MEDLAB BASICS · STUDY SHEET

Body Fluids

CSF, serous, synovial, semen, amniotic fluid, feces and BAL: tubes, appearance, counts, chemistry, crystals, patterns and safety

39 sources + more detail
medlabbasics.com/sheets/lab-body-fluids.html
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1 Cerebrospinal fluid: collection and normal values

- Collected by lumbar puncture (also shunts and reservoirs) into numbered sterile tubes. A common three-tube protocol: tube 1 chemistry and immunology, tube 2 microbiology, tube 3 cell count. With four tubes, tube 1 is often held in reserve and tube 4 gets the cell count. Principle: the last tube has the least blood and debris from the puncture, so it gives the truest count. Follow your laboratory's protocol.
- Count cells promptly: in one study of drain CSF, manual counts had already fallen measurably by 1.5-2.5 hours.
- Draw a blood glucose with the tap so the CSF:blood glucose ratio can be calculated.
- Opening pressure: 60-250 mm H2O from age 8 (10-100 mm H2O in younger children).

ASCP BOC composite ranges (June 9, 2026 guidelines); for exam use, not for clinical use. The MLT list has only the CSF WBC and RBC range

TEST	ASCP EXAM RANGE (ADULT)	NOTES
WBC and RBC	0-5/µL (0-5 × 10^6/L)	Newborns up to about 20 WBC/µL. Normal cells are mostly lymphocytes and monocytes (about 70:30)
Glucose	50-80 mg/dL (2.8-4.4 mmol/L)	About 60% of blood glucose (adult CSF:serum ratio about 0.44-0.90)
Protein	15-45 mg/dL (150-450 mg/L)	Newborns up to 150 mg/dL (1.5 g/L). Other references use slightly different upper limits
Appearance	Clear, colorless	Cloudy: cells, organisms or protein. Pink to orange to yellow: blood and its breakdown

2 Traumatic tap or hemorrhage?

FINDING	TRAUMATIC TAP	SUBARACHNOID HEMORRHAGE
RBC count tube 1 to last tube	Falls from first to last tube	Stays about the same in every tube
Supernatant after centrifuging	Clear (unless more than about 100,000 RBC/µL)	Xanthochromic (pink-orange to yellow) once the bleed is hours old
Timing	At the moment of the tap	Xanthochromia appears over hours, is present in about 90% by 12 hours and lasts up to about 2 weeks

- Other causes of xanthochromia: serum bilirubin of about 10-15 mg/dL (171-257 µmol/L) or more (common in newborns), CSF protein of 150 mg/dL (1.5 g/L) or more, more than 100,000 RBC/µL, and heavy carotenoid intake.
- Correcting the WBC for added blood: predicted WBC = CSF RBC × (blood WBC ÷ blood RBC); subtract it from the observed CSF WBC. Rule of thumb: about 1 WBC per 500-1,000 RBC/µL when the blood count is normal.
- Correcting protein: subtract about 1 mg/dL for every 1,000 RBC/µL, using the same tube for protein and cell count.

EXAM TIP Exam pattern: equal RBC counts in tubes 1 to 4 plus a yellow supernatant means bleeding into the CSF before the tap. A count that falls tube by tube with a clear supernatant means the needle caused it.

3 Meningitis patterns

Typical values; individual patients overlap

CAUSE	WBC/ML AND MAIN CELL	GLUCOSE	PROTEIN	OTHER CLUES
Bacterial	Usually 1,000-5,000; neutrophils 80-90%	Low: under 40 mg/dL (2.2 mmol/L) in half or more; CSF:blood ratio under 0.5; ratio under 0.23 or glucose 18 mg/dL (1.0 mmol/L) or less strongly suggests bacteria	Elevated, often 100-500 mg/dL (1.0-5.0 g/L)	Opening pressure high; lactate above 35.1 mg/dL (3.9 mmol/L) if tapped before antibiotics; Gram stain and culture
Viral	Usually 100-1,000; lymphocytes (neutrophils can lead in the first 24-48 h)	Usually normal	Normal to mildly raised	Lactate low; PCR panels
Fungal (e.g., Cryptococcus)	Raised, up to several hundred; lymphocytes; count can be normal in advanced HIV	Low	Often 50-250 mg/dL (0.5-2.5 g/L)	Cryptococcal antigen (lateral flow, latex, EIA), India ink; opening pressure often high (serial taps may be needed to lower it)
Tuberculous	Usually 5-300; mixed early, then lymphocytes	Low (median about 40 mg/dL; lower when advanced)	Usually 100-200 mg/dL (1.0-2.0 g/L)	AFB stain, culture, NAAT (PCR sensitivity only about 56%); adenosine deaminase raised

SAFETY Suspected bacterial meningitis is an emergency. CSF lactate is reliable only when the tap precedes antibiotics, and a minority of bacterial cases show mostly lymphocytes, so no single value rules bacteria out: read the whole pattern with the Gram stain and culture.

