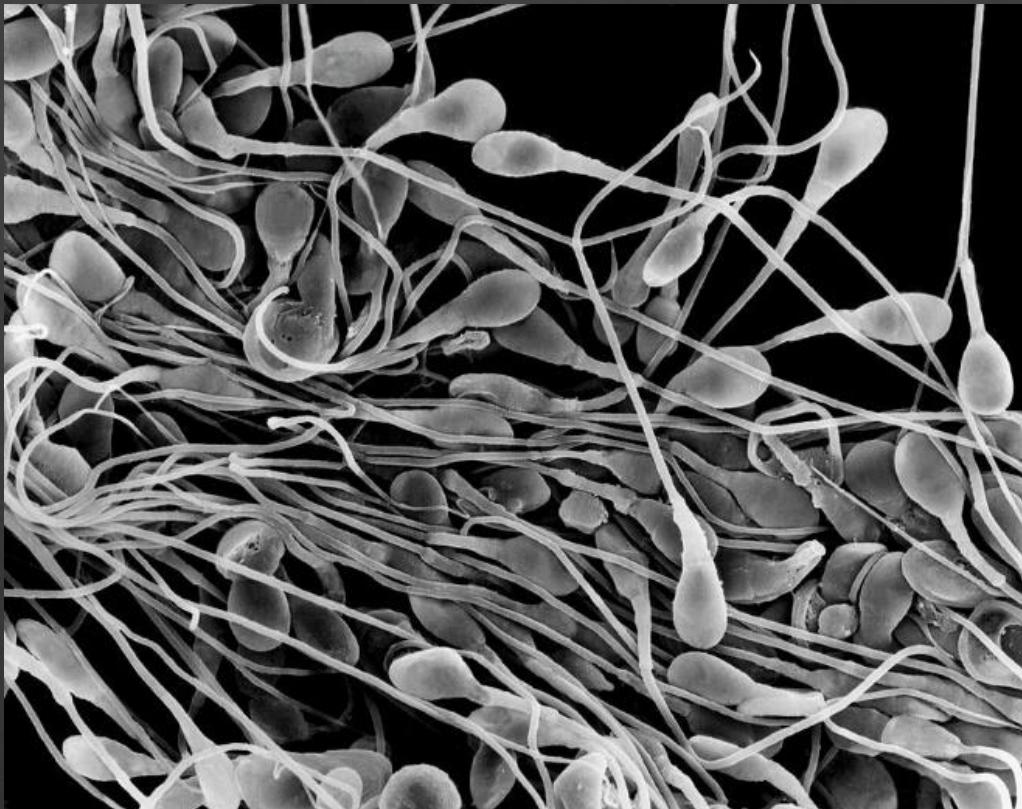


Semen, Amniotic Fluid & Fecal Analysis

Andrew Zelasco, MLS (ASCP)^{CM}

Semen Analysis

- ❖ Collection
- ❖ Gross examination
- ❖ Microscopic
- ❖ Specific testing



<https://www.sciencephoto.com/media/873678/view/human-sperm-sem>

Collection

- ❖ Collection after 2 days of sexual abstinence but no longer than 7 days
 - ❖ Prolonged abstinence – higher volume and decreased motility
- ❖ WHO – recommends 2 or 3 specimens collected not less than 7 days or more than 3 weeks apart
- ❖ If collected outside of the lab, must be delivered at room temperature within 1 hour
- ❖ Majority of sperm contained in 1st portion of ejaculation
 - ❖ 1st part missing = count decreased, pH falsely high, won't liquefy
 - ❖ Last part missing = semen volume decreased, count falsely high, pH falsely low and specimen will not clot
- ❖ Specimens awaiting analysis kept at 37 C

Gross Analysis

- ❖ Volume
- ❖ pH
- ❖ Appearance
 - ❖ Color
 - ❖ Liquefaction
 - ❖ Viscosity



Volume

- ❖ Normal = 2-5 mL
- ❖ Measured in graduated cylinder having 0.1 mL increments
- ❖ Decreased: Infertility, improper functioning of semen producing organ(s)
 - ❖ Most commonly: seminal vesicle abnormality

pH

- ❖ Normal = 7.2-8.0
 - ❖ Balance between acidic prostatic fluid and alkaline seminal vesicle fluid
- ❖ Measured within 1 hour of collection (if not loss of CO₂)
- ❖ Increased: Infection
- ❖ Decreased: Increased prostatic fluid production
- ❖ Tested on urine pH reagent strip!

Appearance

Color

- Normal: Gray-white, translucent
- Increased turbidity indicates presence of WBCs, possible infection
- Red discoloration indicates RBCs
- Yellow discoloration indicates urine contamination
 - Toxic to sperm, effects motility

Liquefaction

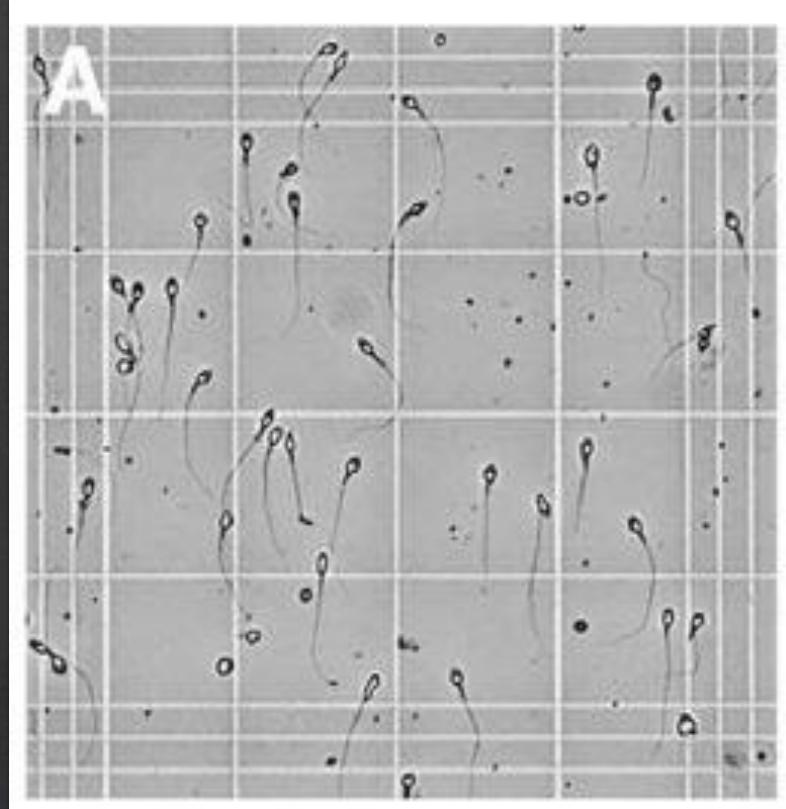
- Specimen initially clotted and should liquefy within 30-60 minutes
- Greater than 60 minutes – decreased prostatic enzymes
- Must occur before testing performed
- After 2 hours of no liquefaction, an equal volume of Dulbeccos's phosphate-buffered saline (DPBS), or other proteolytic enzymes added to specimen to induce liquefaction

Viscosity

- Should be easily drawn into a pipette and form droplets free from clumps or strings
- Threads longer than 2 cm = highly viscous
- Often rated 0 (watery) to 4 (gel-like)

Sperm Count

- ❖ Counted using a Neubauer Chamber
- ❖ Normal Range: >20 – 250 million sperm per mL (10 – 20 million is borderline)
- ❖ Total sperm count for the ejaculate =
 - ❖ Sperm Concentration x Specimen Volume
 - ❖ Dilution of 1:20 with solution containing Sodium bicarbonate and formalin
 - ❖ Immobilize and preserve the cells to count
 - ❖ Sperm concentration = multiple sperm counted by 1,000,000 (dilution and 5 small squares)
- ❖ Spermatids (immature sperm cells) not counted
 - ❖ >1 million spermatids indicates spermatogenesis disruption
- ❖ Crystal violet could be used to better differentiate



