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References Water Content

v5.0 (21.08.2025)

References for the water content of tissues listed in our material properties database. Tissues, which do not have available literature values in the database, are substituted with values from other similar tissues. In these cases, the tissue used is listed instead of a reference.

Table 1: References for the water content of tissues

Tissue	Reference
Adrenal Gland	Charles 1884 ICRP 1975 McIntosh and Anderson 2010 Neufeld 1936 H. Q. Woodard and White 1986
Air	IT'IS Fluid Properties Database
Bile	Bodansky 1952 Cameron 1933 McIntosh and Anderson 2010 Neufeld 1936 Testut 1893 H. Q. Woodard and White 1986
Blood	Altman and Dittmer 1964 Davis, Kenyon, and Kirk 1953 Lijnema et al. 1993 Miller 1942 Neufeld 1936 Ohkuda et al. 1982 Poppendiek et al. 1967 Skelton 1927 H. Q. Woodard and White 1986
Blood Plasma	Hald 1946 Lijnema et al. 1993 Miller 1942 Ohkuda et al. 1982 H. Q. Woodard and White 1986
Blood Serum	R. M. Arnold and Mendel 1927 Faye and Payne 1986
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Tissue	Reference
	Krause and L. Fisher 1879 Mestrezat 1912
Blood Vessel Wall	Abramson 1962 ICRP 1975 H. Q. Woodard and White 1986
Bone (Cancellous)	Best 1961 Gong, J. S. Arnold, and Cohn 1964 Neufeld 1936 Robinson and Elliott 1957
Bone (Cortical)	Gong, J. S. Arnold, and Cohn 1964 Robinson and Elliott 1957 Helen Quincy Woodard 1962 **xxxx** H. Q. Woodard and White 1986
Bone Marrow (Red)	**hartstock1965** Ohkuda et al. 1982 H. Q. Woodard and White 1986
Bone Marrow (Yellow)	H. Q. Woodard and White 1986
Brain	Charles 1884 **cooper1972** Ernst, Kreis, and Ross 1993 Forbes, Cooper, and Mitchell 1953 ICRP 1975 Mitchell et al. 1945 Poppendiek et al. 1967 Skelton 1927
Brain (Grey Matter)	Abbas et al. 2015 Alexander 1938 Bothe, Bodsch, and Hossmann 1984 Cameron 1933 Charles 1884 Close 1933 **cooper1972** Ernst, Kreis, and Ross 1993 Gelman et al. 2001 W. A. Himwich and H. E. Himwich 1957 Randall 1938 Neeb et al. 2008 Shah et al. 2022 Volz, Nöth, and Deichmann 2012 H. Q. Woodard and White 1986
Brain (White Matter)	Best 1961
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Tissue	Reference
	Abbas et al. 2015 Alexander 1938 Bothe, Bodsch, and Hossmann 1984 Cameron 1933 Charles 1884 **cooper1972** Ernst, Kreis, and Ross 1993 Fatouros et al. 1991 Randall 1938 Neeb et al. 2008 Shah et al. 2022 Volz, Nöth, and Deichmann 2012 Warntjes, Dahlqvist, and Lundberg 2007 H. Q. Woodard and White 1986
Breast Fat	Fat
Breast Gland	ICRP 1975 White, H. Q. Woodard, and Hammond 1987 H. Q. Woodard and White 1986
Bronchi	Blood Vessel Wall
Bronchi lumen	Air
Cartilage	Charles 1884 Close 1933 ICRP 1975 McIntosh and Anderson 2010 H. Q. Woodard and White 1986
Cerebellum	Cheng et al. 2018 Neufeld 1936
Cerebrospinal Fluid	**altmandittmer1961** Cameron 1933 Levinson 1929 Mestrezat 1912 Testut 1893 Warntjes, Dahlqvist, and Lundberg 2007
Cervix	Uterus
Commissura Anterior	Brain(White Matter)
Commissura Posterior	Brain(White Matter)
Connective Tissue	Cameron 1933 H. Q. Woodard and White 1986
Diaphragm	Muscle
Ductus Deferens	Blood Vessel Wall
Dura	McIntosh and Anderson 2010
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Tissue	Reference
	Zwirner et al. 2019
Epididymis	Testis
Esophagus	ICRP 1975
Esophagus Lumen	Air
Extracellular Fluids	<**empty citation**> <**empty citation**>
Eye (Aqueous Humor)	Ohkuda et al. 1982 Testut 1893
Eye (Choroid)	Blood
Eye (Ciliary Body)	Muscle
Eye (Cornea)	Castoro, A. A. Bettelheim, and F. A. Bettelheim 1988 Moses and Hart 1987 **truss1971** Xu et al. 2008
Eye (Iris)	Muscle
Eye (Lens)	Moses and Hart 1987 Spector 1956 H. Q. Woodard and White 1986
Eye (Retina)	İnam, Kaplan, and Tezel 2023
Eye (Sclera)	Lee et al. 2004 Nicoli et al. 2009
Eye (Vitreous Humor)	**morris1933** **pirie1967** Poppendiek et al. 1967
Eye Lens (Cortex)	R. F. Fisher and Pettet 1973 Heys, Friedrich, and Truscott 2008
Eye Lens (Nucleus)	R. F. Fisher and Pettet 1973 Heys, Friedrich, and Truscott 2008
Fat	Baker 1969 Charles 1884 Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 Poppendiek et al. 1967 H. Q. Woodard and White 1986
Fat (Average Infiltrated)	Fat
Fat (Not Infiltrated)	Fat
Gallbladder	Neufeld 1936
Heart Lumen	Blood
Heart Muscle	Close 1933 **cooper1972**

