MEDLAB BASICS · STUDY SHEET

Compatibility Testing and Blood Components

Pretransfusion testing, the 3-day rule, crossmatch types, emergency release, ABO compatibility for every component, storage and dating, modifications, QC and donor eligibility

16 sources + more detail

medlabbasics.com/sheets/lab-compatibility-components.html
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1 Pretransfusion testing, step by step

1. Positive identification of the patient and the sample at collection: the tube is labeled at the bedside with the patient's identifiers.
2. Check the sample: correctly labeled, not too old (3-day rule), not grossly hemolyzed.
3. Review the history: previous ABO/Rh, antibodies and special needs (irradiated, antigen-negative). A historical antibody stays on the record even if today's screen is negative.
4. ABO/Rh typing of the patient (forward and reverse grouping, D typing).
5. Antibody screen (indirect antiglobulin test against group O screening cells).
6. Select units: ABO/Rh compatible, antigen-negative for any clinically significant antibody, modified as ordered.
7. Confirm the ABO of each red cell unit (and D of units labeled D-negative) by retyping a segment.
8. Crossmatch: electronic or immediate-spin if the screen is negative and there is no antibody history; AHG crossmatch if there is a clinically significant antibody.
9. Label, inspect and issue; the sample and a donor sample are kept after transfusion.

SPECIMEN RULE	REQUIREMENT
3-day rule (21 CFR 606.151)	If the patient was pregnant or transfused in the previous 3 months, the sample must be less than 3 days old for all pretransfusion testing
Why	Recent exposure can start a new or anamnestic antibody within days; an older sample would miss it
Specimen	Serum or plasma (EDTA plasma is common); fresh sample, positively identified
Retention	Recipient sample and a donor sample (segment) kept at 1–6 °C for at least 7 days after transfusion, for a reaction workup
Mislabeled or unlabeled tube	Reject and recollect; never relabel. Wrong blood in tube is the leading cause of ABO-incompatible transfusion

EXAM TIP Counting the 3 days: the collection day is day 0, so a sample drawn Monday is used through Thursday. The rule applies only when the patient was pregnant or transfused within 3 months, or the history is unknown.

2 Crossmatch types

CROSSMATCH	HOW	USE WHEN	DETECTS OR MISSES
Electronic (computer)	Validated computer checks donor and recipient ABO/Rh; no serologic test	Negative screen, no history of clinically significant antibody, two ABO determinations on record, no unresolved ABO discrepancy	Prevents ABO mismatch by logic; depends on correct sample label and data entry
Immediate-spin (IS)	Patient plasma + donor cells in saline, spin at once, read	Same patients as electronic, when the system is not validated or is down	Confirms ABO compatibility; false positive with cold agglutinins or rouleaux; false negative from prozone
AHG (antiglobulin)	IS, then 37 °C incubation with enhancement, wash, add AHG, read; check negatives with check cells	Current or historical clinically significant antibody	Detects IgG antibody to donor antigens; also positive with a positive DAT on the donor cells

SAFETY A negative screen does not erase history. A patient with a past anti-Jka needs Jk(a–) units and an AHG crossmatch even when today's screen is negative: Kidd antibodies fade and come back after exposure (delayed hemolytic reaction).

3 Emergency release and massive transfusion

SITUATION	WHAT THE BLOOD BANK ISSUES
No sample, life-threatening bleeding	Uncrossmatched group O red cells (D-negative for females of childbearing potential when stock allows, per local policy)
Patient's ABO/Rh typed on a current sample	Group-specific uncrossmatched red cells
Plasma before the type is known	Group AB plasma (some facilities use low-titer group A)
Whole blood programs	Low-titer group O whole blood, under the facility's titer cutoff and maximum-unit policy
Paperwork	Physician signs a record justifying the emergency (21 CFR 606.151); testing is completed as soon as a sample arrives and the physician is told of any incompatibility
Massive transfusion	About 10 or more red cell units in 24 hours; protocols give RBC:plasma:platelets near 1:1:1 to 1:1:2; watch ionized calcium (citrate), temperature, fibrinogen

4 ABO compatibility by component

Red cells must be compatible with the patient's plasma; plasma must be compatible with the patient's red cells. Whole blood must be ABO-identical (group O low-titer whole blood excepted). Granulocytes contain red cells and are crossmatched.