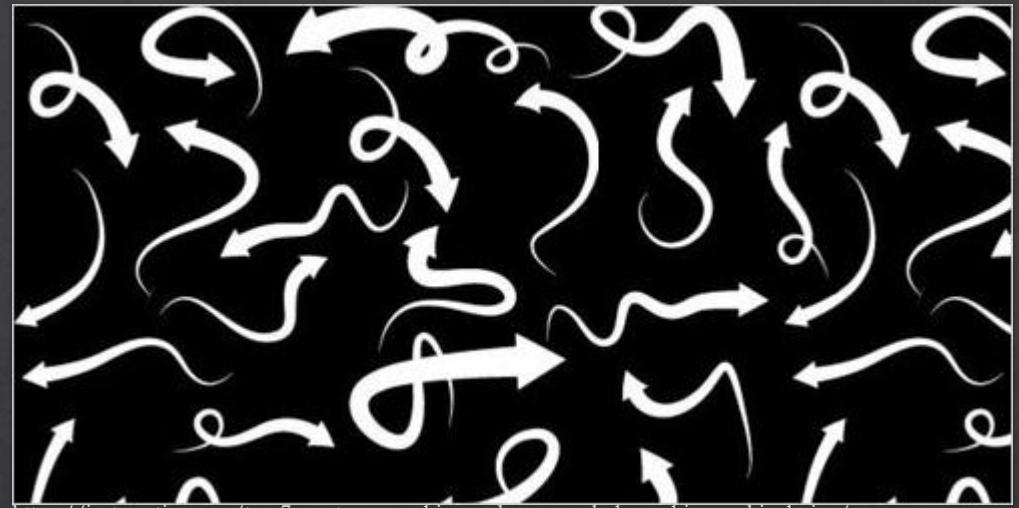
https://www.researchgate.net/publication/5412495_Evaluation_of_a_disposable_plastic_Neubauer_counting_chamber_for_semen_analysis

Sperm Motility

- ❖ Evaluated as a wet preparation on a cover slipped microscope slide
- ❖ Cells allowed to settle for 1 minute
- ❖ The % of sperm showing forward movement is estimated after evaluating ~20 fields

Grade	WHO Criteria	Description
4.0	a	Rapid, straight-line motility
3.0	b	Slower speed, some lateral movement
2.0	b	Slow forward progression, noticeable lateral movement
1.0	c	No forward progression
0	d	No movement

https://fac.ksu.edu.sa/sites/default/files/9_semen.pdf

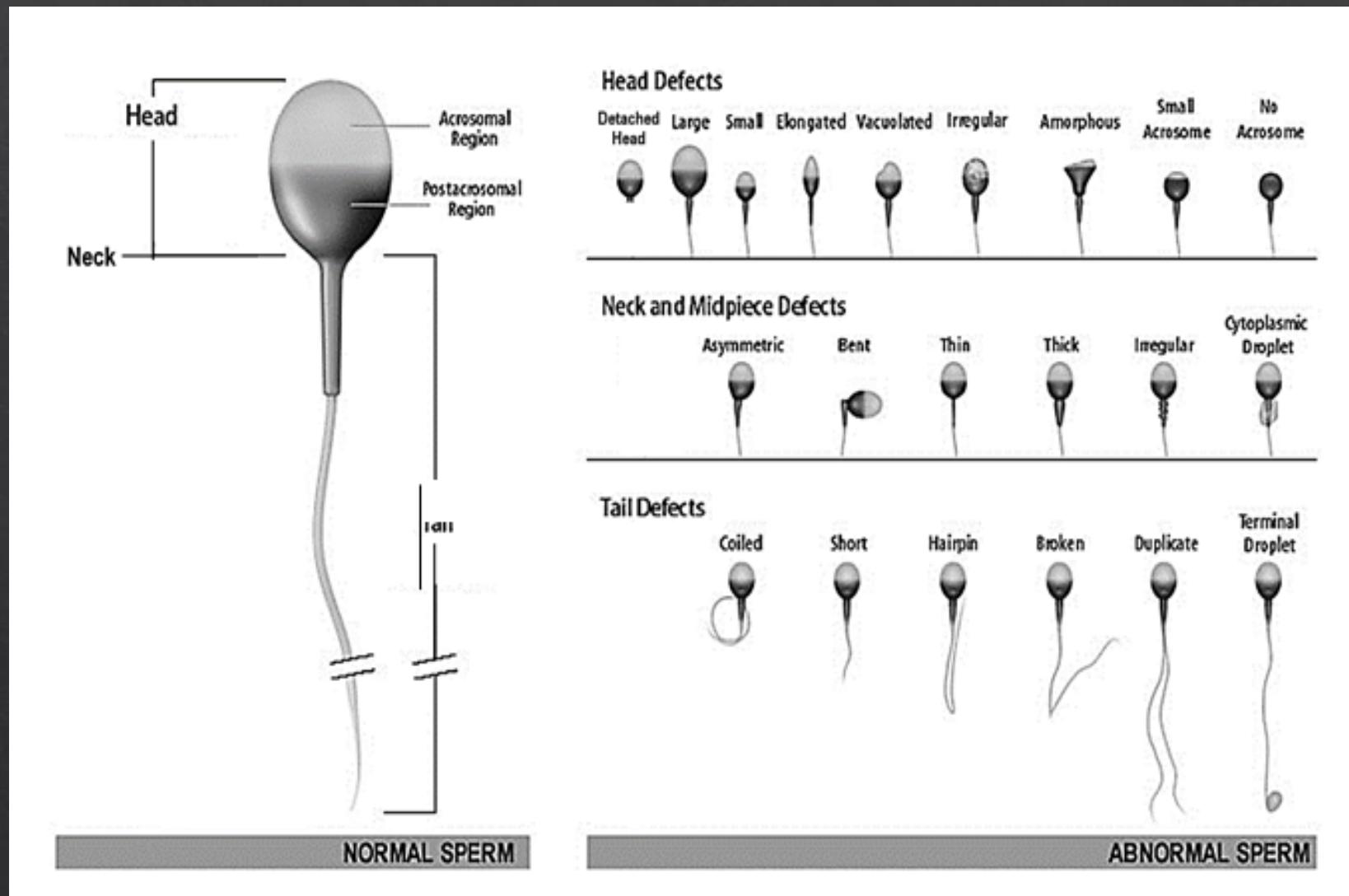


<https://justcreative.com/top-7-most-overused-icons-shapes-symbols-used-in-graphic-design/>

WHO states within 1 hour:

- 50% or more of sperm should be motile in categories a, b and c
- 25% or more should show progressive motility (a and b)

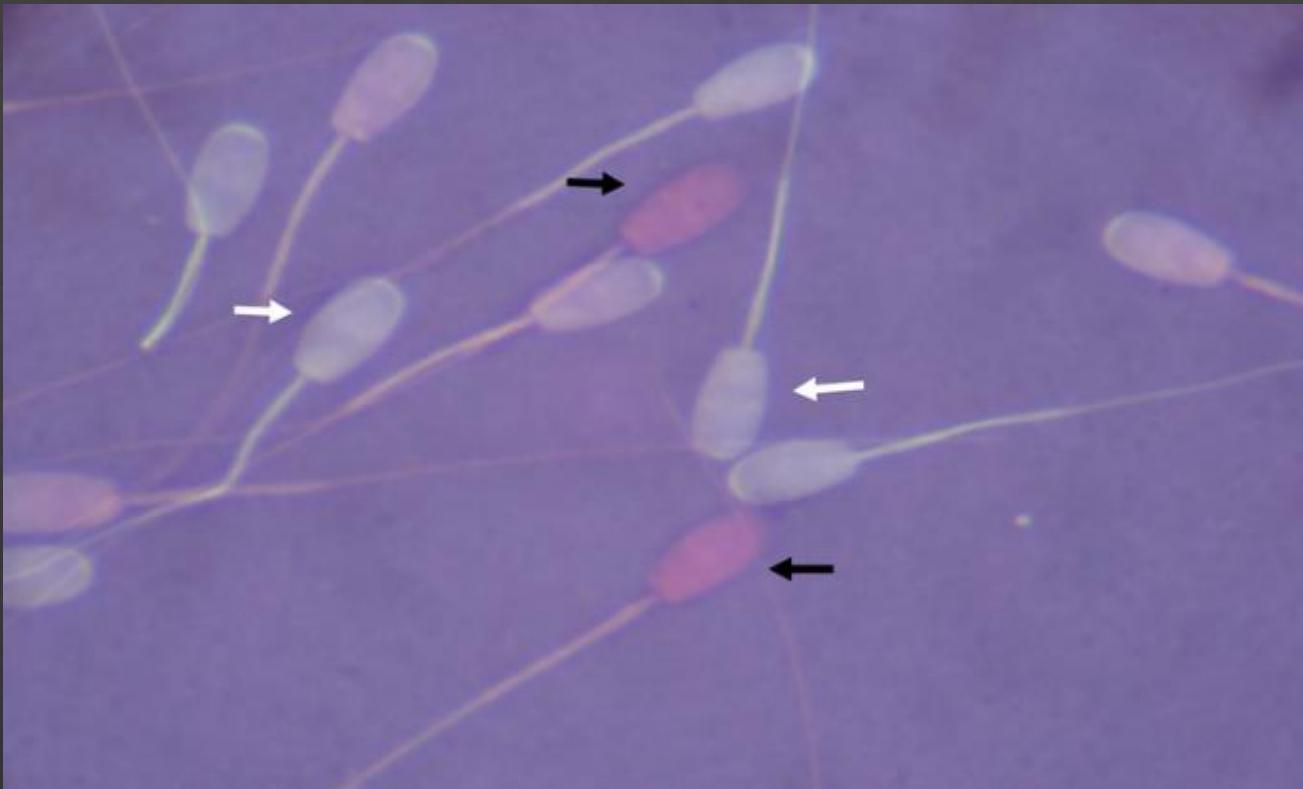
Morphology



- Wright or Papanicolaou Stain
- Normal: >30% routine criteria
> 14% strict criteria