4 Serous fluids: pleural, peritoneal, pericardial

QUESTION	TEST	RULE
Pleural: transudate or exudate?	Light's criteria (paired serum)	Exudate if ANY one: fluid:serum protein 0.5 or more; fluid:serum LD 0.6 or more; fluid LD more than two thirds of the serum upper reference limit
Peritoneal: portal hypertension or not?	SAAG = serum albumin − ascitic albumin (same day)	1.1 g/dL (11 g/L) or more: portal hypertension (cirrhosis, heart failure). Under 1.1: not portal (malignancy, tuberculosis, pancreatitis)
Spontaneous bacterial peritonitis?	Absolute neutrophils = total nucleated cells × % neutrophils	250/µL (250 × 10^6/L) or more supports SBP
Complicated parapneumonic effusion?	pH (anaerobic heparinized syringe, blood gas analyzer) and glucose	pH under 7.20 and glucose under 60 mg/dL (3.3 mmol/L) point to drainage
Tuberculous pleurisy or pericarditis?	Adenosine deaminase	40 U/L or more (ascites: 39 U/L or more); culture confirms
Hemothorax?	Fluid hematocrit	More than half of the blood hematocrit

MILKY FLUID	CHYLOUS (TRUE CHYLE)	PSEUDOCHYLOUS (CHOLESTEROL)
After centrifuging	Stays milky	Stays milky (if the supernatant clears, think empyema: cells and debris)
Triglyceride	Over 110 mg/dL (1.24 mmol/L)	Under 50 mg/dL (0.56 mmol/L)
Cholesterol	Under 200 mg/dL (5.18 mmol/L)	Over 200 mg/dL (5.18 mmol/L); cholesterol crystals
Chylomicrons	Present (lipoprotein electrophoresis is definitive)	Absent
Causes	Thoracic duct injury (surgery, trauma), lymphoma and other malignancy	Long-standing effusions: tuberculosis, rheumatoid pleuritis, chronic empyema

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4 Serous fluids: pleural, peritoneal, pericardial CONTINUED

EXAM TIP Exams like Light's criteria with one ratio in and two out: one criterion is enough to call an exudate. For ascites, compute the absolute neutrophil count before comparing with 250/µL.

5 Synovial fluid

Boundaries overlap between sources; gout fluid can reach 100,000/µL

CLASS	APPEARANCE AND VISCOSITY	WBC/MM	NEUTROPHILS	EXAMPLES
Normal	Colorless to straw, clear; high viscosity (long string)	Under 200	Under 25%	-
Noninflammatory	Straw, clear to slightly cloudy; viscous	200-2,000	Under 25%	Osteoarthritis, trauma, osteonecrosis
Inflammatory	Yellow, cloudy; low viscosity (string under 3 cm)	2,000-50,000	Over 50%	Rheumatoid arthritis, gout, CPPD, SLE
Septic	Turbid, purulent, yellow-green; low viscosity	Over 50,000 (lower with gonococcal, TB, fungal or partly treated infection)	Over 75%, often over 90%	Bacterial, fungal, mycobacterial infection
Hemorrhagic	Red-brown, xanthochromic	About equal to blood	About equal to blood	Trauma, hemophilia, anticoagulation, tumor, prosthesis

CRYSTAL	SHAPE	BIREFRINGENCE	PARALLEL TO COMPENSATOR SLOW AXIS	DISEASE
Monosodium urate	Needles or rods, about 2-15 µm; free or inside neutrophils	Strong, negative	YELLOW (blue when perpendicular)	Gout
Calcium pyrophosphate (CPPD)	Rhomboids or short rods	Weak, positive (many show little or none)	BLUE (yellow when perpendicular)	CPPD disease (pseudogout); look for hyperparathyroidism, hemochromatosis, hypomagnesemia, hypophosphatasia
Cholesterol	Flat rectangular plates	-	-	Chronic effusions, e.g., rheumatoid arthritis
Hydroxyapatite	Tiny, clumped; not resolved by light microscopy	-	-	Needs electron microscopy
Corticosteroid	Variable; can mimic urate or CPPD	Variable	Variable	Months after an intra-articular injection

SAFETY Crystals do not rule out infection. Gout and septic arthritis can coexist, so a fluid with urate crystals and 88,000 WBC/µL still needs Gram stain (insensitive) and culture before infection is excluded.

