Appendix 2

Concentration Ranges of Common Metabolites Detected by MRS in Healthy Human Tissue

Table 1. Contributed by Ivan Kirov, New York University School of Medicine.

Metabolite	Brain		Muscle		Prostate[a,1]		Liver	Kidney[2]
	Gray matter	White matter	Skeletal	Cardiac[a,3]	Glandular	Stromal		
Acetate (Ace)	0.0–0.5[4]							
ATP	2.2–3.3[b,5,6]		7.1–9.7[7]	5.7			1.6–3.8[8]	
Alanine (Ala)	0.3–1.4[9,10]				8.6	6.8		
GABA	0.8–2.5[11–13]	0.3–0.4[13]						
Ascorbic acid (Asc)	1.1–1.4[11,14]							
Aspartate (Asp)	1.4–3.1[9,11,14]							
Carnosine			20[4]					
Choline, total (tCho)	0.9–1.8[11,15–18]	1.4–1.8[15–18]			7.1	7	8.6[a,19]	
Citrate					43.1	16.1		
Creatine, total (tCr)	5.8–9.7[15–18]	4.5–6.2[15–18]			9.1	7.6		
Deoxymyoglobulin			<0.1[20]					
Glutamate (Glu)	7.7–12.8[11,16,18,21,22]	4.5–7.3[16,18,21,22]						
Glutamine (Gln)	1.5–5.5[11,22]	1.7–2.4[22]						
Glutathione (GSH)	0.7–3.2[11,13,14,23,24]	1.0–2.2[13,23]						
Glycine	0.6–1.7[11,24–26]							
Glycogen	2–6[b,27]		153–166[28]				375–397[28]	
Glucose (Glc)	1.0–2.2[11,29]							
Histidine	<0.1[30,31]							
Histamine	<0.1[30,31]							
Homocarnosine	0.3–0.6[32]							
Lactate (Lac)	0.4–0.7[4,11,14,31]				46.5	45		
myo-Inositol (mI)	4.1–7.7[11,15–18]	3.1–4.6[15–18]			34.2	26.9		
scyllo-Inositol (sI)	0.3–0.4[11,14,33]	0.3[33]			1.8	2		
NAA	8.0–13.5[11,15–18]	7.6–10.6[15–18]						
NAAG	0.6–1.8[11–13,34]	1.5–2.7[13,34]						
NTP	2.9[35]	2.9[35]	4.9–8.2[2]				2.2–2.9[2]	2.0
Phenylalanine	<0.1[31,36]							

(*continued overleaf*)

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Table 1. (*Continued*)

Metabolite	Brain		Muscle		Prostate[a,1]		Liver	Kidney[2]
	Gray matter	White matter	Skeletal	Cardiac[a,3]	Glandular	Stromal		
Phosphate, inorganic (P_i)	1.0–1.7[b,6,35]		2.5–6.6[2,7]				1.4–2.8[2,8]	1.6
Phosphocreatine (PCr)	2.5–5.0[b,5,6,11,35]		18–42[2,7]	8.8				
Phosphodiesters (PDE)	1.0[35]	14.2[35]	3.8–4.2[2]				3.5–9.9[2,8]	4.9
GPC	0.5–0.9[5]							
GPE	0.4–0.7[5]							
Phosphomonoesters (PM)	3.1[35]	4.3[35]	2.0–2.5[2]				0.7–3.8[2,8]	2.6
PCh	0.5–1.0[5]							
PEth	1.2–2.8[5,11]							
Pyruvate	<0.2[4,31]							
Serine	0.4[31,37]							
Succinate	<0.5[4,9]							
Taurine	1.3–3.3[9,11,24]				11.7	10.1		
Threonine	0.0–0.5[4,31]							
Tryptophan	<0.1[b,31,38]							
Tyrosine	<0.1[4,31]							
Valine	<0.1[4,31]							

Notes: Values are mmol l^{-1} of solvent (tissue water) except for [a]heart and prostate which are in millimole per kilogram wet tissue weight. To convert to millimole per liter tissue volume (as measured by MRS voxel volumes), divide millimole per liter water by the tissue water content. To convert millimole per liter tissue of volume to millimole per kilogram wet weight, divide by the specific gravity (see Appendix A1, Table 2 for tissue water contents and specific gravities). [b]From nonhuman mammalian tissue.

ATP, adenosine triphosphate; GABA, γ-aminobutyric acid; GPC, glycerophosphorylcholine; GPE, glycerophosphorylethanolamine; PCh, phosphorylcholine; PEth, phosphorylethanolamine; NAA, total *N*-acetyl-aspartate; NAAG, *N*-acetyl-aspartyl-glutamate; and NTP, nucleoside triphosphate.

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