Vitality

- ❖ Within 1 hour of collection
- ❖ Eosin-Nigrosin Stain
 - ❖ Live sperm are unstained
 - ❖ Dead sperm stain pink
- ❖ Vitality = # of dead cells in 100 sperm
 - ❖ Normal = 50% living cells

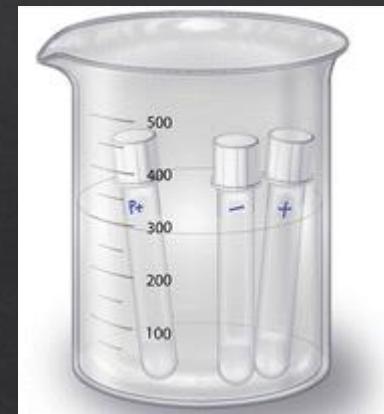


https://www.researchgate.net/figure/The-viability-of-sperm-was-evaluated-under-a-light-microscope-1000X-following_fig1_282222961

Additional Testing

❖ Fructose

- ❖ Low sperm concentration may be caused by lack of support medium which can be indicated by low or absent fructose level
- ❖ Screened using resorcinol test
 - ❖ Orange when fructose present
- ❖ Normal levels: (= or >)13 um per ejaculate (spectrophotometric method)



❖ Antisperm Antibodies

- ❖ Present in men and woman
- ❖ Blood-testes barrier normally separates sperm from male immune system
 - ❖ Can be disrupted and antigens on sperm produce an immune response in female partner that will damage sperm
 - ❖ Vasectomy, Trauma, Infection
- ❖ Suspected when clumps of sperm are present
- ❖ Testing:
 - ❖ MAR (Mixed Agglutination Reaction):
 - ❖ Detects IgG antibodies
 - ❖ Semen incubated with AHG (antihuman globulin) and a suspension of latex particles of RBCs coated with IgG
 - ❖ <10% of sperm attached to particles is normal
 - ❖ Immunobead test:
 - ❖ Detects IgG, IgM and IgA
 - ❖ Demonstrates what area of sperm is affected (head, neck-piece, mid-piece or tail)
 - ❖ Beads on <50% of sperm is normal

- ❖ Chemical Testing
 - ❖ Spectrophotometrically detected
 - ❖ Neutral alpha glucosidase – decreased in disorders of the epididymis
 - ❖ Zinc, citric acid, glutamyl transpeptidase and acid phosphatase – decreased when lack of prostatic fluid
- ❖ Legal Issues
 - ❖ Microscopically examining vaginal fluid for sperm
 - ❖ Non-motile sperm detected up to 3 days (mobile 24 hours) and heads detected up to 7 days
 - ❖ Most specific test: measuring seminal PSA (prostatic specific antigen)

Other Sperm Function Tests

- ❖ Hamster egg penetration
 - ❖ Sperm incubated with species non-specific hamster eggs and penetration observed microscopically
- ❖ Cervical mucus penetration
 - ❖ Partner's midcycle cervical mucus
- ❖ Hypo-osmotic swelling
 - ❖ Low sodium environment and monitored for membrane integrity and sperm viability
- ❖ In-vitro acrosome reaction
 - ❖ Evaluate acrosome ability to produce enzymes

Amniotic fluid

- ❖ What is amniotic fluid?
- ❖ What are the indications for amniocentesis?
- ❖ What is the appearance of amniotic fluid?
- ❖ Discussion of tests for Fetal Distress
- ❖ Discussion of tests used to determine fetal maturity
- ❖ Differentiating maternal urine from amniotic fluid



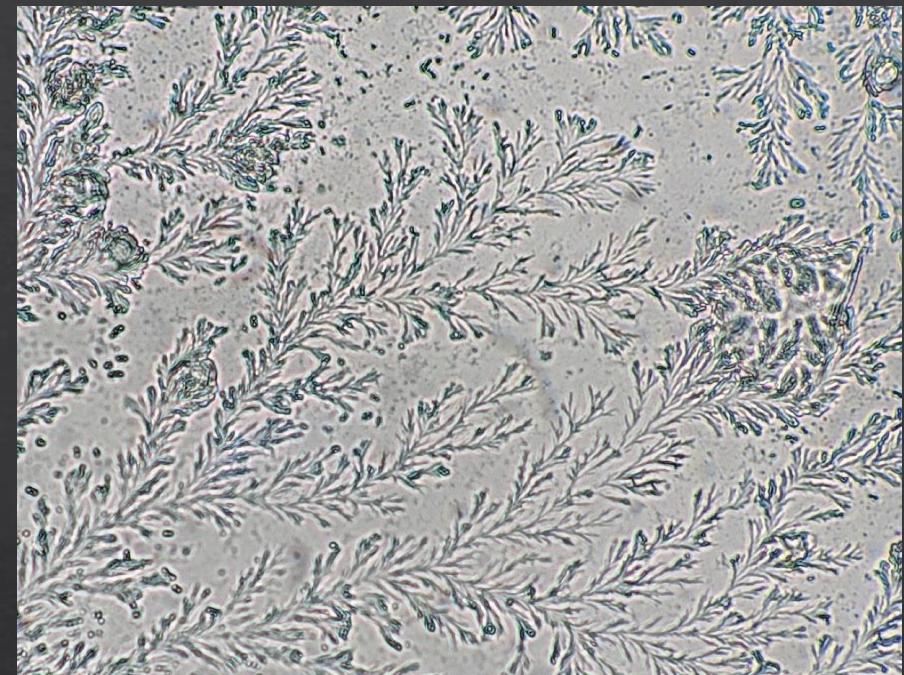
<http://www.longlonglife.org/en/uncategorized/amniotic-fluid-reverses-ageing-bones/>

What is amniotic fluid?

- ❖ Basics
 - ❖ Metabolically active fluid inside the amnion
 - ❖ Exchanges H₂O and other chemicals between fluid/fetus/maternal blood
 - ❖ Provides protective cushion for fetus and allows fetal movement
 - ❖ Stabilizes temperature and permits proper lung development
- ❖ Volume
 - ❖ Regulated balance between production of fetal urine and lung fluid and the absorption from fetal swallowing and intramembranous flow
 - ❖ Increases throughout pregnancy
 - ❖ Peaks 3rd trimester: ~ 1L (800-1200 mL)
 - ❖ <800 mL = oligohydramnios
 - ❖ >1200 mL = polyhydramnios

What is amniotic fluid? Continued...

- ❖ Placenta is the ultimate source of amniotic fluid water and solutes
- ❖ Composition changes after 1st trimester when fetal urine production begins
 - ❖ Increase:
 - ❖ Creatinine - <3.5 mg/dL (maternal urine – 10 mg/dL)
 - ❖ Urea - <30 mg/dL (maternal urine – 300 mg/dL)
 - ❖ Uric acid
 - ❖ Decrease
 - ❖ Glucose and Protein
- ❖ Fern test – presence of fern-like crystals due to protein and NaCl indicates fluid is amniotic



<https://www.sciencefriday.com/articles/cervical-mucus-health/>

Amniocentesis: When is the procedure indicated and why?