- Tubes: liquid EDTA for cell count and crystals; plain for chemistry; sterile for culture. Avoid oxalate, lithium heparin and powdered EDTA: they form crystal-like artifacts.
- Keep at room temperature; refrigeration can precipitate crystals in vitro. Examine as soon as possible, ideally within 2 hours.
- Very viscous fluid: pretreat with hyaluronidase before counting (correct for the dilution). The mucin clot (Ropes) test is obsolete.

6 Semen analysis

The ASCP column is what the exam uses: answer with it. WHO values are shown only because laboratories now report against them. The MLT list has only volume and concentration.

PARAMETER	ASCP EXAM RANGE	WHO 6TH EDITION (2021) 5TH CENTILE
Volume	2-5 mL	1.4 mL
Sperm concentration	Over 20 × 10^6/mL (20 × 10^9/L)	16 × 10^6/mL
Total sperm number	-	39 × 10^6 per ejaculate
Motility	Over 50% within 1 hour	Total 42%; progressive 30%
Morphology	Over 30% normal forms	4% normal forms (strict criteria)
pH	7.2-8.0	-
Liquefaction	30-60 minutes	-
WBC	Under 1 × 10^6/mL (1 × 10^9/L)	Leukocyte testing moved to extended examinations

- Collection: 2-7 days of abstinence, the whole ejaculate by masturbation into a clean wide-mouthed container (a lost first fraction loses the most sperm); transport at about 20-27 °C and assess within 30-60 minutes.
- Physiology: seminal vesicles give about 70% of the volume (alkaline, fructose-rich), prostate about 25% (acidic). Low volume + acid pH + no fructose + no sperm suggests ejaculatory duct obstruction or absent seminal vesicles.
- Post-vasectomy: test 8-16 weeks after the procedure. Success is azoospermia or rare nonmotile sperm (100,000/mL or fewer). Motile sperm mean success is not yet confirmed: report them so testing is repeated. Back-up contraception until confirmed.

7 Amniotic fluid, feces and BAL at a glance

SPECIMEN	TEST	KEY POINTS
Amniotic fluid	Fetal lung maturity (largely historical)	L/S ratio 2.0 or more mature; phosphatidylglycerol present supports maturity; lamellar body count over 50,000/µL mature, under 15,000/µL immature (counted on a hematology analyzer, cutoffs set per analyzer)
Amniotic fluid	Bilirubin, delta OD450 (Liley)	Spectral scan at 450 nm as an indirect measure of fetal hemolysis in HDFN; now replaced by middle cerebral artery Doppler (peak velocity over 1.5 MoM predicts anemia)
Feces	Guaiac FOBT	Peroxidase activity of hemoglobin; 3 samples; avoid red meat 3 days, vitamin C over 250 mg/day and NSAIDs 7 days
Feces	FIT	Antibodies to human hemoglobin, so dietary peroxidases do not react; yearly. FIT-DNA every 3 years. Any positive stool test needs colonoscopy
Feces	Fat	Sudan III smear screens; 72-hour quantitative fat on at least 100 g fat/day: over 7 g/day abnormal
Feces	Elastase-1	Under 200 µg/g abnormal, under 100 severe pancreatic insufficiency; normal in mucosal malabsorption
Neonatal blood in stool or vomit	Apt (alkali denaturation) test	Fetal hemoglobin resists alkali (stays pink); adult hemoglobin turns yellow-brown: swallowed maternal blood vs infant bleeding. Specimen must be grossly bloody, not tarry, and tested fresh (stool left in air over about 30 minutes can make fetal blood read as adult)
BAL	Cell differential	Normal nonsmoker: macrophages over 85%, lymphocytes 10-15%, neutrophils under 3%, eosinophils under 1%; squamous cells mean airway contamination

8 Safety and analyzers

- OSHA counts CSF, synovial, pleural, pericardial, peritoneal and amniotic fluid, semen and vaginal secretions as other potentially infectious materials, so the bloodborne pathogens rules (engineering controls, PPE at no cost, hepatitis B vaccine, post-exposure follow-up) apply to every body fluid. Biosafety levels and cabinets are on the Laboratory Safety and Biosafety page.
- Automated body fluid modes are preferred for serous and synovial counts, but check each analyzer's limit of quantitation: some cannot count reliably near the CSF limit of 5/µL. Reflex to a hemocytometer count and a stained cytospin when counts are low, flags appear, or malignant cells are possible.
- Report the fluid type with every result, and state when an assay has not been validated for that fluid.

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