** / >52 umol/ejaculate **Zinc** / >2.4 umol/ejaculate
	_____ **(5%)** ✓ Production of mucus-like alkali substance (to neutralize the acidity of vagina and the acids produced by prostate gland
Abstinence period	_____ days but not >7 days
Storage	Waiting for semenalysis: 37°C Artificial insemination: frozen state at -85°C Fructose level: tested within ____ hours or _____
Methods of collection	_____: BEST method of collection Coitus interruptus: withdrawal method
	Silastic condom collection: condoms with no lubricant
Volume	_____ **Increased in:** increased abstinence **Decreased in:** infertility, incomplete collection
Appearance	_____, **translucent** Infection: increased white turbidity Increased abstinence, urine contamination, medication: yellow coloration Increased RBCs, blood: Red or brown coloration
Viscosity	**Pours in droplets** __ = watery __ = gel-like
Ph	_____ Increased: infection Decreased: prostatic fluid production increased
Sperm concentration	_____ Methods: 1. Improved neubauer counting chamber ☻ Dilution: _____ ☻ Diluents (to immobilize sperm) ✓ Saline ✓ Distilled water ✓ **Tap water** ✓ Formalin sodium bicarbonate **2.** Makler counting chamber ☻ for undiluted specimen ☻ heat: for immobilization
Sperm count	_____
Motility	**>50% w/1hr** **Computer Assisted Semen Analysis (CASA)** ☻ assesses sperm cell velocity, trajectory, sperm concentration and morphology
Quality	**>2.0** **Grade** / **WHO criteria** a / Rapid, straight-line motility b / Slower speed, some lateral movement

		b	Slow forward progression, noticeable lateral movement
		c	No forward progression
		d	No movement
Morphology	Routine: >30% normal forms Kruger's strict: >14% normal forms _____**: stain of choice** Head: for ovum penetration; oval shaped (normal) ☻ Varicocele: tapered head sperm ✓ Most common cause of male infertility ✓ Hardening of veins that drain the testes Midpiece: contains mitochondria Tail: for motility		
Sperm viability (Modified Bloom's test)	Stain: _____ Living sperms: does not take up stain; _____ Dead sperms: takes up stain; _____ NV: 50% living sperms (Strastinger, 6th ed) 75% living sperms (Strasinger, 5th ed)		
Round cells (WBCs and spermatids)	_____		
Other tests	☻ _____ – for fructose; (+) orange-red color ☻ Mixed agglutination reaction – detects IgG antibodies ☻ Immunobead test – detects IgG, IgA and IgM ☻ _____ – for choline ✓ Reagents: potassium iodide & iodine crystals ✓ (+) dark brown rhombic crystals ☻ _____ – for spermine ✓ Reagents: TCA & saturated picric acid ✓ (+) yellow leaf-like crystals		
Terminologies	☻ _____ – absence of sperm cells ☻ _____ – no ejaculate ☻ Oligospermia – sperm concentration is decreased ☻ _____ – immotile or dead sperm cells		

Amniotic fluid

Purpose of amniotic fluid	**1. Fetal cushion** **2. Allows fetal movement** **3. For proper lung development** **4. Temperature stabilizer**	
Volume	NV: 800-1,200mL (3rd trimester) <800mL = oligohydramnios ☻ Increased swallowing of urine by fetus ☻ Urinary tract deformities ☻ Membrane leakage >1200mL = polyhydramnios ☻ Decreased swallowing of urine by fetus ☻ Neural tube defects	
Method of collection	Amniocentesis (up to ___mL) ☻ 14th week of gestation: ☻ 16th week of gestation: chromosomal analysis	
Appearance	Normal: colorless (may exhibit slight turbidity)	
	Blood streaked	Traumatic tap
		Meconium (1st fetal bowel movement)
	Yellow	Bilirubin
		Fetal death
Tests	HDN	_____ ☻ Measured at intervals 365 nm and 550 Nm ☻ Readings are plotted in a Liley graph ✓ _____ – non affected or mildly affected fetus ✓ _____ – fetus is moderately affected; requires close monitoring ✓ _____ – fetus is severely affected; already requires intervention (labor/intrauterine transfusion) ☻ NV: _____ (increased: HDN)