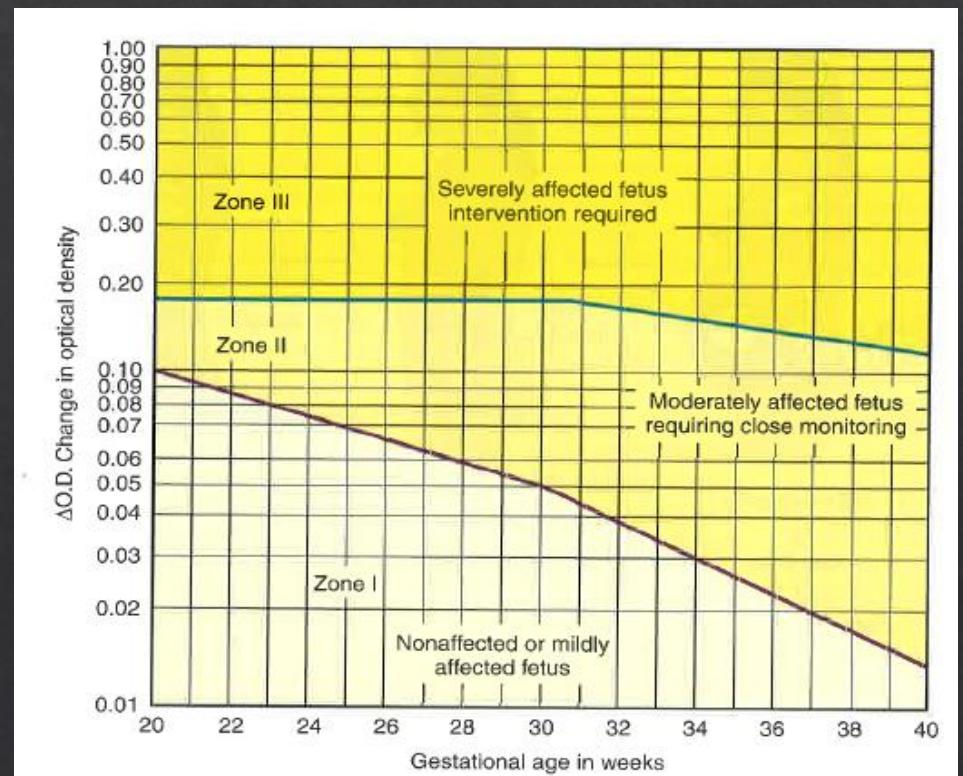
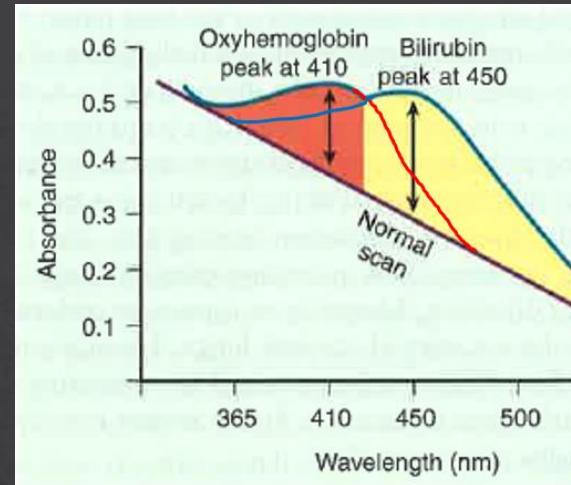
- ❖ Generally considered safe if done at 15 to 18 weeks
- ❖ Need for early treatment or early intervention
 - ❖ Genetic testing (16 weeks)
 - ❖ Mature mother (>35)
 - ❖ Past history (3 or more miscarriages)
 - ❖ Elevated alpha fetoprotein (trisomy 21)
 - ❖ Evaluation of fetus maturity (done in 3rd trimester)
 - ❖ Fetal lung maturity
 - ❖ HDN
 - ❖ Fetal distress
 - ❖ Infection



<https://www.youtube.com/watch?v=BrBZXZMGwwg>

Fetal Distress Tests: HDFN

- ❖ Hemolytic Disease of the Fetus and Newborn
 - ❖ Anti-Rh antibody production
 - ❖ RhoGam
- ❖ Testing to measure bilirubin in amniotic fluid to determine severity of anemia
 - ❖ Spectrophotometric analysis of optical density (365 – 550 nm)
 - ❖ Rise at 450 nm when bilirubin present
 - ❖ Extremely sensitive to light exposure (decreased)
 - ❖ Blood can interfere with measurement (OxyHb)
 - ❖ Liley graph (ΔA_{450})
 - ❖ Difference in OD at 450
 - ❖ Meconium can cause falsely low result

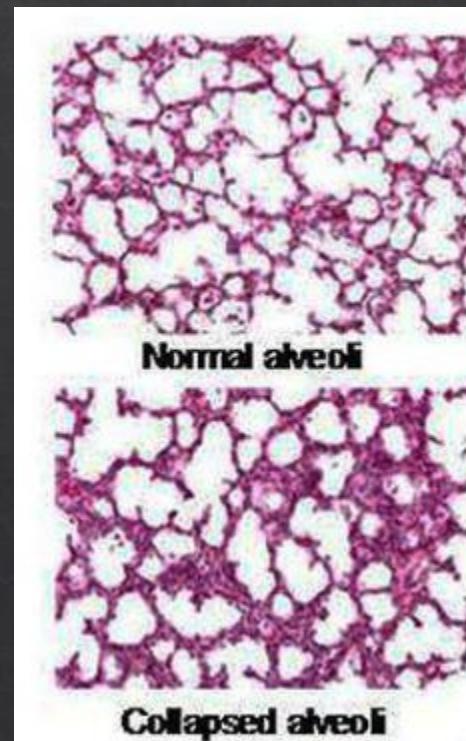
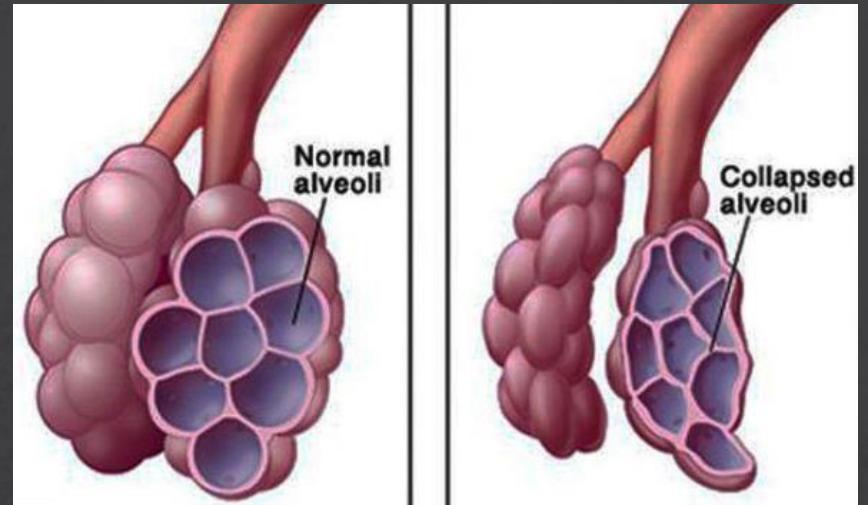


Fetal Distress Tests: NTD-Neural Tube Defects

- ❖ Increased alpha-fetoprotein (AFP) can be indicative of fetal neural tube defects
 - ❖ Can be measured in both maternal serum and amniotic fluid
 - ❖ Anencephaly
 - ❖ Spina bifida
 - ❖ AFP
 - ❖ Major protein produced by fetal liver during early gestation (prior to 18 wks, max between 12-15 wks)
 - ❖ Reported in MoM (Multiples of Median)
 - ❖ Value >2 MoM considered abnormal
 - ❖ If elevated, amniotic acetylcholinesterase (AChE) is measured
 - ❖ More specific for neural tube defects
 - ❖ (Blood contains AChE) so contamination will alter the results)

Tests for Fetal Maturity

- ◊ When considering preterm delivery
- ◊ Respiratory distress syndrome
 - ◊ Frequent complication of early delivery
 - ◊ Insufficiency of lung surfactant
- ◊ Testing used:
 - ◊ Lecithin-Sphingomyelin Ratio
 - ◊ Phosphatidyl glycerol
 - ◊ Foam Stability
 - ◊ Lamellar bodies



Lecithin/Sphingomyelin Ratio

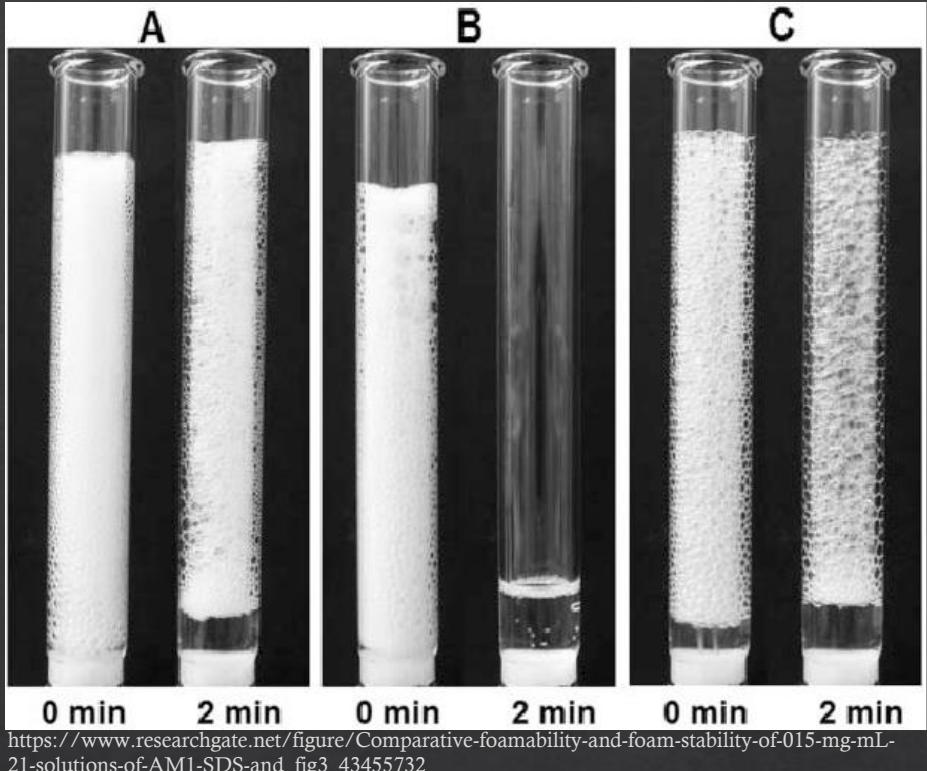
- ❖ Lecithin is the primary component of the surfactants (phospholipids, neutral lipids, and proteins)
 - ❖ Make up the alveolar lining and account for stability
 - ❖ Produced at low levels until 35 weeks gestation
- ❖ Sphingomyelin is a lipid that is produced at a constant rate after 26 weeks of gestation
- ❖ Both can be measured using TLC
- ❖ Before 35 weeks' gestation, the L/S ratio is usually less than 1.6
 - ❖ Due to large of amounts of lecithin not being produced
- ❖ After 35 weeks' gestation, lecithin concentration increases while sphingomyelin remains constant
 - ❖ L/S ratio will rise to 2.0 or higher (at this time only, preterm delivery can be considered safe)

