

TABLE 1. COMPILATION OF STUDIES DESCRIBING THE STABILITY OF SPECIFIC BIOMARKERS FOR BIOSPECIMENS (BIOFLUIDS, CELLS, TISSUES) AS A FUNCTION OF STORAGE TEMPERATURE/DURATION

Fluid biospecimens					
Biospecimen	Duration	Storage temperature	Tracked analyte	Stability*	Reference
Biological fluids	60 min	-80°C, -120°C	Creatinine	M	103
Blood	2 to 96 hours	-80°C	C-reactive protein, retinol, ferritin, folic acid, fatty acids	M	104
Blood	10 min to 8 hours	-4.3°C	Heparin	S	105
Blood	120 hours	-20°C	Hormones in plasma and serum	M	106
Blood	1 year	20 to -196°C	Hemoglobin	M	107
Blood, plasma	24 hours	-80°C	Cell-free DNA	N	81
Blood, plasma	80 days	-70°C	Ascorbic acid	N	75
Blood, plasma	14 days	-6°C	Vitamin B ₁₂ , folate	N	79
Blood, plasma	3 to 48 months	-20°C	Vitamin A,B ₁ , B ₂ , B ₆ , B ₁₂ , E, niacin	M	108
Blood, plasma	1.3,4.5 months	-20°C	Anti-dengue IgM and IgG antibodies	N	109
Blood, serum	1 year	-80°C	Matrix metalloproteinase-9	N	71
Plasma	2 year	-20°C, -80°C	Triglyceride, high-density lipoprotein, cholesterol	N	110
Plasma	37 months	-38°C to -42°C	Coagulation factors FV, FVIII:C and FXI: major inhibitor antithrombin III (AT III)	S	111
Plasma	15 min to 8 hours	-80°C, -196°C	Lithium-heparin, sodium-citrate	M	76
Plasma	24 months	-24°C, -74°C	Clotting assays for factors II, V, VII, VIII, IX, X, XI and XII	M	112
Plasma and urine	1 year	-20°C, -70°C	Catecholamines (CA)	M	113
Serum	5 years	-20°C	Matrix metalloproteinase-7	M	70
Serum	18 days	-20°C, -70°C	Folate	N	114
Serum	7 days	-80°C	Free prostate-specific antigen	M	72
Serum	1 to 24 hours	-20°C	ACT-PSA	M	115
Serum	7 days	-20°C	PSA, fPSA, cPSA, tPSA	M	116
Serum	1 week, 3 months	-20°C, -80°C	Serum apo E	M	73
Serum	10 days, 3 months	-20°C	Lipid, lipoprotein, apolipoprotein	M	117
Serum	10 years	-2°C, -80°C	Cancer antigens, CA-125 and CA-15-3	N	118
Serum fatty acids	12 to 24 months	-20°C, -80°C, -150°C	Docosapentaenoic acid, docosahexaenoic acid	M	119
Serum, plasma	3 years	-25°C	C-telopeptides of type I collagen (CTX)	S	74
Serum	0.5 to 23 years	-80°C	Thyrotropin, thyroid hormones, and thyroid autoantibodies (TSH, fT4, TPO-Ab, or TG-Ab)	N	77
Serum	8 to 11 years	-80°C	Thyroid-stimulating hormone (TSH)	N	78
Specimens for gastrin	2 weeks	-70°C	Cholylglycine, cortisol, digoxin, ferritin, follitropin, immunoglobulin E, lutropin, prolactin, thyroxin (also blood-spot thyroxin), triiodothyronine	M	48
Urine	3 to 24 months	-20°C	Urinary albumin	M	120
Urine	160 days	-20°C, -70°C	Urinary albumin	S	121
Cells					
Biospecimen	Duration	Storage temperature	Tracked analyte	Stability*	Reference
Bone marrow cells	40 to 42 months	-85°C, -140°C, -190°C	Cell number and granulocyte-monocyte colony - forming cell (CFU-c)	M	91
Bone marrow cells, peripheral blood mononuclear cells (PBMCs)	48 hours, 26 to 78 months	-90°C	Cell recovery, viability, colony-forming unit-granulocyte macrophage (CFU-GM), clonogenic potential of autologous hematopoietic progenitor cells	M	92

(continued)

TABLE 1. (CONTINUED)
Cells

<i>Biospecimen</i>	<i>Duration</i>	<i>Storage temperature</i>	<i>Tracked analyte</i>	<i>Stability[†]</i>	<i>Reference</i>
Erythrocytes	37 years	-10°C to -75°C	Freeze-thaw-wash recovery, hemolysis, ATP, 2,3-DPG and P50 levels, and 60% of normal RBC K ⁺ levels	S	84
Haematopoietic progenitor cells	1 to 31 months	-80°C	Cell recovery, viability, colony-forming unit-granulocyte macrophage (CFU-GM),	M	87
Hemopoietic stem cells (HSCs)	5 to 14 years	-196°C	Viability, colony formation	S	122
Hemopoietic stem cells (HSCs)	12 to 24 months	-40°C, -80°C, -130°C	Viability, colony formation	M	123
Hemopoietic stem cells (HSCs)	11 to 19 years	-180°C	Viability, colony formation	S	124
Liver cell spheroids (alginate-encapsulated)	1 to 12 months	-80°C, -196°C	Hepatospecific protein enzyme-linked immunosorbent assay	N	95
Peripheral blood progenitor cells (PBPCs)	10 to 12 months	-140°C	Nucleated cells count, multilineage colony-forming assay, long-term culture-initiating cell assay and erythroid burst-forming assay	S	90
Peripheral blood progenitor cells (PBPCs)	1 to 2 years	-80°C, -196°C	Membrane integrity, colony formation	M	89
Peripheral blood progenitor cells (PBPCs)	7 weeks	-80°C	CD34 ⁺ , Colony-forming units granulocyte-macrophage (CFU-GM), burst-forming units erythroid (BFU-E)	M	88
Peripheral blood progenitor cells (PBPCs)	30 days	-150°C, -80°C, -30°C	Membrane integrity, apoptosis, necrosis	M	125
Peripheral blood stem cells (PBSCs)	5 years	-80°C, -135°C	Total nucleated cell, cell viability (using acridine orange and propidium iodide), CD34 ⁺ -cell content, colony-forming unit-granulocyte-macrophage content	M	94
Peripheral blood stem cells (PBSCs)	1 to 61 months	-80°C	Colony-forming units granulocyte-macrophage (CFU-GM), burst-forming units erythroid (BFU-E)	M	93
Platelets	9 days	-80°C	Septin 2	M	126
Sperm	7 days, 3 months	-70°C, -196°C	Motility, morphology	M	127

Tissue biospecimens

<i>Biospecimen</i>	<i>Duration</i>	<i>Storage temperature</i>	<i>Tracked analyte</i>	<i>Stability[†]</i>	<i>Reference</i>
Breast tumor	100 days	-20°C, -196°C	Specific estrogen receptor	S	101
Heart valves	~3 months, 1, 2 years	-80°C, -135°C	Triated-glycine	M	102
Prostatic tissue extracts, plasma	45 days	-20°C, -90°C	Creatine kinase	M	128
Reproductive tract	2 to 8 weeks	-196°C	Estrogen and progesterone receptor	S	100
Skin	1 to 12 months	-196°C	Chromosome	S	99
Breast, colon, liver, lung, ovary, endometrium, cervix	5 days	-70°C	DNA, RNA	M	97
Tumor tissue, tumor cells	1 year	-80°C	Cell cycle phases	M	80

[†]Notation for the stability of the tracked analyte: M, multiple outcome; N, nonstable; S, stable.