	Neural Tube Defects	_____ **&** _____ ☻ Increase: NTDs ✓ Spina bifida ✓ Anencephaly ☻ Decrease: Down syndrome ☻ ____: **major protein produced by fetal liver during gestation** ☻ AFP (in serum & amniotic): reported in terms of multiples of median (MoM) ☻ NV: _____
	Fetal lung maturity	_____ ☻ Reference method ☻ Lecithin: a primary component of surfactants for alveolar stability ☻ Sphingomyelin: serves as control on which to base an increase in lecithin ↓**surfactant conc. = collapsed alveoli = respiratory distress syndrome (RDS)** ☻ Results of: ✓ 2,0 = alveolar stability, safe for preterm delivery ✓ <1.5 = RDS
		_____ ☻ Phospahtidyl glycerol: can be detected at 35 weeks of gestation ☻ Uses antisera against PG-containing lamellar bodies ☻ Read macroscopically ☻ Results: ✓ Negative = pulmonary immaturity ✓ Low/high positive = pulmonary maturity ☻ **NOT AFFECTED BY MECONIUM OR BLOOD**
		_____ **or** _____ ☻ Screening test
		☻ Fluid is mixed with 95% EtOH, shaken for 15 secs and allowed to sit for 15 mins ✓ Result: continuous line of bubble = sufficient amount of phospholipids **Foam Stability Index** ☻ Semi-quantitative ☻ Fluid is mixed with varying amounts of 95% EtOH ☻ Result: ✓ >47 = mature lungs ✓ <47 = immature lungs
		_____ ☻ Decrease in the presence of phospholipids ☻ Principle: fluorescence polarization ☻ Results: ✓ Dye bound to albumin = high polarization ✓ Dye to bound to surfactant = low polarization
		_____ ☻ Secreted by type II pneumocytes ☻ Surfactant ☻ Principle: Optical or Impedance (similar to platelets) ☻ Diameter: 1.7 – 7.3 fL; 1-5 um ☻ Results: ✓ >50,000/uL = FLM ✓ <15,000/uL = immaturity
	Fetal age	_____ ☻ Measured by Jaffe's reaction ☻ 1.5 – 2.0 mg/dl = <36 weeks of gestation ☻ >2.0 mg/dl = > 36 weeks of gestation

Synovial fluid

Details	☻ **"joint fluid"** ☻ **Ultrafiltrate of plasma** ☻ _____**: cells lining the synovial membrane** ☻ _____**: responsible for the viscosity of synovial fluid**	
Collection	☻ _____ ☻ **During collection, avoid using** powdered EDTA, oxalate and sodium heparin **(interferes with crystal identification)** ☻ 3 tubes: ✓ 1st tube- chemical & immunological (non-anticoagulated) ✓ 2nd tube- hematology (liquid EDTA) ✓ 3rd tube- microbiology (sterile heparinized tube)	
Volume	_____ Inflammation = _____	
Appearance	Pale yellow, clear	
	Deeper yellow	Inflammation
	Red	Traumatic tap, hemorrhagic arthritis
		Bacterial infection
		Presence of crystals
	Turbidity	Presence of WBCs
Viscosity	_____ cm long string	
	_____**test** ☻ Reagent: 2-5% acetic acid	
	Solid clot	Good
	Soft clot	Fair
	Friable clot	Low
	No clot	Poor
Count	RBC	<2,000 cells/uL
	WBC	<200 cel;s/uL
	Neutrophils	<20% of differential
	Lymphocytes	<15% of differential
	Monocytes and Macrophages	65% of differential

Tests	Crystal identification	Presence of crystals in joints leads to	
			☻ Needle-shaped ☻ Parallel ☻ (-) birefringence ☻ Yellow ☻ Gout
			☻ Rhombic-shaped ☻ Perpendicular ☻ (+) birefringence ☻ Blue ☻ Pseudogout
			☻ Small particles (req. electron microscopy) ☻ No birefringence ☻ Osteoarthritis
		Cholesterol	☻ Notched, rhombic plates ☻ (-) birefringence ☻ Extracellular
		Calcium Oxalate	☻ Envelopes ☻ (-) birefringence ☻ Renal dialysis
		Corticosteroid	☻ Flat, variable-shaped plates ☻ (+) & (-) birefringence ☻ Injections
	Chemistry	☻ Glucose determination: <10mg/dl lower than blood glucose	