Phosphatidyl Glycerol - PG

- ❖ Another crucial lung surface lipid
 - ❖ Parallels lecithin production (after 35 weeks) except it is delayed in cases of maternal diabetes
- ❖ Amniostat FLM
 - ❖ Immunologic agglutination test for PG (prevents the need of TLC)
 - ❖ Polyclonal anti-sera specific for phosphatidyl glycerol containing lamellar bodies in amniotic fluid
 - ❖ Lamellar bodies = layered storage granules containing surfactant
 - ❖ Negative = indicates pulmonary immaturity
 - ❖ Positive = indicates pulmonary maturity

Foam Stability Index

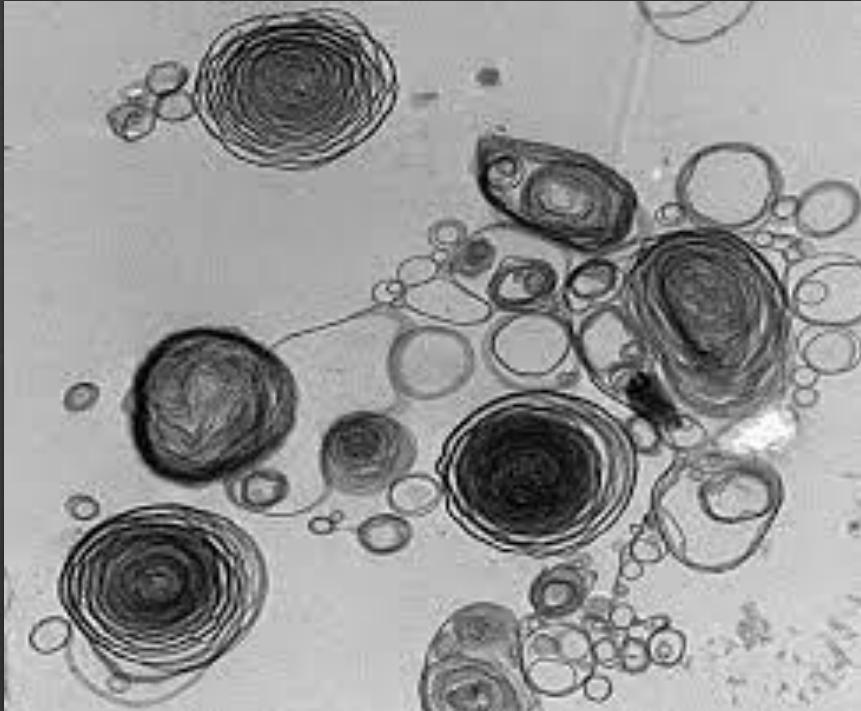
- ❖ Screening test (could be performed at the bedside)
- ❖ Measures presence of lung-surface surfactants
- ❖ Test:
 - ❖ Add 95% ethanol and shake 15 seconds
 - ❖ Sit undisturbed for 15 minutes
 - ❖ Presence of bubbles on the outside edge
 - ❖ Indicates sufficient amount of phospholipids to reduce the surface tension of the fluid allowing the bubbles to remain
 - ❖ Slightly modified procedure:
 - ❖ 0.5 mL of amniotic fluid added to increasing amounts of 95% ethanol
 - ❖ Ratio of ethanol/fluid >47 indicates fetal lung maturity
 - ❖ Falsely high with blood or meconium contamination



https://www.researchgate.net/figure/Comparative-foamability-and-foam-stability-of-015-mg-mL-21-solutions-of-AM1-SDS-and_fig3_43455732

Lamellar Bodies

- ❖ Storage granules for surfactant composed of 90% phospholipid and 10% protein
- ❖ Increase in concentration after 26 weeks gestation (50,000) to almost 200,000 per microliter by the end of the 3rd trimester
- ❖ As fetal lung matures, increased lamellar bodies production is reflected by increase in phospholipids and L/S ratio
- ❖ Presence of these lamellar bodies increases the amniotic fluid OD
 - ❖ After centrifugation an OD of 0.150 correlates with an L/S ratio of greater than or equal to 2 and the presence of PG



https://www.google.com/url?sa=i&url=https%3A%2F%2Facademic.oup.com%2Fajcp%2Farticle-pdf%2F134%2F3%2F420%2F24989415%2Fajcp134-0420.pdf&psig=AOvVaw1-hcO5F_Grf4-y-kGpk-h&ust=1622211990046000&source=images&cd=vfe&ved=0CAMQjB1qFwoTCMCuguWI6vACFQAAAAAdAAAAABAJ

❖ Lamellar Body Counts

- ❖ Similar in size to platelets (1 – 5 um)
- ❖ Can be obtained using platelet channel on automated hematology analyzers
- ❖ Depending on method used (optical/impedance) values for FLM differ
- ❖ General consensus:
 - ❖ LBC greater than 50,000/uL = FLM
 - ❖ LBC less than 15,000/uL = immature FL

Fecal Analysis

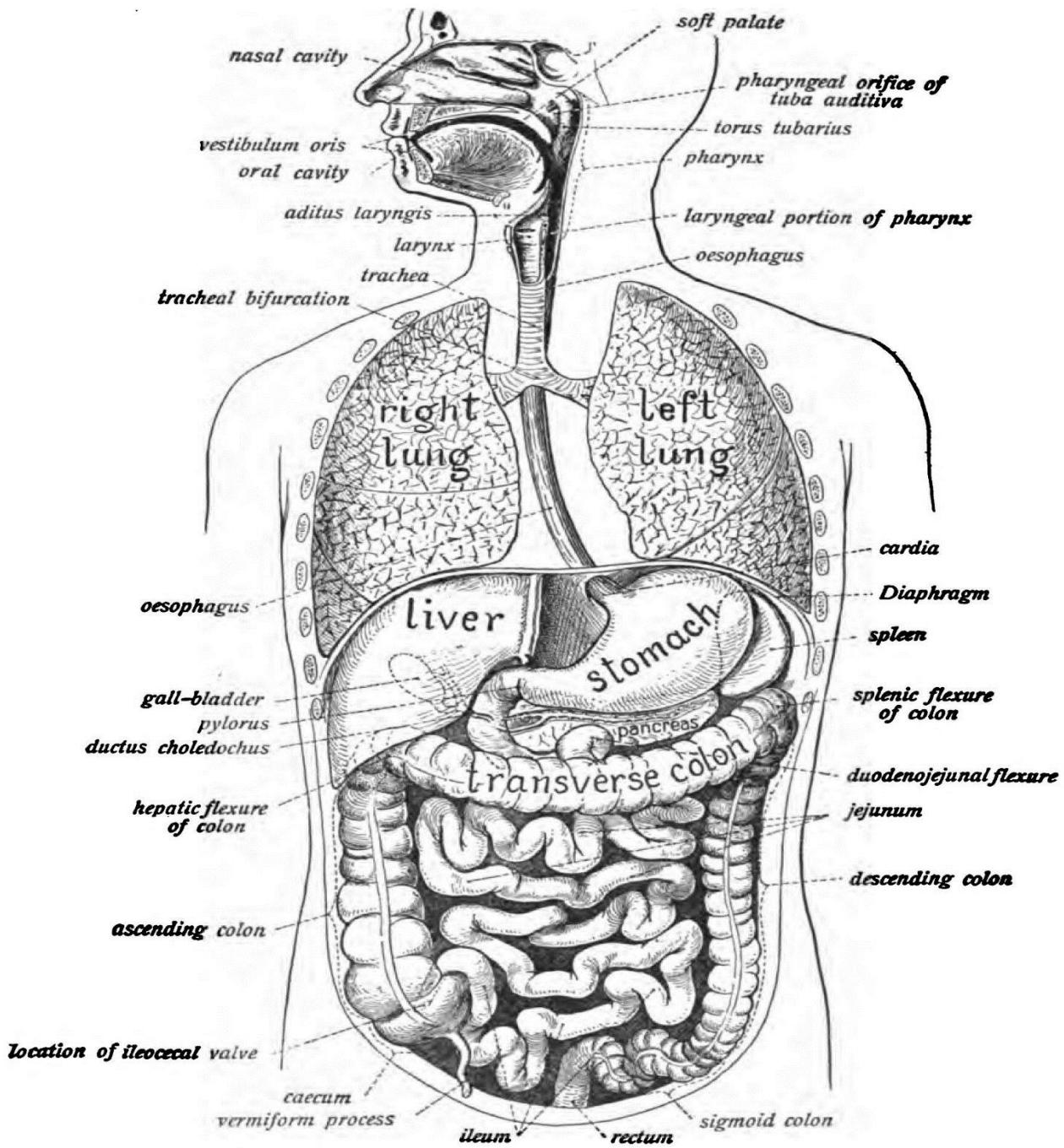
- ❖ Macroscopic, microscopic and chemical analysis
- ❖ Early detection of:
 - ❖ GI bleeding
 - ❖ Liver/biliary duct disorders
 - ❖ Maldigestion/malabsorption syndromes
 - ❖ Pancreatic diseases
 - ❖ Inflammation
 - ❖ Other causes of diarrhea and steatorrhea



