Scaling and systems biology for integrating multiple organs-on-a-chip

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Electronic Supplementary Information (ESI)

We provide in both PDF and Excel formats a Scaling Spreadsheet with ~250 physiological parameters describing brain, heart, kidney, liver, lung, and blood. In this section, we also discuss in more detail than in the manuscript the Shannon-Wiener Index as a measure of cellular heterogeneity.

Cellular Heterogeneity

The Shannon-Wiener Index (*SWI*)[1;2] provides a useful measure of the effective heterogeneity of organs that can guide organ-on-chip (OoC) and human organ construct (HOC) design:

$$SWI = -\sum_{i}^{N} p_i \log_2 p_i \ ,$$

where there are N cell types and p_i is the probability that a cell is of type i. By using log base 2, we compute *SWI* in bits. The Diversity Index (*DI*)[1] is simply 2^{SWI} and indicates the effective number of cell types in the tissue. If we have only one cell type in a tissue, then $SWI = -1 \log_2 1 = 0$, and $DI = 1$. If we have two cell types that are equally abundant (*i.e.*, $p_1 = p_2 = 0.5$), $SWI = -(0.5 \log_2(0.5) + 0.5 \log_2(0.5)) = -(0.5 \times -1 + 0.5 \times -1) = 1$. If we have two cell types with disparate abundances (*e.g.*, $p_1 = 0.1$ and $p_2 = 0.9$), then $SWI = -(0.1 \log_2(0.1) + 0.9 \log_2(0.9)) = -(0.1 \times -3.32 + 0.9 \times -.152) = -(-.332 + -.136) = 0.469$, and $DI = 2^{0.469} = 1.38$. So the more monodisperse (less heterogeneous) is a two-cell tissue, the closer the *SWI* is to 0 because one cell type dominates. The more heterogeneous the tissue, then the closer is *SWI* to 1, since each cell type is equally represented ($DI = 2$). If the abundance of the two cell types is imbalanced, then the SI is intermediate between 1 and 2. Table S1 lists *SWI* and *DI* for several organs, which we can use in designing and validating OoCs and HoCs. The sources of the brain data are listed in the Scaling Spreadsheet. We were unable to identify from the literature a self-consistent set of cell distributions for the kidney.

Table S1 Heterogeneity of cell types in different organs and the corresponding the Shannon-Wiener Index (*SWI*), in bits, and the effective number of cell types, known as the diversity index ($DI = 2^{SWI}$)

Organ	# of cell types, *N*	Cell type	%	Shannon-Wiener Index, *SWI*	Diversity Index, *DI*	$P_i = 1/N$ for uniform distribution of *N* cell types	*SWI* for uniform cell-type distribution
Brain (Neocortex)[3]	4	Glia	41%				
		Neurons	33%				
		Vascular	17%				
		Microglia	8%				
		Total	100%	1.8	3.4	0.25	2.0
Heart[4;5]	5	Cardiomyocytes	55%				
		Fibroblasts	25%				
		Vascular smooth muscle	10%				
		Endothelial	7%				
		Neuronal	3%				
		Total	100%	1.7	3.3	0.20	2.3
Liver[6]	4	Hepatocyte	60%				
		Sinusoidal endothelial	20%				
		Kupffer	15%				
		Hepatic stellate	5%				
		Total	100%	1.5	2.9	0.25	2.0
Lung (Alveolar)[7]	5	Endothelial	39%				
		Interstitial	29%				
		Type II epithelial	18%				
		Type I epithelial	11%				
		Alveolar macrophages	3%				
		Total	100%	2.0	4.0	0.20	2.3
Blood[8]	6	Erythrocytes	99%				
		Neutrophils	0.50%				
		Lymphocytes	0.30%				
		Monocytes	0.050%				
		Eosinophils	0.025%				
		Basophils	0.007%				
		Total	99.9%	0.1	0.1	0.20	2.3

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Scaling Spreadsheet

The following pages contain a PDF of **Table S1. Structural and functional parameters to guide the scaling of organs-on-chips and human organ constructs based upon human and animal data.** This is in the form of a spread sheet, with ~250 parameters from brain, heart, kidney, liver, lung and blood that are useful in designing coupled organs on a chip. The user is urged to validate all numbers from the primary references therein and report any discrepancies to the authors. A live version of the spread sheet can be downloaded from http://www.vanderbilt.edu/viibre/organs-on-a-chip.php . There is a moderated section for comments on and additions to the table.