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Tissue	Reference
	Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 McIntosh and Anderson 2010 Mitchell et al. 1945 Neufeld 1936 Skelton 1927 H. Q. Woodard and White 1986
Hippocampus	Abbas et al. 2015 Shah et al. 2022
Hypophysis	Neufeld 1936
Hypothalamus	Brain (Grey Matter)
Intervertebral Disc	Yong Gu, Justiz, and Yao 2002
Kidney	Close 1933 **cooper1972** Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 ICRP 1975 McIntosh and Anderson 2010 Mitchell et al. 1945 Neufeld 1936 Poppendiek et al. 1967 Skelton 1927 H. Q. Woodard and White 1986
Kidney (Cortex)	Levitin et al. 1962
Kidney (Medulla)	Levitin et al. 1962
Large Intestine	Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1953 ICRP 1975 Mitchell et al. 1945 Neufeld 1936 Skelton 1927
Large Intestine Lumen	Goldberg, Smith, and Nichols 1977 Reddy and Saha 1984 Silvester et al. 1997
Larynx	ICRP 1975
Liver	Close 1933 **cooper1972** Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 ICRP 1975 McIntosh and Anderson 2010

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Tissue	Reference
	Neufeld 1936 Poppendiek et al. 1967 Skelton 1927 Helen Quincy Woodard 1962
Lung	Lung (Inflated)
Lung (Deflated)	Close 1933 Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 ICRP 1975 McIntosh and Anderson 2010 Mitchell et al. 1945 Neufeld 1936 Ohkuda et al. 1982 Skelton 1927 Widdowson and Dickerson 1960 H. Q. Woodard and White 1986
Lung (Inflated)	Iyer et al. 2024
Lymph	R. M. Arnold and Mendel 1927 Mestrezat 1912
Lymphnode	Blood Vessel Wall
Mandible	Bone (Cortical)
Medulla Oblongata	Abbas et al. 2015 Neufeld 1936 Shah et al. 2022
Meniscus	Cartilage
Midbrain	Abbas et al. 2015 Shah et al. 2022
Mucous Membrane	McIntosh and Anderson 2010
Muscle	Close 1933 Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 ICRP 1975 Mitchell et al. 1945 Neufeld 1936 Ohkuda et al. 1982 Poppendiek et al. 1967 Skelton 1927 H. Q. Woodard and White 1986
Nerve	Charles 1884
Ovary	ICRP 1975 Helen Quincy Woodard 1962

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Tissue	Reference
Pancreas	Cameron 1933 Forbes, Cooper, and Mitchell 1953 Hill et al. 1906 ICRP 1975 McIntosh and Anderson 2010 Mitchell et al. 1945 Neufeld 1936 H. Q. Woodard and White 1986
Penis	Blood Vessel Wall
Pharynx	Air
Pineal Body	Hypophysis
Placenta	ICRP 1975
Pons	Abbas et al. 2015 Shah et al. 2022
Prostate	ICRP 1975 **leissner/sjun/1979** Neufeld 1936 H. Q. Woodard and White 1986
Salivary Gland	White, H. Q. Woodard, and Hammond 1987
SAT (Subcutaneous Fat)	Fat
Scalp	Skin
Seminal vesicle	Prostate
Skin	Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 ICRP 1975 Mitchell et al. 1945 Skelton 1927 Spector 1956 Widdowson and Dickerson 1960 H. Q. Woodard and White 1986
Skull	Agna, Knowles, and Alverson 1958
Skull Cancellous	Bone (Cancellous)
Skull Cortical	Bone (Cortical
Small Intestine	Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 Mitchell et al. 1945 Neufeld 1936 H. Q. Woodard and White 1986
Small Intestine Lumen	Charles 1884
Spinal Cord	Cameron 1933 Charles 1884

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Tissue	Reference
	ICRP 1975 Spector 1956 White, H. Q. Woodard, and Hammond 1987
Spleen	**cooper1972** Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 Hill et al. 1906 ICRP 1975 McIntosh and Anderson 2010 Mitchell et al. 1945 Neufeld 1936 Skelton 1927 H. Q. Woodard and White 1986
Stomach	Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 ICRP 1975 McIntosh and Anderson 2010 Mitchell et al. 1945 Neufeld 1936 H. Q. Woodard and White 1986
Stomach Lumen	McIntosh and Anderson 2010
Tendon and Ligament	Close 1933 ICRP 1975 McIntosh and Anderson 2010 Mlyniec et al. 2021
Testis	ICRP 1975 Neufeld 1936 H. Q. Woodard and White 1986
Thalamus	Abbas et al. 2015 Gelman et al. 2001 Randall 1938 Shah et al. 2022 Warntjes, Dahlqvist, and Lundberg 2007
Thymus	ICRP 1975 Neufeld 1936 White, H. Q. Woodard, and Hammond 1987
Thyroid Gland	Close 1933 ICRP 1975 Neufeld 1936 H. Q. Woodard and White 1986
Tongue	ICRP 1975

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Tissue	Reference
Tooth	Forbes, Cooper, and Mitchell 1953 Forbes, Cooper, and Mitchell 1956 ICRP 1975 McIntosh and Anderson 2010
Tooth (Dentine)	ICRP 1975 **toto1971**
Tooth (Enamel)	**xxx** ICRP 1975
Trachea	ICRP 1975
Trachea Lumen	Air
Ureter Urethra	Blood Vessel Wall
Urinary Bladder Wall	ICRP 1975 McIntosh and Anderson 2010
Urine	H. Q. Woodard and White 1986
Uterus	ICRP 1975 McIntosh and Anderson 2010 Neufeld 1936
Vagina	Large Intestine
Vertebrae	Bone (Cortical)

N/A: A value exists in the database but its reference is no longer traceable, **None:** The property is not existent for the tissue in question, **Not in Database:** Values for that property are not yet included in the material properties database.

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