https://www.reddit.com/r/funny/comments/j6fu9/stool_sample/

Physiology

- ❖ Normal fecal specimen contains:
 - ❖ Bacteria, cellulose, undigested foodstuffs, GI secretions, bile pigments, cells from the intestinal walls, electrolytes and water
 - ❖ Approximately 100 to 200 g of feces excreted in 24-hour period
 - ❖ Digestive enzymes released by the pancreas (trypsin, chymotrypsin, amino peptidase and lipase) – secreted into small intestine, the primary site for final breakdown of proteins, carbs and fats
 - ❖ Large intestine can absorb approximately 3,000 mL of water
 - ❖ >3,000 mL of water = diarrhea
 - ❖ <3,000 mL of water = constipation



Diarrhea

- ❖ >200 g of stool weight a day, increased liquidity of stools and >3 movements a day
- ❖ >4 weeks is chronic and <4 weeks is acute
- ❖ Measure by fecal electrolytes (Na an K), Osmolality and Fecal pH
- ❖ Normal Stool:
 - ❖ pH: between 7-8
 - ❖ Osmolality: 290 mOsm/kg
 - ❖ Fecal Na: 30 mmol/L
 - ❖ Fecal K: 75 mmol/L
 - ❖ Osmotic Gap = $290 - [2(\text{fecal Na} + \text{fecal K})]$



Diarrhea Continued...

Osmotic

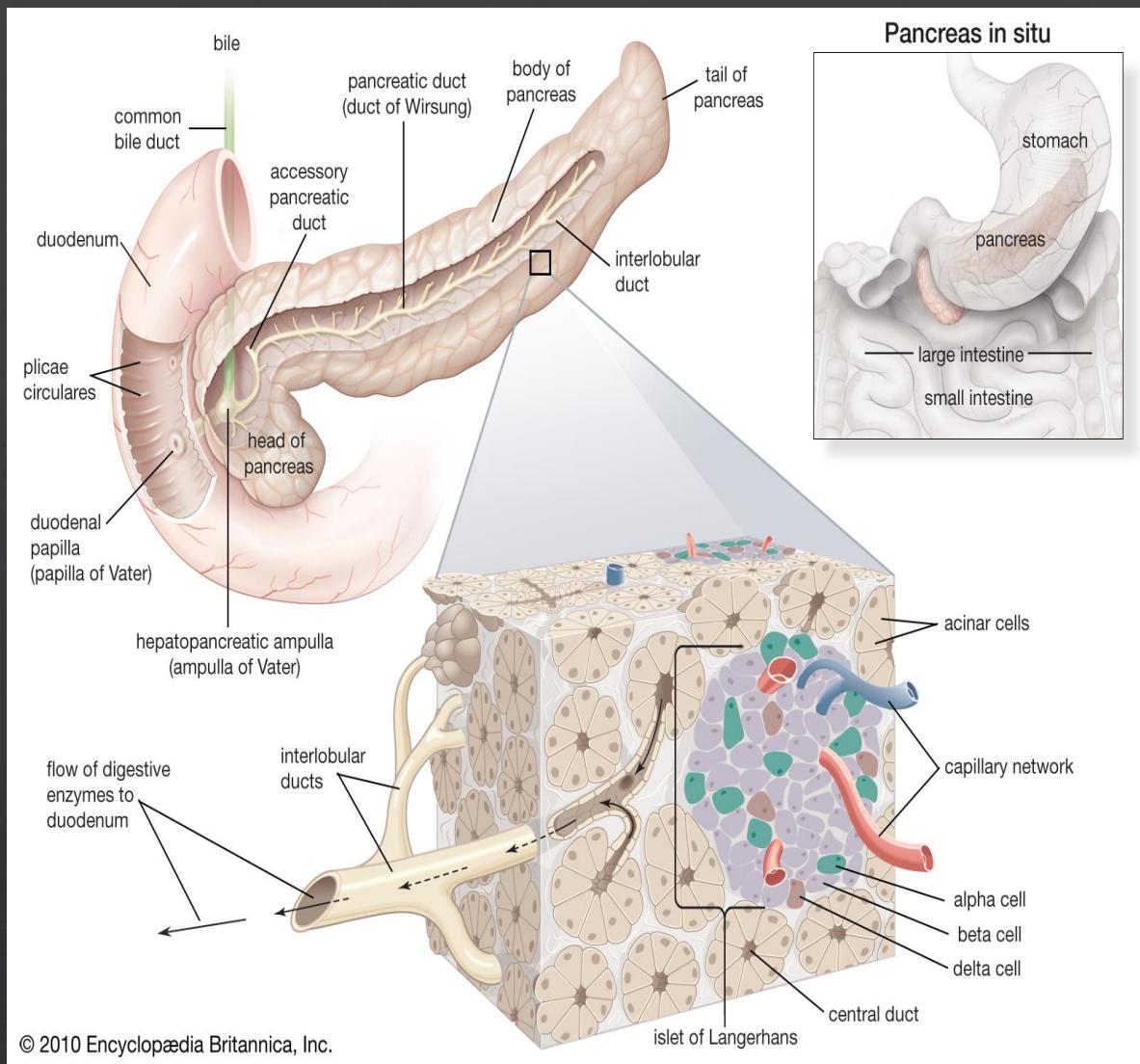
- ❖ Poor absorption exerting osmotic pressure across intestinal mucosa
- ❖ Water and electrolyte retention in large intestine = watery stools
- ❖ Maldigestion and Malabsorption
 - ❖ Osmotic Gap = >50 Osm/kg
 - ❖ Na = <60 mmol/L
 - ❖ pH = <5.3
 - ❖ Stool Output in 24 hours = <200 g

Secretory

- ❖ Increased secretion of water
- ❖ Bacterial, viral and protozoan infections
 - ❖ Enterotoxin-producing organisms:
 - ❖ E.coli O157, Shigella, Vibrio cholera ...
- ❖ Other causes: drugs, laxatives, hormones, IBS (Crohns, Ulcerative Colitis, Diverticulitis), endocrine disorders (Zollinger-Ellison syndrome)
 - ❖ Osmotic Gap = <50 Osm/kg
 - ❖ Na = >90 mmol/L
 - ❖ pH = >5.6
 - ❖ Stool Output in 24 hours = >200 g

Steatorrhea

- ◊ Fecal fat – important to detect when diagnosing pancreatic insufficiencies and small bowel disorders that cause malabsorption
- ◊ Absence of bile salts that assist pancreatic lipase in breakdown and subsequent reabsorption of dietary fat produces an increase in stool fat = > 6g per day
- ◊ Pancreatic disorders: cystic fibrosis, chronic pancreatitis, and carcinoma can decrease production of pancreatic enzyme and cause steatorrhea



Stool Collection

- ❖ Sample collection:
 - ❖ Clean container – transferred to provided lab container depending on specific testing
 - ❖ Avoid contamination with urine or toilet water
 - ❖ Qualitative testing: (blood or certain microscopic observations)
 - ❖ Plastic or glass screw top container
 - ❖ Quantitative testing: (fecal fats)
 - ❖ Timed specimen usually required
 - ❖ (Fecal fats) most representative sample is 3-day collection