PATIENT GROUP	RED CELLS	PLASMA	PLATELETS	CRYO
O	O only	O, A, B, AB	Any; ABO-identical preferred	Any; ABO-compatible preferred in neonates
A	A, O	A, AB	Any; ABO-identical preferred	Any; ABO-compatible preferred in neonates
B	B, O	B, AB	Any; ABO-identical preferred	Any; ABO-compatible preferred in neonates
AB	AB, A, B, O	AB only	Any; ABO-identical preferred	Any; ABO-compatible preferred in neonates

COMPONENT	COMPATIBILITY TESTING	RH (D)
Red cells, whole blood, granulocytes	Yes (electronic, IS or AHG crossmatch)	D-negative patients get D-negative red cells when possible
Plasma	No crossmatch; ABO compatible	Not considered
Platelets	No, unless the unit contains 2 mL or more of red cells (pink to salmon)	D-positive to D-negative is common; RhIG may be considered (mainly whole-blood-derived units)
Cryo	No	Not considered

EXAM TIP Universal donors: group O for red cells, group AB for plasma. Universal recipients: group AB for red cells, group O for plasma. Out-of-group platelets carry incompatible plasma and can cause a positive DAT or hemolysis; small children should get plasma-compatible platelets.

5 Components: content, storage and dating

COMPONENT	CONTENT	STORAGE	SHELF LIFE
Whole blood	450 or 500 mL ±10% + anticoagulant; plasma about 170 mL or more	1–6 °C	CPD, CP2D: 21 days; CPDA-1: 35 days
Red cells	Hct 65–80% (CPD); 55–65% with additive solution	1–6 °C	CPD: 21 d; CPDA-1: 35 d; additive solution (AS-1, -3, -5, -7): 42 d
Frozen red cells (glycerol)	Red cells with glycerol cryoprotectant	−65 °C or colder	10 years
Deglycerolized red cells	Glycerol washed out; 80% or more of red cells recovered	1–6 °C	Open system: 24 h; closed system with additive: 14 d
Platelets (whole-blood-derived)	≥5.5×10^{10} platelets in 40–70 mL plasma	20–24 °C, continuous gentle agitation	5 days (up to 7 with an FDA bacterial risk control strategy)
Apheresis platelets	≥3.0×10^{11} platelets (one adult dose, about 6 whole-blood units)	20–24 °C, agitated	5 to 7 days by bacterial strategy; cold-stored 1–6 °C: up to 14 days, for active bleeding only

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5 Components: content, storage and dating CONTINUED

COMPONENT	CONTENT	STORAGE	SHELF LIFE
Fresh frozen plasma (FFP)	All factors including labile V and VIII; 200–250 mL (apheresis up to 400–600 mL)	−18 °C or colder (frozen within 8 h)	1 year
Plasma frozen within 24 h (PF24)	Factor VIII and protein C lower; stable factors as FFP	−18 °C or colder	1 year
Cryoprecipitated AHF	≥80 IU factor VIII and ≥150 mg fibrinogen per unit; also vWF and factor XIII, in 5–20 mL	−18 °C or colder	1 year
Plasma cryoprecipitate reduced	Lacks fibrinogen, VIII, XIII, large vWF multimers; used for TTP	−18 °C or colder	1 year
Liquid plasma	Never frozen; contains viable lymphocytes	1–6 °C	5 days after the whole blood expires
Apheresis granulocytes	>1.0 × 10^{10} granulocytes plus 20–50 mL red cells	20–24 °C, no agitation	24 hours; must be irradiated; no leukocyte reduction filter

6 Expiration after thawing, opening or processing

EVENT	NEW EXPIRATION
Container entered (open system), refrigerated	24 hours (4 hours if kept at 20–24 °C)
Washed red cells or platelets	24 hours at 1–6 °C, or 4 hours at 20–24 °C
Irradiated red cells	28 days from irradiation or the original date, whichever is sooner
Irradiated platelets or plasma	Unchanged
FFP or PF24 thawed (30–37 °C)	24 hours at 1–6 °C; if collected closed, relabel Thawed Plasma: 4 more days (5 days from thaw)
Cryo thawed (30–37 °C, up to 15 min)	Keep at room temperature: 6 hours (single or closed pool); 4 hours if pooled in an open system. Never refreeze
Platelets pooled in an open system	4 hours
Any unit spiked for transfusion	Finish within 4 hours

⚠ **SAFETY** Only 0.9% sodium chloride may run with blood. Never add medications, and never give lactated Ringer's or other calcium-containing fluids through the same line as citrated blood: the calcium reverses the anticoagulant and clots form.