References

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Table S1. Structural and functional parameters to guide the scaling of organs-on-chips and human organ constructs based upon human and animal data. The user is urged to validate all numbers from the primary references cited and report any discrepancies to john.wikswo@vanderbilt.edu
Version: 6/10/2013
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										Hu mass, kg	7.00E+01		mHu mass, kg	7.00E-02	Mouse mass, kg	2.00E-02		uH mass, kg	7.00E-05	nH mass, kg	7.00E-08	<<ENTER MASS
Organ	Type of Quantity	Quantity	Base unit	Allometric coefficient A	Allometric power B	+/-	SE	Allometric Reference Unit	Notes	Human (Hu)	±	SE	mHu Allometric	mHu Functional	Mouse	±	SE	uH Allometric	uH Functional	nH Allometric	nH Functional	References
Brain																						
Brain	Structural	Organ volume	L	0.029	0.922				Scaled to body mass. Brain Mass and volume scale linearally	1.45E+00			2.50E-03	1.45E-03				4.28E-06	1.45E-06	7.34E-09	1.45E-09	1
Brain	Structural	Intracranial Volume	mm^3						Total volume of gray matter+White matter+cerebrospinal fluid	1.50E+06		0.15	N/A	1.50E+03				N/A	1.50E+00	N/A	1.50E-03	2
Brain	Structural	Gray Matter V	cm^3						gray matter mass=volume (cm^3)	5.72E+02			N/A	5.72E-01				N/A	5.72E-04	N/A	5.72E-07	
Brain	Structural	White Matter V	cm^3	1	1.23				Scaled to gray matter volume	2.46E+03			N/A	2.46E+00				N/A	2.46E-03	N/A	2.46E-06	3
Brain	Structural	White Matter V	cm^2	1	1.243	+/-	0.036		White matter surface area is used to derive White Matter Volume	2.69E+03			N/A	2.69E+00				N/A	2.69E-03	N/A	2.69E-06	3
Brain	Structural	Interstitial Volume	uL						Extracellular space is 200ul/g tissue LHH ref 28	3.02E+05			N/A	3.02E+02				N/A	3.02E-01	N/A	3.02E-04	4
Brain	Structural	Organ Mass (primates)	g	0.029	0.922				Scaled to body mass	1.51E+03		299.14	2.50E+00	1.51E+00	4.16E-01			4.28E-03	1.51E-03	7.34E-06	1.51E-06	1;5
Brain	Structural	Cerebellum Mass	g							1.54E+02		19.29	N/A	1.54E-01	5.60E-02			N/A	1.54E-04	N/A	1.54E-07	5
Brain	Structural	Rest of Brain Mass	g							1.18E+02		45.42	N/A	1.18E-01				N/A	1.18E-04	N/A	1.18E-07	5
Brain	Structural	Whole Cortical Mass	g	1.05E-08	1.097	+/-	0.081		Scaled to # gray matter neurons. Mass from LHH Ref 2.	1.23E+03		233.68	N/A	6.31E-01	1.73E-01			N/A	3.23E-04	N/A	1.65E-07	3;5
Brain	Structural	Cortical White Matter Mass	g	4.35E-10	1.197	+/-	0.091		Scaled to # gray matter neurons. >40% of cerebral cortex in humans, mass of one hemisphere from LHH Ref 2.	5.23E+02		119.7	N/A	1.34E-01				N/A	3.44E-05	N/A	8.81E-09	3
Brain	Structural	Cortical White Matter Mass	g	3.88E-09	1.032	+/-	0.04		Scaled to # of cortical non-neuronal cells. Other cells are primarily oligodendrocytes	5.23E+02		119.7	N/A	4.19E-01				N/A	3.36E-04	N/A	2.69E-07	3
Brain	Structural	Cortical White Matter Mass	g	0.3572094	1.148				Scaled to gray matter mass	5.23E+02		119.7	0.00E+00	1.34E-01				6.43E-14	1.71E-14	2.00E-17	2.69E-18	3
Brain	Structural	Cortical Gray Matter mass	g	2.25E-09	1.043	+/-	0.073		Scaled to whole brain # neuronal cells. Mass from LHH Ref 2.	5.72E+02		105.32	0.00E+00	4.25E-01				7.92E-12	2.50E-12	6.97E-15	1.22E-15	3;5
Brain	Structural	Cortical Surface A	cm^2	1.43E+00	1.059				Scaled to brain mass (g)	3.33E+03			3.77E+00	2.21E+00				4.44E-03	1.47E-03	5.23E-06	9.79E-07	6
Brain	Structural	White Matter Surface A	cm^2	8.88E-07	0.873	+/-	0.102		Scaled to # gray matter neurons	5.74E+02			0.00E+00	1.38E+00				2.96E-09	3.32E-03	1.10E-11	7.98E-06	3
Brain	Structural	Capillary Linear Dimension	um						per neuron	4.60E+01			N/A	4.60E+01				N/A	4.60E+01	N/A	4.60E+01	7
Brain	Structural	Capillary Length Per Neuron (Calculated)	um/neuron						Calculated from total capillary length divided by number of neurons	7.55E+00			N/A	7.55E+00				N/A	7.55E+00	N/A	7.55E+00	
Brain	Structural	Capillary Luminal Diameter	um							3.00E+00			N/A	3.00E+00				N/A	3.00E+00	N/A	3.00E+00	8