		✓ Inflammatory or septic disorder: markedly decrease ☻ Lactate: <250 mg/dl ☻ Total protein: <3 g/dl ☻ Uric acid: equal to blood volume
	Microbiological	☻ GS/CS ☻ Haemophilus spp. ☻ N. gonorrhoea
	Serological	☻ For the diagnosis of joint disorders ☻ Antibodies to B. burgdorferi: arthritis secondary to lyme disease
Cells and Inclusions	LE cell	Neutrophil that engulfed "round body"
		Macrophage that engulfed a neutrophil
		Neutrophil containing immune complexes
	Rice bodies	Resembles polished rice macroscopically
		"ground pepper" appearance
Classification of Joint disorders	I. Non-inflammatory	☻ Due to aging ☻ Good viscosity ☻ <1,000/uL WBC count
	IIa. Inflammatory (Immunologic)	☻ Positive for autoantibodies
	IIb. Inflammatory (Crystal-induced)	☻ Milky fluid ☻ Positive for crystals
	III. Septic	☻ Cloudy, yellow-green fluid ☻ >75% neutrophils ☻ Positive for culture and gram stain
	IV. Hemorrhagic	☻ Red fluid ☻ Positive for RBCs

Sputum, Bronchoalveolar Lavage and Sweat

SPUTUM		
Details	☻ Tracheobronchial secretions ☻ Mixture of plasma, electrolytes, mucin and water ☻ Bartlett's criteria: <10 SEC/LPF and >25 WBC/LPF	
Collection	First morning	Preferred for routine workup
	24 hour	For measurement of volume
	Sputum induction	Patients who are non-cooperative
		For debilitated patients
		Pediatric patients
	Preservation through: refrigeration or 10% formalin	
Color	Colorless or translucent	
	Red or bright red	Fresh blood or hemorrhage TB Bronchitis
	Rusty (with pus)	Lobar Pneumonia
	Rusty (without pus)	Congestive Heart Failure
	Anchovy sauce	Old blood Gangrene Pneumonia
		Infection with *Klebsiella pneumonia*
		cancer
Odor	Odorless	
Consistency		Lung edema
		Asthma Bronchitis
	Mucopurulent	TB with cavities Bronchiectasis
Macroscopic structures	Layers ☻ Top: frothy mucus ☻ Middle: opaque, water material ☻ Bottom: pus, bacteria, tissues	Bronchiectasis Gangrene Lung abscess
	Lung stones (aka Pneumoliths or broncholiths) ☻ Hard concretions (calcified)	Chronic TB Histoplasmosis (most common)
	Bronchial casts	Lobar pneumonia Diphtheria

	☻ Casts that assume a branching-tree like appearance of bronchi	Bronchitis
	• _____ ☻ Yellow or gray in color When forcibly crushed, foul odor is produced	**Bronchial asthma**
Microscopic structures	• _____ _____ ☻ Double pyramid ☻ Formed from breakdown of eosinophils	**Bronchial asthma**
	• _____ ☻ Coiled mucus strands	**Bronchial asthma**
	• _____ ☻ Columnar cells	**Bronchial asthma**
	• _____ ☻ Mistaken as *Blastomyces*	
	Heart-failure cells ☻ Hemosiderin-laden MAC	Congestive heart falure
	Carbon-laden cells ☻ Angular black granules	Heavy smokers
Microorganisms	Parasites	Larva **A**scaris **S**trongyloides **H**ookworm
		Egg P. westermani E. histolytica E. granulosus E. gingivalis T. tenax T. canis
	Fungi	C. albicans C. neoformans C. immitis B. dermatitidis A. fumigatus H, capsulatum

BRONCHOALVEOLAR LAVAGE		
Cells	Alveolar MAC	Most predominant (56-80%)
	Ciliated columnar bronchial epithelial cells	4-17%
	Lymphocytes	1-15%
	Neutrophils	<3%
	Eosinophils	<1 to 20%
SWEAT		
• _____ **Test**	For Cystic Fibrosis (aka Mucoviscidosis) ☻ Affects mucous secreting glands ☻ Increased Na+ and Cl- (inability of sweat glands to reabsorb these ions)	
Gibson and Cooke Pilocarpine Iontophoresis	☻ Mild current + pilocarpine = for sweat production ☻ Na+ (flame photometry & ISE) and Cl (manual titration) are measured ✓ Diagnostic for CF = >70 mEq/L ✓ Bordeline for CF = 40 mEq/L	