7 Modifications: what each one prevents

MODIFICATION	WHAT IT DOES	PREVENTS OR REDUCES	DOES NOT PREVENT
Leukocyte reduction	Filter to <5.0 × 10^{6} WBCs per unit (<8.3 × 10^{5} per whole-blood platelet unit), ≥85% of red cells or platelets kept	Febrile reactions, HLA alloimmunization (platelet refractoriness), CMV transmission	TA-GVHD
Irradiation	Gamma or x-ray, 25 Gy (2500 cGy) to the center, at least 15 Gy anywhere; T cells cannot divide	TA-GVHD	Febrile reactions, CMV; raises supernatant potassium in red cells
Washing	Saline wash removes plasma proteins, antibodies, glycerol, additives	Severe allergic or anaphylactic reactions (IgA deficiency with anti-IgA), incompatible plasma (maternal platelets for NAIT)	Is not leukocyte reduction
Volume reduction	Centrifuge, remove supernatant	Volume overload in infants and TACO-prone patients	Is not washing
CMV-safe	CMV-seronegative donor, or prestorage leukocyte reduction (accepted as equivalent)	CMV in at-risk seronegative patients	Plasma and cryo never need it
Pathogen reduction	Amotosalen plus UVA light (platelets, plasma); nucleic acid cross-linking	Bacterial sepsis, many viruses and parasites; inactivates T cells, so accepted in place of irradiation	HAV, HEV, parvovirus B19, Bacillus cereus spores (resistant to some processes)

EXAM TIP Who needs irradiated cellular components: intrauterine transfusions and at-risk neonates, HPC transplant recipients, severe cellular immunodeficiency (not HIV alone), purine analogs (fludarabine, cladribine) or alemtuzumab/ATG, HLA-selected units, units from blood relatives, and all granulocytes.

8 Component quality control

COMPONENT	QC STANDARD
Leukocyte-reduced RBC, whole blood, apheresis platelets	<5.0 × 10^{6} residual WBCs; ≥85% recovery; plan giving 95% confidence that more than 95% of units meet it
Whole-blood-derived platelets	≥5.5 × 10^{10} in at least 75% of units tested; pH ≥6.2 at the end of storage; 4 units from different donors tested each month (count, pH, plasma volume)
Leukocyte-reduced whole-blood platelets	<8.3 × 10^{5} WBCs per unit; a pool <5.0 × 10^{6}
Apheresis platelets	≥3.0 × 10^{11} platelets
Cryoprecipitated AHF	Average ≥80 IU factor VIII per unit; at least 150 mg fibrinogen
Red cells, plasma, platelets at issue	Visual check: no abnormal color, clots, clumps, hemolysis, or segments darker or lighter than the bag; frozen units show no thawing or breakage

9 Donor eligibility basics (FDA, 21 CFR 630)

CHECK	ALLOGENEIC DONOR LIMIT
Temperature	37.5 °C (99.5 °F) or lower
Blood pressure	Systolic 90–180, diastolic 50–100 mm Hg (outside: physician must approve)
Pulse	50–100/min and regular (outside: physician must approve)
Weight	At least 50 kg (110 lb)
Hemoglobin or hematocrit	Women ≥12.5 g/dL (125 g/L) or Hct ≥38%; men ≥13.0 g/dL (130 g/L) or Hct ≥39%; fingerstick or venous, never earlobe; autologous ≥11.0 g/dL or Hct ≥33%
Interval	Whole blood: 8 weeks; double red cells: 16 weeks; plateletpheresis: up to 24 times a year
Pregnancy	Deferred during pregnancy and for 6 weeks after
Arms	Phlebotomy site free of lesions; no marks of injected drug use
HIV risk (FDA 2023)	Same individual risk questions for every donor; new or multiple partners plus anal sex in 3 months: 3-month deferral; oral PrEP/PEP: 3 months; injectable PrEP: 2 years; HIV treatment or positive test: permanent

EXAM TIP Every donation is tested for ABO, Rh including weak D, unexpected red cell antibodies, HBsAg, anti-HBc, anti-HCV, anti-HIV-1/2, anti-HTLV-I/II, syphilis, and NAT for HIV, HCV, HBV and West Nile virus; Chagas once per donor; Babesia NAT in states where FDA requires it unless the unit is pathogen reduced.

10 Exam pearls

EXAM TIP Leukoreduction does not prevent TA-GVHD; irradiation does. Irradiated red cells: 28 days or original date, whichever is sooner. Washing is not leukoreduction. Platelets: 20–24 °C with agitation, 5 days. Cryo: ≥80 IU VIII and ≥150 mg fibrinogen, thaw and use within 6 hours (4 if pooled open). FFP: −18 °C, 1 year; thawed 24 hours. Frozen red cells: −65 °C, 10 years. Open system: 24 hours. 3-day sample if pregnant or transfused within 3 months. Electronic crossmatch needs two ABO determinations and no antibody history.

MORE Pretransfusion testing in detail

The federal rule for compatibility testing is short. 21 CFR 606.151 asks for a method that positively identifies recipient samples, a sample less than 3 days old when the recipient has been pregnant or transfused in the previous 3 months, a procedure that demonstrates incompatibility between donor cells and recipient serum or plasma, and procedures to expedite transfusion in life-threatening emergencies with a physician-signed record. AABB Standards and each facility's procedures fill in the detail.

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