Brain	Structural	Total Capillary Length	km						Calculated by length/neuron*# neurons	6.50E+02			N/A	6.50E-01				N/A	6.50E-04	N/A	6.50E-07	8
Brain	Structural	Capillary Volume (resident blood vol)	mL						From LHH source 13	1.00E+00			N/A	1.00E-03				N/A	1.00E-06	N/A	1.00E-09	8
Brain	Structural	Capillary Volume (calculated)	mL						Calculated from diameter and length	4.59E+00			N/A	4.59E-03				N/A	4.59E-06	N/A	4.59E-09	9
Brain	Structural	Total Capillary Volume	uL						131 um^3/neuron X Whole Brain # Neuronal Cells	1.13E+04		1.06E+03	0.00E+00	1.13E+01				0.00E+00	1.13E-02	1.34E-03	1.13E-05	2
Brain	Structural	Cerebrospinal fluid volume	mL							1.60E+02			N/A	1.60E-01					1.60E-04		1.60E-07	10
Brain	Structural	Capillary Surface Area	cm^2/g							1.75E+02		25	N/A	1.75E+02				N/A	1.75E+02	N/A	1.75E+02	4;8;11
Brain	Structural	Capillary Surface Area	m^2						Average of total capillary surface area range from multiple sources 12-18 m^2	1.50E+01		3	N/A	1.50E-02				N/A	1.50E-05	N/A	1.50E-08	4;8;11
Brain	Structural	Total Capillary Surface Area	um^2						174 um^2 per neuron X Whole Brain # Neuronal Cells	1.50E+13			0.00E+00	1.50E+10				0.00E+00	1.50E+07	1.77E+06	1.50E+04	
Brain	Structural	Axonal Cross Sectional Area	um^2	3.69E-01	0.032	+/-	0.049		Essentially invariant for primate brains. Scaled to cortical gray matter # neurons	7.85E-01			0.00E+00	7.58E-01				3.00E-01	7.58E-01	2.44E-01	7.58E-01	3;12
Brain	Structural	Axonal Length	mm		0.662	+/-	0.186		Scaled to cortical radius	NV			N/A	NV				N/A	NV	N/A	NV	3
Brain	Structural	Axonal Length	mm		0.242	+/-	0.085		Scaled to cortical gray matter # neurons	NV			N/A	NV				N/A	NV	N/A	NV	3
Brain	Structural	mitochondrial surface area			0.86				Follows metabolic rate and scales to brain mass													
Brain	Structural	Total cell number	cells							1.70E+11		1.39E+10	0.00E+00	1.70E+08				0.00E+00	1.70E+05	1.06E+04	1.70E+02	1
Brain	Structural	Whole Brain # Neuronal Cells	cells	5.49E+06	0.801				Scaled to body mass	8.61E+10		8.12E+09	0.00E+00	8.61E+07				0.00E+00	8.61E+04	1.02E+04	8.61E+01	1;5
Brain	Structural	Whole Brain # Non-Neuronal Cells	cells	5.49E+06	1				Scaled to body mass	8.46E+10		9.83E+09	0.00E+00	8.46E+07				0.00E+00	8.46E+04	3.84E+02	8.46E+01	1;5
Brain	Structural	Whole Brain: #Non-Neuronal/#Neuronal								9.83E-01			N/A	9.83E-01				N/A	9.83E-01	N/A	9.83E-01	
Brain	Structural	Cerebellum # cells	cells							8.51E+10		6.92E+09	N/A	8.51E+07				N/A	8.51E+04	N/A	8.51E+01	5
Brain	Structural	Cerebellum # Neurons	cells							6.90E+10		6.65E+09	N/A	6.90E+07	4.20E+07			N/A	6.90E+04	N/A	6.90E+01	5
Brain	Structural	Cerebellum # Non-Neuronal	cells							1.60E+10		2.17E+09	N/A	1.60E+07				N/A	1.60E+04	N/A	1.60E+01	5
Brain	Structural	Cerebellum: #Non-Neuronal/#Neuronal								2.32E-01			N/A	2.32E-01				N/A	2.32E-01	N/A	2.32E-01	
Brain	Structural	Cerebral Cortex # cells	cells							7.72E+10		7.72E+09	N/A	7.72E+07				N/A	7.72E+04	N/A	7.72E+01	5
Brain	Structural	Cerebral Cortex # Neurons	cells							1.63E+10		2.17E+09	N/A	1.63E+07	1.30E+07			N/A	1.63E+04	N/A	1.63E+01	5
Brain	Structural	Cerebral Cortex #Non-Neuronal	cells							6.08E+10		7.02E+09	N/A	6.08E+07				N/A	6.08E+04	N/A	6.08E+01	5
Brain	Structural	Cerebral Cortex: #Non-Neuronal/#Neuronal								3.72E+00			N/A	3.72E+00				N/A	3.72E+00	N/A	3.72E+00	
Brain	Structural	Cortical Grey matter # Neurons	cells	1.89E+07	0.911				Scaled to cortical mass	1.24E+10		3.44E+09	0.00E+00	1.24E+07				1.45E-03	1.24E+04	2.40E-06	1.24E+01	5
Brain	Structural	Cortical Grey matter # Non-Neuronal	cells							1.74E+10		1.56E+09	N/A	1.74E+07				N/A	1.74E+04	N/A	1.74E+01	5
Brain	Structural	Cortical Gray Matter: #Non-Neuronal/#Neuronal								1.40E+00			N/A	1.40E+00				N/A	1.40E+00	N/A	1.40E+00	
Brain	Structural	Cortical White Matter # Neurons	cells							2.58E+09		1.08E+09	N/A	2.58E+06				N/A	2.58E+03	N/A	2.58E+00	5