Serous fluids

- ☻ Fluids between the parietal and visceral membranes
- ☻ An ultrafiltrate of plasma
- ☻ Provides **lubrication**

- **Collected in:**

  Tubes:

  1. EDTA – cell count and differential
  2. Sterile hepain tubes – cytology and microbiology
  3. Plain/heparin tubes – chemistry

_____ – **accumulation of fluid between the membranes**		
	TRANSUDATE	**EXUDATE**
Cause	disorders that disrupt the production and regulation of fluid between membranes Eg. **congestive heart failure** nephrotic syndrome hypoproteinemia	Direct damage to membranes Eg. **I**nfection **M**alignancy **I**nflammation
Appearance		
Fluid:serum protein ratio	<0.5	>0.5
Fluid:serum LD ratio	<0.6	>0.6
WBC count	<1,000/uL	>1,000/uL
Spontaneous clotting	No	Possible
Pleural fluid cholesterol (mg/dL)	<45-60	>45-60
Pleural fluid: serum cholesterol ratio	<0.3	>0.3
Pleural fluid: bilirubin ratio	<0.6	>0.6
Serum Ascites Albumin Gradient (SAAG) **SAAG = serum albumin – peritoneal fluid albumin**	≥1.1	<1.1
Glucose	Equal to serum	Possibly low
Protein (g/dL)	•	•
Rivalta's test	•	•

Acetic acid + water + unknown fluid (+) **heavy precipitation = EXUDATE**		

PLEURAL FLUID			
Method of collection	•		
Volume	Less than ___ mL		
Appearance	Clear, pale yellow		
	Black	Aspergillosis	
	MILKY APPEARANCE		
		Chylous material	**Pseudochylous material**
	Cause	Thoracic duct leakage	Chronic inflammation
	Cholesterol crystals	•	•
	Triglycerides	>110 mg/dL	<50 mg/dL
	Sudan III staining	+++	-/weakly (+)
	BLOODY APPEARANCE		
		Hemothorax	Hemorrhagic effusion
	Distribution	Uneven	Even
	Hematocrit	**>50%** to that of whole blood	**<50%** to that of whole Blood
Tests	Glucose		Decreased: rheumatoid inflammation, purulent Infection
	Lactate		Increased in: bacterial Infection
	Triglyceride		Increased: chylous Effusion
	pH		Markedly decreased: esophageal rupture, Empyema
	Adenosine deaminase (ADA)		TB

	Amylase	Increased in: Pancreatitis
Tumor markers	CYFRA 21-1	Lung cancer Breast cancer
	CEA	Colon cancer
	CA 125	Ovarian/ metastatic uterine cancer
	CA 15-3, CA 549	Breast cancer
PERICARDIAL FLUID		
Method of collection	•	
Volume	Less than ____ mL	
Appearance	Clear, pale yellow	
	Blood-streaked	Malignancy, Infection
	Grossly bloody	Cardiac puncture, anticoagulant medications
	Milky	Chylous and pseudochylous effusions
• _____ – **buildup of blood or other fluid that puts so much pressure on the heart**		
PERITONEAL FLUID ☻ _____ **– accumulation of fluid in peritoneal cavity** ☻ **Transudates frequent cause – hepatic disorders** ☻ **Exudates frequent cause – bacterial infection and malignancy**		
Method of Collection	•	
Volume	Less than ____mL	
Appearance	Clear, pale yellow	
	Turbid	Microbial infection
	Green	Pancreatic and gallbladder disorders
	Blood-streaked	Malignancy, infection and trauma
	Milky	Lymphatic trauma and blockage
_____ – **sensitive test for detection of intra-abdominal bleeding (>100,000 RBCs/uL)**		