Macroscopic Screening

- ❖ Brown Color – from intestinal oxidation of stercobilinogen to urobilin
- ❖ Pale stools – acholic stools – signify blockage of bile duct or barium sulfate
- ❖ Green stools – oral antibiotics or increased green veggies
- ❖ Bloody stools:
 - ❖ Bright Red = bleed in lower GI, beets
 - ❖ Black = upper GI bleed, charcoal or bismuth
- ❖ Watery – Diarrhea
- ❖ Small, hard – constipation
- ❖ Slender, ribbon-like – obstruction
- ❖ Bulky/frothy – biliary obstruction and steatorrhea
- ❖ Mucus-coated – inflammation or irritation

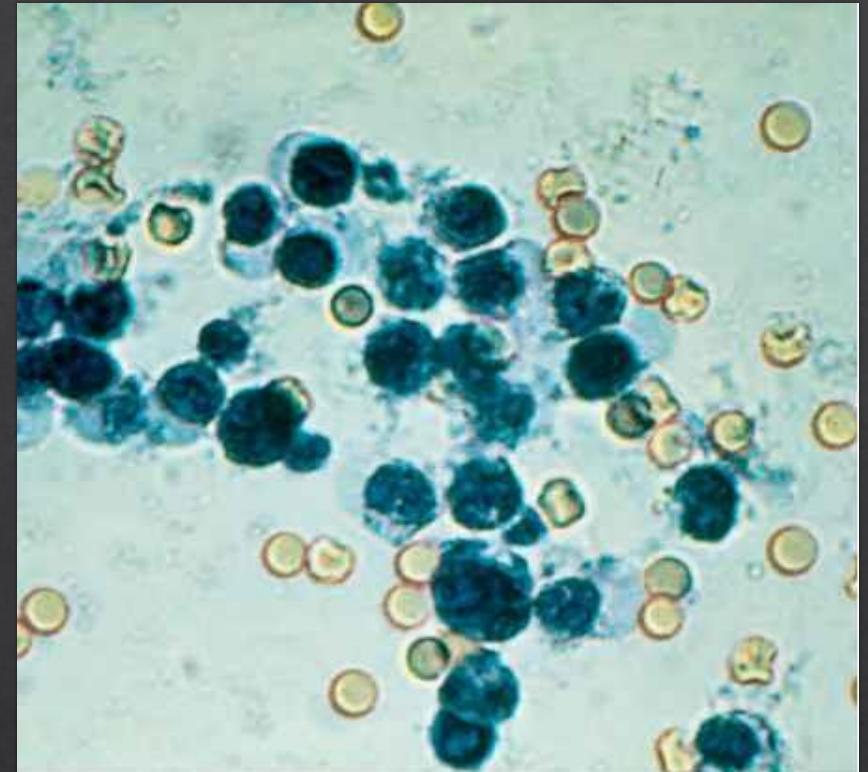
Bristol Stool Chart		
Type 1		Separate hard lumps, like nuts (hard to pass)
Type 2		Sausage-shaped but lumpy
Type 3		Like a sausage but with cracks on its surface
Type 4		Like a sausage or snake, smooth and soft
Type 5		Soft blobs with clear-cut edges (passed easily)
Type 6		Fluffy pieces with ragged edges, a mushy stool
Type 7		Watery, no solid pieces. Entirely Liquid

Microscopic Evaluation

- ❖ Leukocytes
- ❖ Undigested muscle fiber
- ❖ Fecal Fats

Leukocytes

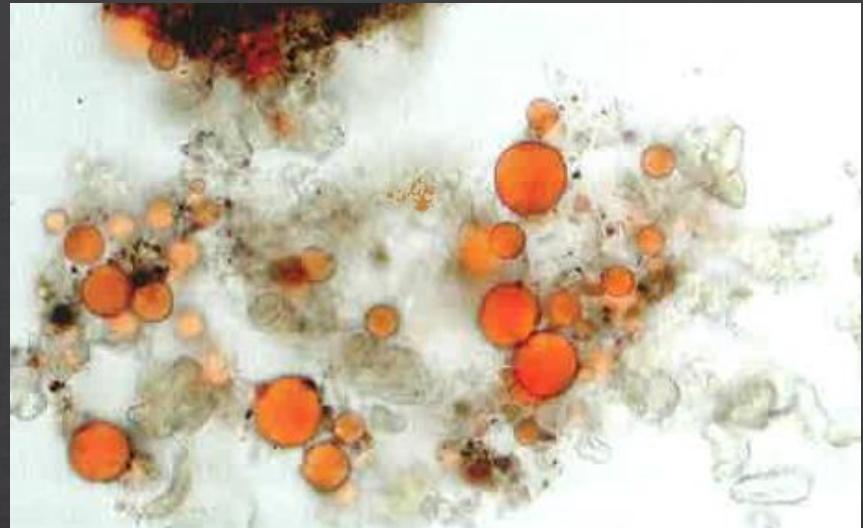
- ❖ Primarily neutrophils
 - ❖ Seen in conditions affecting intestinal mucosa
- ❖ Bacteria causing diarrhea by toxin production DO NOT cause leukocytes
- ❖ WBCs examined as wet prep stained with methylene blue or dried smears using gram stain
 - ❖ High power scope – few as 3 neutrophils per field = invasive condition
 - ❖ Oil immersion – any neutrophils = invasive condition
- ❖ Lactoferrin latex agglutination is available for detecting leukocytes and remains sensitive for frozen and refrigerated specimens



Source: Knoop KJ, Stack LB, Storrow AB, Thurman RJ: *The Atlas of Emergency Medicine*, 3rd Edition: <http://www.accessmedicine.com>

Fecal Fats

- ❖ Qualitative
- ❖ Lipids included in microscopic exam of feces are:
 - ❖ Neutral fats (triglycerides)- stained by Sudan III
 - ❖ More than 60 droplets/high power field = steatorrhea
 - ❖ Can use a split fat stain for better indication
 - ❖ Fatty acid salts (soaps) – do not stain with Sudan III
 - ❖ Second slide must then be examined after specimen mixed with acetic acid/heated
 - ❖ Size of droplets important as well
 - ❖ High number (over 100 droplets) and larger size = steatorrhea
 - ❖ Cholesterol – stained by Sudan III after heating, as specimen cools crystals form
- ❖ Increased neutral fat on first slide = maldigestion
- ❖ Increased amount of total fat on split fat stain (second slide) with normal fat on first slide = malabsorption

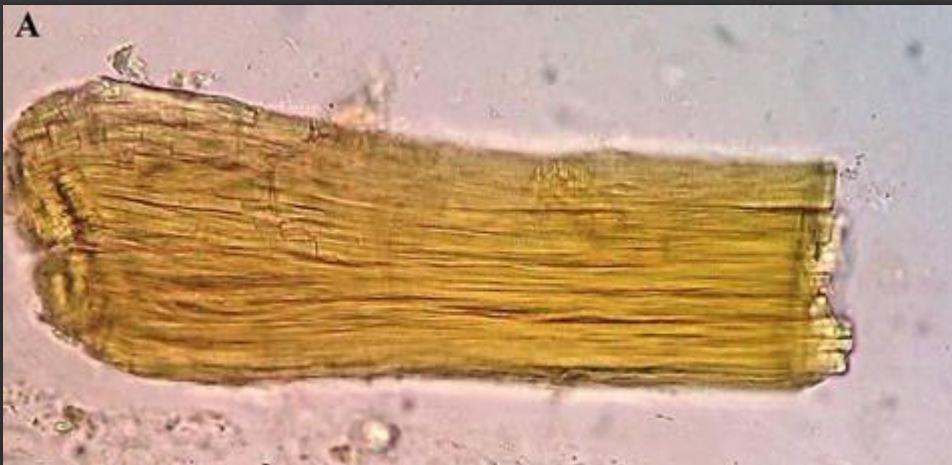


Courtesy of Urinalysis and Body Fluids, 7th Edition

Muscle Fibers

- ❖ Undigested muscle fibers – patients with pancreatic insufficiency (cystic fibrosis)
- ❖ Detected by prepared emulsion with 10% alcoholic eosin (enhance striations)
 - ❖ Examined for exactly 5 minutes (only digested striations counted)

- ❖ Undigested fibers – vertical and horizontal striations
- ❖ Partially digested fibers – striations in one direction
- ❖ Digested fibers – no visible striations