Brain	Structural	Cortical White Matter # Non-Neuronal	cells	6.95E-02	1.165	+/-	0.07	Scaled to cortical gray matter # neurons	3.98E+10	5.66E+09	0.00E+00	3.98E+07		3.44E-05	3.98E+04	1.97E-08	3.98E+01	5
		Cortical White Matter: #Non-Neuronal/#Neuronal							1.54E+01		N/A	1.54E+01		N/A	1.54E+01	N/A	1.54E+01	
Brain	Structural	Rest of Brain # Cells	cells						8.42E+09	1.50E+09	N/A	8.42E+06		N/A	8.42E+03	N/A	8.42E+00	5
Brain	Structural	Rest of Brain # Neurons	cells					<1% total cells	6.90E+08	1.20E+08	N/A	6.90E+05		N/A	6.90E+02	N/A	6.90E-01	5
Brain	Structural	Rest of Brain # Non-Neuronal	cells					RoB = Basal ganglia, diencephalon, brainstem	7.73E+09	1.45E+09	N/A	7.73E+06		N/A	7.73E+03	N/A	7.73E+00	5
Brain	Structural	Rest of Brain: #Non-Neuronal/#Neuronal							1.12E+01		N/A	1.12E+01		N/A	1.12E+01	N/A	1.12E+01	
Brain	Structural	Neocortical # Cells	cells						3.87E+10		N/A	3.87E+07		N/A	3.87E+04	N/A	3.87E+01	13
Brain	Structural	Neocortical # Neurons	cells						1.67E+10		N/A	1.67E+07		N/A	1.67E+04	N/A	1.67E+01	13
Brain	Structural	Neocortical # Glia	cells						1.92E+10		N/A	1.92E+07		N/A	1.92E+04	N/A	1.92E+01	13
Brain	Structural	Neocortical: # Glia/# Neurons							1.15E+00		N/A	1.15E+00		N/A	1.15E+00	N/A	1.15E+00	
Brain	Structural	Neocortical # Vascular Cells	cells						7.73E+09		N/A	7.73E+06		N/A	7.73E+03	N/A	7.73E+00	13
Brain	Structural	Neocortical # Microglia	cells						3.48E+09		N/A	3.48E+06		N/A	3.48E+03	N/A	3.48E+00	13
Brain	Functional	Cell Turnover	%					Scales with Age	1.00E+01									9
Brain	Functional	Cerebral Blood Flow	L/min					13% of total body blood flow	7.00E-01		N/A	7.00E-04		N/A	7.00E-07	N/A	7.00E-10	14
Brain	Functional	Cerebral Blood Flow	mL/100g.min					Agrees with cerebral blood flow in L/min when calculated with brain mass	5.27E+01		N/A	5.27E+01		N/A	5.27E+01	N/A	5.27E+01	15
Brain	Functional	CBF changes with aging						linear regression with age, slope =	-1.18E-01	0.043	N/A	N/A		N/A	N/A	N/A	N/A	16
Brain	Functional	Capillary Shear Stress	Pa	57.13	-1.5779			Max around 10 (microvessels) min around 0.28 (venules). Scaled to capillary diameter	1.54E+00			1.54E+00		N/A	1.54E+00	N/A	1.54E+00	17;18
Brain	Functional	Mean Arterial Blood Pressure	mmHg						8.20E+01		N/A	8.20E+01		N/A	8.20E+01	N/A	8.20E+01	15
Brain	Functional	Cerebral Vascular Resistance	mmHg/100g						1.56E+00		N/A	1.56E+00		N/A	1.56E+00	N/A	1.56E+00	15
Brain	Functional	Arteriovenous Oxygen Difference	volume %						6.10E+00		N/A	6.10E+00		N/A	6.10E+00	N/A	6.10E+00	15
Brain	Functional	Oxygen extraction fraction changes with aging						Linear regression with age, slope =	1.00E-03		N/A	N/A		N/A	N/A	N/A	N/A	
Brain	Functional	Arterial CO2 content	volume %						4.75E+01		N/A	4.75E+01		N/A	4.75E+01	N/A	4.75E+01	15
Brain	Functional	CO2 Partial Pressure	mmHg						3.71E+01		N/A	3.71E+01		N/A	3.71E+01	N/A	3.71E+01	19
Brain	Functional	Conduction Velocity	s^-1		0.242	+/-	0.085	Decreased connectivity as the cortex grows. This decreases the average conduction delay along global connections. Scaled to cortical gray matter # neurons	NV		N/A	NV		N/A	NV	N/A	NV	3
Brain	Functional	Conduction Velocity Primates			0.165			Scaled to cortical gray matter # neurons	NV		N/A	NV		N/A	NV	N/A	NV	3
Brain	Functional	Conduction Velocity Rodents			0.466			Scaled to cortical gray matter # neurons	NV		N/A	NV		N/A	NV	N/A	NV	20
Brain	Functional	Computational Capacity Primates			0.623			Scaled to cortical gray matter # neurons	NV		N/A	NV		N/A	NV	N/A	NV	20
Brain	Functional	Computational capacity Rodents			0.446			Scaled to cortical gray matter # neurons	NV		N/A	NV		N/A	NV	N/A	NV	20