Tests	Alkaline phosphatase	Intestinal perforation

Gastric fluid

Components	☻ Hydrochloric acid (Pepsinogen → Pepsin) ☻ Electrolytes ☻ Mucus ☻ Enzymes ✓ _____(major) ✓ _____ ✓ _____	
Method of collection	Aspiration Patient prep: ✓ Must fast for _____ ✓ No medication for the last _____ ✓ Must not swallow excessive amount of saliva during collection ✓ Must be well-rested	
	Tube	**Details**
		Inserted through **nose** smallest diameter
		Inserted through **mouth** Metal tip
		Large diameter
		Longest tube
	Miler abbott	Mercurial tip
		Tubeless Spx: urine (+) blue
Basal Acid Output	Measures fasting levels (4) 15-30 minute specimens are collected NV: 0-6 mEq/hr	
Maximal Acid Output	Measured 1 hr after stimulation NV: 5-40 mEq/hr	
Appearance	Translucent, pale gray and slightly viscous	
	Green	Old bile
	Yellow	Fresh bile

	Red	Blood
	Ground coffee	Old blood
Volume	Fasting state – 20-50 ml After test meal – 20-80 ml Chemical stimulant – 45-150 ml	
	Test meals	**Components**
	• _____ (aka breakfast meal)	Bread, weak tea or water
	• _____ (recommended for lactic acid determination)	oatmeal
	• ____ (for achylia hypoacidity)	Beef steak and mashed potato
	Stimulants	**Details**
		Most preferred
	Histamine	With allergic effects
		Histamine without allergic effects
	Insulin	Assesses vagotomy procedure
Odor	Faintly pungent	
pH	1.6 – 1.9	
Terminologies	**Euchlorhydria**	Normal gastric activity
		Absence of free HCl
		Absence of **all** acids
	Hyperchlorhydria	Increased free HCl
	Hypochlorhydria	Decreased free HCl

Fecalysis

- ☻ Feces
  - ✓ ¾ = water
  - ✓ ¼ = bacteria, undigested food stuffs, bile pigments, cells, electrolytes and GI secretions
  - ✓ 100-200 g of stool/per day is defecated

Appearance	Brown (due to urobilin/stercobilin)	
		Upper GI bleeding, bismuth
		Lower GI bleeding
		Barium sulfate

	Frothy	Pancreatic disorders
	Rice watery	Cholera
	Pea-soup	Typhoid
	Scybalous	Constipation
	Ribbon-like	Intestinal constriction
	Increased fats in stool, (>6 g/day)	
	Screening test	Microscopic exam
	Definitive test	Fecal fat determination
	Qualitative fecal fat det.	**Quantitative fecal fat det.**
	1. Neutral fat stain (TAG) – 95% ethanol 2. Split fat stain (Fatty acids) – 36% acetic acid	Van de Kamer titration ☻ Gold standard ☻ Sample: 72 hrs stool ☻ Titration with NaOH
	Abnormal excretion of muscle fibers ☻ Px's diet should include meat ☻ Reagent: 10% Eosin ☻ Abnormal - >10 undigested muscle fibers ✓ No striations – completely digested ✓ Striations in one direction – partialy digested ✓ Striations in both directions – undigested	
Leukocytes	Invasive = ≥3 fecal leukocytes **Diarrhea with WBCs**: Salmonella, Shigella, Yersinia,EIEC and Campylobacter **Diarrhea without WBCs**: SAU, V. cholera, virus, parasites	
FOBT	Occult = "hidden" Screening test for colorectal cancer Principle: Pseudoperoxidase activity of hemoglobin Chromogen: Guaiac (preferred because least sensitive) **False (+):** aspirin (avoid for 7 days) and other NSAIDs, and oxidizers **False (-):** ascorbic acid (avoid for 3 days)	
	For differentiation of fetal blood from maternal blood Spx: infant stool/vomitus Reagent: 1% NaOH Results: ✓ Pink solution = (+) for fetal blood (alkali-resistant)	

	✓ Yellow-brown supernatant = (+) for maternal blood (denatured by NaOH)
Diarrhea	>200g/day defecation Acute = <4 weeks Chronic = > 4 weeks
	1. _____ ✓ Due to incomplete breakdown or reabsorption of food ✓ Eg. Maldigestion, malabsorption, disaccharide deficiencies (lactose intolerance), laxatives, antibiotics, antacids, amebiasis
	2. _____ ✓ Increased secretion of electrolytes and water ✓ Intestinal reabsorption capability is overridden ✓ Eg. Enterotoxin producing infections
	3. _____ ✓ Hypermotility or constipation ✓ Causes: irritable bowel syndrome, rapid gastric emptying, dumping syndrome

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