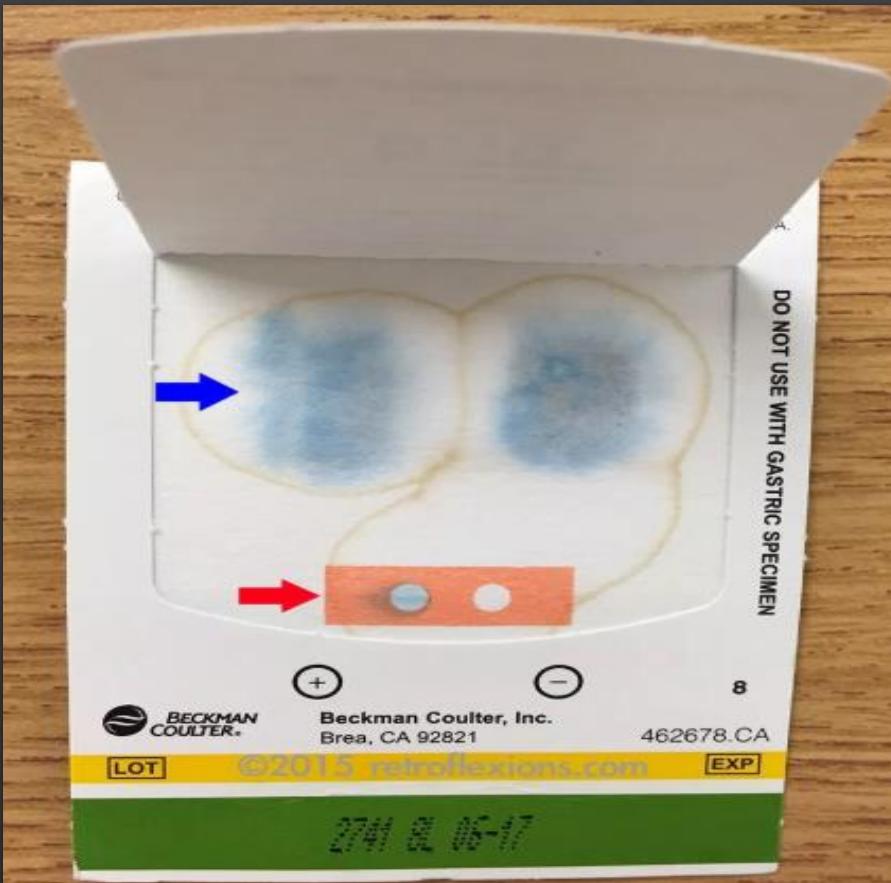
<https://docplayer.es/31845086-Fibras-musculares-y-granos-de-almidon-sin-digerir-en-las-heces-de-un-paciente-diabetico-con-diarrea.html>



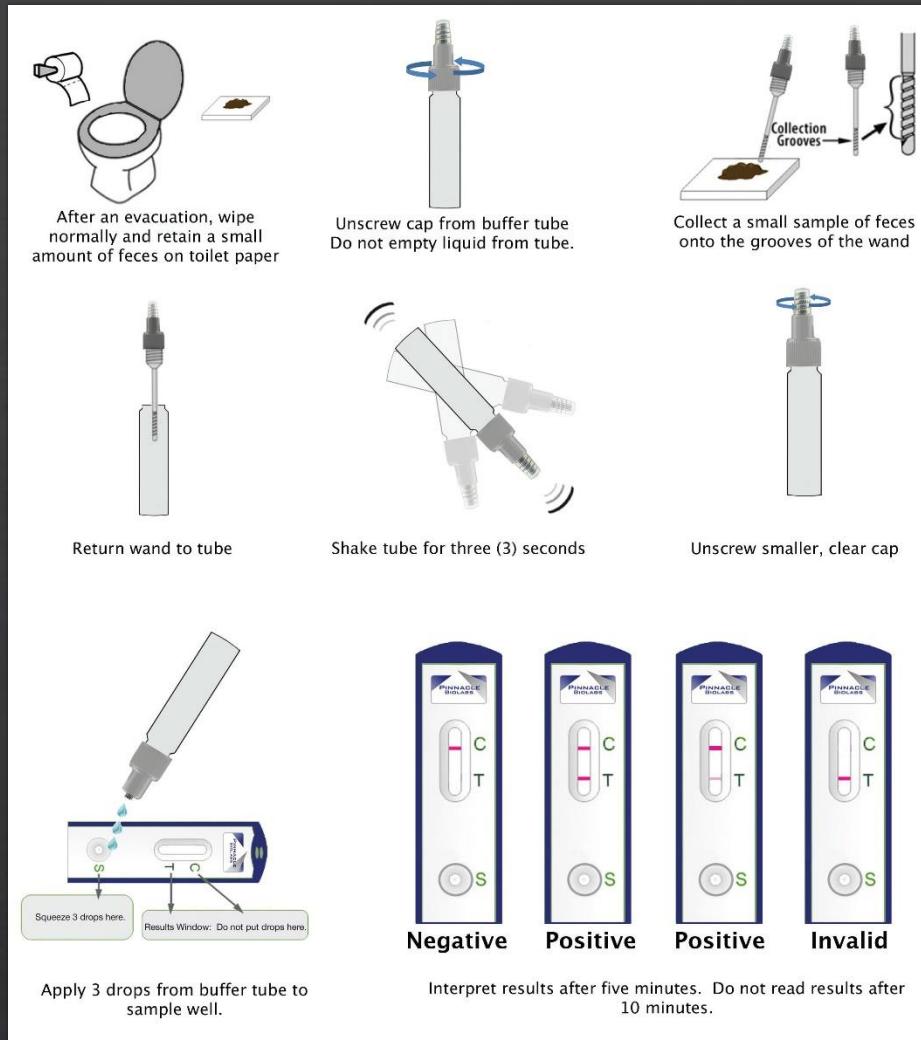
<https://www.tuyenlab.net/2018/03/microbiology-atlas-of-fecal-analysis.html>

Fecal Chemical Testing

- ❖ Occult Blood
 - ❖ Bleeding in excess of 2.5mL/150g of stool is considered pathologically significant
 - ❖ (may not be visible) – (hidden = occult)
 - ❖ FOBT = fecal occult blood testing – high predictive value for colorectal cancer
- 1) Guaiac –Based Fecal Occult Blood Test (gFOBT)
- ❖ Same as reagent urinary strip with different indicator
 - ❖ Measures pseudoperoxidase activity of hemoglobin
 - ❖ 3 consecutive day sample tested within 6 days
 - ❖ Should avoid meat/veggies/NSAIDS and Vitamin C before collection
 - ❖ Meat/veggies – dietary pseudoperoxidase
 - ❖ NSAIDs – intestinal irritation
 - ❖ Vit. C – strong reducing agent
 - ❖ -Guaiac is least sensitive reagent (small amount of blood can be normal)
- 2) Immunochemical Fecal Occult Blood Test (iFOBT)
- ❖ Specific for globin portion of human Hb
 - ❖ Uses polyclonal anti-human Hb antibodies
 - ❖ No dietary or drug restrictions
 - ❖ Hb from upper GI bleed broken down by bacteria – immunochemically inactive
- ❖ Porphyrin-Based Fecal Occult Blood Test
- ❖ Fluorometric test measuring conversion of heme to fluorescent porphyrins
 - ❖ More sensitive to upper GI bleed
 - ❖ Avoid red meat for 3 days



<https://retroflexions.com/endoscopy/occult-gastrointestinal-bleeding-and-the-stool-guaiac-test/>



<https://www.pblabs.com/pages/what-is-a-fecal-immunochemical-test>

Additional Testing

- ❖ Quantitative Fecal Fat Testing
 - ❖ 3 day specimen with regulated fat intake
 - ❖ Primary method is Van de Kamer titration (gold standard)
 - ❖ More rapid test is hydrogen nuclear magnetic resonance spectroscopy (^1H NMR) or Near-infrared reflectance spectroscopy (NIRS)
- ❖ APT Test (Fetal Hemoglobin)
 - ❖ Grossly bloody stools or vomitus seen in neonates
 - ❖ Material to be tested is emulsified in water to release Hb and after centrifugation, 1% sodium hydroxide added to the pink Hb supernatant
 - ❖ Presence of alkali-resistant fetal Hb - solution remains pink
 - ❖ Denaturation of maternal hemoglobin (Hb A) produces a yellow-brown color
- ❖ Fecal Enzymes
 - ❖ Proteolytic enzymes produced by pancreas include trypsin, chymotrypsin and elastase I
 - ❖ Measured by spectrophotometric methods (chymotrypsin), immunoassay (elastase I)
- ❖ Carbohydrates
 - ❖ Presence of increased carbs = osmotic diarrhea from osmotic pressure of unabsorbed sugar in intestine drawing in fluid and electrolytes
 - ❖ Increased carbohydrate – detected by serum/urine tests but also copper reduction test

References

- ❖ Urinalysis and Body Fluids, 7th Edition, Susan King Strasinger and Marjorie Schaub Di Lorenzo