Brain	Structural	Non-Neuronal (Glial) cell density per Neuron			1			Scaled to whole brain # neuronal cells.	NV		N/A	NV		N/A	NV	N/A	NV	21
Brain	Structural	Neuronal Cell Density (Primates)	Neurons/mg		-0.123			Average of two papers +/- Stdev. Scaled to brain mass	NV		N/A	NV		N/A	NV	N/A	NV	21
Brain	Structural	Neuronal Cell Density (Rodents)			-0.367			Scaled to brain mass	NV		N/A	NV		N/A	NV	N/A	NV	21
Brain	Structural	neuronal density with brain mass (all)			-0.172			Scaled to brain mass	NV		N/A	NV		N/A	NV	N/A	NV	21
Brain	Functional	metabolic demand/value range	Metabolic Rate/g		-0.14			Scaled to brain mass	NV		N/A	NV		N/A	NV	N/A	NV	21
Brain	Functional	Whole Brain Glucose Consumption	umol/min	0.785329379	0.873			Across 6 species. Scaled to brain mass	4.68E+02		1.75E+00	2.05E-01	3.70E-01	6.72E-03	2.05E+02	2.59E-05	2.05E+05	21
Brain	Functional	Glucose consumption per mass	umol/g.min	0.785329547	-0.127			Across 6 species. Scaled to brain mass	3.10E-01		6.99E-01	3.10E-01	8.90E-01	1.57E+00	3.10E-01	3.52E+00	3.10E-01	21
	Functional	Glucose per neuron	umol/min		1			Calculated from whole brain glucose consumption divided by number of neurons	5.44E-09			5.44E-09			5.44E-09		5.44E-09	
Brain	Functional	Whole Brain Oxygen Consumption	mL/min	0.092281743	0.862			Across 6 species, human number average of 2 sources +/- Stdev. Scaled to brain mass.	5.07E+01	2.1	2.03E-01	5.28E-02	1.90E-01	8.39E-04	5.28E-05	2.59E-05	8.85E-07	10;21
Brain	Functional	Whole Brain Oxygen Consumption	mL/g.min					For humans, calculated from whole brain oxygen consumption divided by organ mass	3.50E-02	0.005	8.13E-02	3.50E-02	0.084 (rat)	1.96E-01	3.50E-02	3.52E+00	3.50E-02	10
Brain	Functional	Cerebral Cortex Glucose Consumption	umol/g.min						3.40E-01	0.05	N/A	3.40E-01	1.10E+00	N/A	3.40E-01	N/A	3.40E-01	10
Brain	Functional	Cerebral Metabolic Rate (oxygen/mass)	mL/100g.min						3.21E+00		N/A	3.21E+00		N/A	3.21E+00	N/A	3.21E+00	15
Brain	Functional	CMRO2 changes with aging						Linear regression with age, slope =	-2.40E-01	0.05								16
Brain	Functional	Firing Rate			-0.15			Also differs for type of neuron. Scaled to body mass	1-40 Hz			1-40 Hz			1-40 Hz		1-40 Hz	10
Heart																		Heart
Heart	Structural	Organ Weight	g	5.05E+00	0.98			w/o blood	2.55E+02	± 2.40E+01	3.73E-01	2.55E-01	1.50E-01 ± 5.00E-02	4.28E-04	2.55E-04	4.92E-07	2.55E-07	22;23
Heart	Structural	Organ Volume	L	4.21E-03	1.00				2.95E-01	± 1.50E-02	2.95E-04	2.95E-04	9.50E-05	2.95E-07	2.95E-07	2.95E-10	2.95E-13	14
Heart	Structural	Organ Mean Linear Dimension	cm	3.25E+00	0.33				13.5	1.5	1.35E+00	1.35E+00	1 cm	1.38E-01	1.35E-01	1.41E-02	1.35E-02	23;24
Heart	Structural	LV Weight	g	3.51E+00	0.98				1.78E+02	± 4.40E+01	2.59E-01	1.78E-01	9.10E-02 ± 2.00E-02	2.97E-04	1.78E-04	3.41E-07	1.78E-07	25
Heart	Structural	LV Wall Thickness	mm	1.80E+00	0.33				7.5	2.5	7.50E-01	7.50E-01	1.50E+00	7.67E-02	7.50E-02	7.85E-03	7.50E-03	26;27
Heart	Structural	LV Wall Thickness	cells	3.61E+01	0.33				150	30	1.50E+01	1.50E+01	150 (rat)	1.53E+00	1-2	1.57E-01	1.00E+00	28;29
Heart	Structural	LV Surface Area	cm^2	1.32E+01	0.67			Ranges from 180-260 cm^2	2.23E+02	± 3.75E+01	2.23E+00	2.23E+00	1.00E+00	2.17E-02	2.17E-02	2.12E-04	2.17E-04	30;31
Heart	Structural	LV Radii	mm	7.73E+00	0.33				3.22E+01	± 2.25E-01	3.22E+00	3.22E+00	5.15 (rat)	3.29E-01	3.22E-01	3.37E-02	3.22E-02	32
Heart	Structural	LV Radius of Curvature	mm	8.45E+04	3				2.90E+00		2.90E+01	2.90E+01	19.4 (rat)	2.90E-08	2.90E+02	2.90E-17	2.90E+03	33
Heart	Structural	Resident Vascular Blood Volume	L	3.83E-04	1.00			~10.5 mL/100g of tissue	2.68E-02		2.68E-05	2.68E-05	2.84E-05	2.68E-08	2.68E-08	2.68E-11	2.68E-11	34;35

Heart	Structural	End Diastolic Vlood Volume	mL	1.71E+00	1.00		1.20E+02		1.20E-01	1.20E-01	6.00E-02		1.20E-04	1.20E-04	1.20E-07	1.20E-07	36;37
Heart	Functional	Perfusion Rate	L/ min	9.92E-03	0.75		2.40E-01		1.35E-03	2.40E-04	2.80E-04		7.59E-06	2.40E-07	4.27E-08	2.40E-10	14
Heart	Structural	Total Cell Number	cells	N/A	N/A	Using 20,000,000 cells/cm^3	5.90E+09			5.90E+06	2.81E+06		N/A	5.90E+03	N/A	5.60E+00	38
Heart	Structural	Mass Per Cell	g	N/A	N/A		4.32E-08			4.32E-08	5.34E-08		N/A	4.32E-08	N/A	4.32E-08	
Heart	Structural	Cell Density	cells/cm^3	N/A	N/A		2.00E+07			2.00E+07	5.80E+07		N/A	2.00E+07	N/A	monolayer	29;39
Heart	Structural	Number of Important Cell Types	cell types	N/A	N/A	Cardiomyocytes, Fibroblasts, VSMCs, ECs, neurons	5.00E+00			5.00E+00	5.00E+00		N/A	1-2	N/A	1.00E+00	
Heart	Functional	Cell Turnover Rate	new cells (yr^{-1})	N/A	N/A	1% turnover at 25, 0.45% turnover at 75 years (calculated assuming 1% turnover)	5.90E+07		N/A	5.90E+04	1.41E+01		N/A	5.90E+01	N/A	5.60E-02	40;41
Heart	Functional	Fractional Cell Shortening	um/cell	N/A	N/A		1.05E+01			1.05E+01	4.14E+00		N/A	1.05E+01	N/A	1.05E+01	27;42;43
Heart	Metabolic	MVO_2	ml O_2/100g/min	4.13E-01	0.75		1.00E+01	± 3.00E+00	5.62E-02	1.00E+01	8.30E-01	± 1.20E-01	3.16E-04	1.00E+01	1.78E-06	1.00E+01	44;45
Heart	Functional	Total Transport Capacity	mL/min	2.17E+02	0.75		5.25E+03	± 9.75E+02	2.95E+01	5.25E+00	2.00E+01	± 5.00E+00	1.66E-01	5.25E-03	9.34E-04	5.25E-06	46;47
Heart	Functional	Ejection Fraction	%				6.25E-01	± 7.50E-02		6.25E+01	6.60E+01	± 4.00E+00	N/A	6.25E-01	N/A	6.25E-01	37;48
Heart	Functional	Oscillatory Frequency	bpm	2.02E+02	-0.25		6.50E+01		3.93E+02	6.50E+01	6.32E+02	± 5.68E+01	2.21E+03	6.50E+01	1.24E+04	6.50E+01	49
Heart	Functional	Wall Shear Stress	dynes/cm^2	1.66E+01	-0.20	Experimental: -0.2027; Theoretical: -0.375	7.00E+00		2.84E+01	7.00E+00	3.50E+01		1.15E+02	7.00E+00	4.67E+02	7.00E+00	50
Heart	Metabolic	Max O2 Consumption nmol/mm^3/s	nmol/mm^3/s	N/A	N/A	Human value is average *at rest* (250 mL O_2 min^{-1})	5.55E-01				7.00E-01						22
Heart	Structural	Capillary Density	capillaries/mm^2	N/A	N/A	in children and adults, higher density in infants	2.39E+03	± 7.50E+01			2.25E+03	± 8.50E+01					22
Heart	Structural	Myocyte Fractional area	%	N/A	N/A		1.20E+01	± 5.90E+00			8.21E+01	± 9.00E-01					22
Heart	Metabolic	Max MVO2 Calculation	mL O2/100g/min	N/A	N/A	in men	5.59E+01				6.77E+01						22
Heart	Structural	% Mitochondria (v/v)		N/A	N/A	% of CM cytosolic volume	2.53E-01				3.80E-01						45
Kidney																	Kidney
Kidney	Structural	Kidney Mass	g			Mass from literature	3.10E+02				3.20E-01						14
Kidney	Structural	Kidney Mass	g	2.12E-02	0.85	Mass from allometric scaling	2.78E+02		7.85E-01		2.71E-01		2.21E-03		6.23E-06		51-54
Kidney	Structural	Kidney Volume	mL			Volume from literature	2.80E+02				3.40E-01						14
Kidney	Structural	Kidney Volume	mL	2.18E-02	0.84	Volume from allometric scaling	2.65E+02		7.83E-01		2.72E-01		2.32E-03		6.85E-06		55
Kidney	Structural	Cortical Thickness	mm	2.62E+00	0.17		5.39E+00		1.67E+00		1.35E+00		5.15E-01		1.59E-01		56
Kidney	Structural	Medullary Thickness	mm	8.15E+00	0.13		1.41E+01		5.78E+00		4.92E+00		2.37E+00		9.73E-01		57
Kidney	Structural	Outer Medullary Thickness	mm	3.17E+00	0.18		6.81E+00		1.96E+00		1.57E+00		5.66E-01		1.63E-01		56
Kidney	Structural	Inner Medullary Thickness	mm	5.09E+00	0.14		9.23E+00		3.51E+00		2.94E+00		1.33E+00		5.07E-01		56
Kidney	Structural	Loop Length	um	1.85E+03	1.02		0.00E+00		0		0		0		0		57
Kidney	Structural	Renal Blood Flow (RBF)	mL/min			Renal Blood Flow from literature	1.24E+03				1.30E+00						14
Kidney	Structural	Renal Blood Flow (RBF)	mL/min	4.31E+01	0.77	Renal Blood Flow from allometric scaling	1.13E+03		5.56E+00		2.12E+00		2.72E-02		1.33E-04		58
Kidney	Structural	Plasma Flow Rate (PFR)	mL/min			Plasma Flow Rate from literature	7.00E+02				8.00E-01						55
Kidney	Structural	Plasma Flow Rate (PFR)	mL/min	8.45E-02	0.80	Plasma Flow Rate from allometric scaling	6.50E+02		2.55E+00		9.34E-01		1.00E-02		3.93E-05		55
Kidney	Structural	# Nephrons, Both Kidneys		1.88E+05	0.62		2.62E+06		3.62E+04		1.66E+04		4.99E+02		6.89E+00		52;53;55
Kidney	Structural	# Glomeruli, Both Kidneys		1.91E+05	0.62		2.66E+06		3.67E+04		1.69E+04		5.06E+02		6.98E+00		59
Kidney	Structural	# Nephrons/g of Kidney		3.24E+04	-0.32		8.32E+03		7.59E+04		1.13E+05		6.92E+05		6.31E+06		59
Kidney	Structural	Glomerular Surface/g of Kidney	mm^2	2.81E+03	-0.15		1.49E+03		4.19E+03		5.05E+03		1.18E+04		3.32E+04		59
Kidney	Structural	Total Glomerular Volume	mL	1.37E-01	0.85		5.07E+00		1.43E-02		4.93E-03		4.03E-05		1.14E-07		53;59
Kidney	Structural	Total Glomerular SA	mm^2	8.37E+03	0.73		1.86E+05		1.20E+03		4.81E+02		7.76E+00		5.01E-02		59
Kidney	Structural	SA/Glomerulus	mm^2	8.60E-02	0.18		1.85E-01		5.33E-02		4.25E-02		1.54E-02		4.43E-03		59
Kidney	Structural	Proximal Tubule Length	mm	1.43E+01	0.10		2.19E+01		1.10E+01		9.69E+00		5.50E+00		2.76E+00		59
Kidney	Structural	Proximal Tubule Diameter	mm	6.00E-02	0.02		6.53E-02		5.69E-02		5.55E-02		4.96E-02		4.32E-02		59
Kidney	Structural	Proximal Tubule Volume	mm^3	4.60E-02	0.12		7.66E-02		3.34E-02		2.88E-02		1.46E-02		6.37E-03		59
Kidney	Structural	Total of Proximal Tubule Volumes	mm^3	4.28E+03	0.68		7.70E+04		7.02E+02		3.00E+02		6.40E+00		5.84E-02		59
Kidney	Structural	Proximal Tubule Volume/g of Kidney	mm^3	1.47E+03	-0.20		6.29E+02		2.51E+03		3.22E+03		9.97E+03		3.97E+04		59
Kidney	Structural	Mean Glomerular Diameter	um	6.10E+01	0.11		2.08E+02		9.73E+01		8.48E+01		0.00E+00		2.13E+01		54
Kidney	Functional	Glomerular Filtration Rate (GFR)	mL/min				1.25E+02			1.25E-01	2.80E-01			1.25E-04			14
Kidney	Functional	Glomerular Filtration Rate (GFR)	mL/min	5.36E+00	0.72		1.14E+02		7.90E-01		3.21E-01		5.47E-03		3.78E-05		60
Kidney	Functional	Single Nephron GFR	nL/min	2.80E+01	0.10		4.28E+01		2.15E+01		1.89E+01		1.08E+01		5.39E+00		53
Kidney	Functional	Urine Flow	mL/day			Urine Flow from literature	1.40E+03				1.00E+00						14
Kidney	Functional	Urine Flow	mL/day	6.09E+01	0.75	Urine Flow from allometric scaling	1.47E+03		8.28E+00		3.24E+00		4.66E-02		2.62E-04		58
Kidney	Functional	Urinary Concentrating Ability (*#4)	mmol/kgH2O	2.67E+03	-0.10		1.77E+03		3.45E+03		3.90E+03		6.75E+03		1.32E+04		56;57
Kidney	Functional	Clearance			0.75												53
Kidney	Functional	Clearance, Urea	mL/hr	1.59E+00	0.72		3.39E+01		2.34E-01		9.51E-02		1.62E-03		1.12E-05		52;55
Kidney	Functional	Clearance, Inulin	mL/min	5.36E+00	0.72		1.14E+02		7.90E-01	1.14E-01	3.21E-01		5.47E-03	1.14E-04	3.78E-05		53;58
Kidney	Functional	Clearance, Creatinine	mL/min	8.20E+00	0.69		1.54E+02		1.31E+00		5.51E-01		1.11E-02		9.48E-05		52;55;61
Kidney	Functional	Clearance, Methotrexate (MTX)	mL/min	1.09E+01	0.69		2.04E+02		1.74E+00		7.33E-01		1.48E-02		1.26E-04		61
Kidney	Functional	Clearance, Para-aminohippurate (PAH)	mL/min	2.18E+01	0.77		5.74E+02		2.81E+00		1.07E+00		1.38E-02		6.75E-05		58
Kidney	Functional	Excretion, Urinary Nitrogen	mg/day	1.46E+02	0.72		3.11E+03		2.15E+01		8.73E+00		1.49E-01		1.03E-03		60
Kidney	Functional	Excretion, Creatinine Nitrogen	mg/day	1.27E+01	0.90		5.71E+02		1.17E+00		3.82E-01		2.40E-03		4.93E-06		60
Kidney	Functional	Excretion, Neutral Sulfur	mg/day	6.85E+00	0.74		1.59E+02		9.57E-01		3.79E-01		5.77E-03		3.48E-05		60
Kidney	Metabolic	Species Basal Metabolic Rate	W	3.89E+00	0.76		9.82E+01		5.15E-01		1.99E-01		2.71E-03		1.42E-05		57
Kidney	Metabolic	Species Mass Specific Metablic Rate	W/kg	3.89E+00	-0.24		1.40E+00		7.36E+00		9.95E+00		3.86E+01		2.03E+02		57
Kidney	Metabolic	Kidney Mass Specific Metabolic Rate	kJ kg-1 day-1	2.89E+03	-0.08		2.06E+03		3.57E+03		3.95E+03		6.21E+03		1.08E+04		51;62
Kidney	Metabolic	Mass Specific Oxygen Consumption			-0.10												63
Kidney	Metabolic	Mitochondrial Volume Density (% of cell vol)	%	3.80E+01	-0.14		7.96E+00		2.09E+01		2.50E+01		5.51E+01		1.45E+02		64

Kidney	Metabolic	Mitochondrial Membrane SA (m^2) per cm^3 Tissue	m^2/cm^3	2.17E+01	-0.22					1.87E+00			8.53E+00			1.12E+01			3.90E+01			1.78E+02		64
Kidney	Metabolic	Vol Mitochondria/mTAL Cell Vol	%	5.62E+01	-0.06					4.43E+01			6.53E+01			7.00E+01			9.61E+01			1.41E+02		63
Kidney	Metabolic	Inner Mitochondial Membrane Area/Vol mTAL Mito	um^-1	4.90E+01	-0.03					4.24E+01			5.36E+01			5.59E+01			6.78E+01			8.58E+01		63
Kidney	Metabolic	Inner Mitochondial Membrane Area/mTAL Cell Vol	um^-1	2.75E+01	-0.09					1.86E+01			3.52E+01			3.95E+01			6.64E+01			1.25E+02		63
Kidney	Metabolic	Basolateral Membrane Area/mTAL Cell Vol	um^-1	5.50E+00	-0.08					4.00E+00			6.71E+00			7.38E+00			1.13E+01			1.89E+01		63
Liver																								Liver
Liver	Structural	Organ Weight	g	3.70E-02	0.85					1.52E+03			1.36E+00	1.52E+00		1.50E+00			3.87E-03	1.52E-03		1.10E-05	1.52E-06	65
Liver	Structural	Organ Volume	mL							1.69E+03				1.69E+00		1.30E+00				1.69E-03			1.69E-06	14
Liver	Metabolic	Oxygen Consumption	mL/min	3.50E-02	0.69					2.07E+03			6.56E-01	2.07E+00					5.59E-03			4.76E-05		65;67
Liver	Functional	Blood Flow	mL/min	9.40E-02	0.75					1.45E+03			2.27E+00	1.45E+00					1.28E-02	1.45E-03		7.19E-05	1.45E-06	14;65
Liver	Structural	Resident Blood Volume	mL	2.50E-02	0.86								9.65E-01						2.54E-03			6.68E-06		65
Liver	Functional	Bile Flow	mL/day							3.50E+02				3.50E-01		2.00E+00				3.50E-04			3.50E-07	14
Liver	Structural	Hepatocytes	cells	9.10E+06	0.89					3.00E+11			3.92E+08	3.00E+08					8.63E+05	3.00E+05		1.90E+03	3.00E+02	65
Liver	Structural	Hepatocyte Cell Density	cells/g liver							1.39E+08	±	2.50E+07		1.39E+05		1.35E+02	±	1.00E+01		1.39E+02			1.39E-01	68
Liver	Functional	Protein Concentration	mg/g liver							9.00E+01	±	1.70E+01		9.00E-02		1.15E+02	±	7.00E+00		9.00E-05			9.00E-08	68
Liver	Structural	Liver Density	g liver/mL							1.03E+00				1.03E-03						1.03E-06			1.03E-09	14
Liver	Functional	Potassium Uptake Rate	µmol K+/g wet * min	1.20E+00	-0.14								6.62E-01						1.74E+00			4.58E+00		69
Liver	Metabolic	Tissue Metabolic Rate (Oxygen)	µmol O2/g wet * min	3.60E+00	-0.21								1.48E+00						6.29E+00			2.68E+01		69
Liver	Functional	Shear Stress	MPa						Liver sinusoid	5.00E+01				5.00E-02						5.00E-05			5.00E-08	70
Liver	Functional	CI, intrinsic																						
Liver	Functional	Antipyrine	mL/min	5.00E-02	1.84				Corrected with brain weight	3.43E+02			3.75E-04	3.43E-01					1.13E-09	3.43E-04		3.42E-15	3.43E-07	71
Liver	Functional	Caffeine	mL/min	7.00E-02	1.53				Corrected with brain weight	1.40E+02			1.20E-03	1.40E-01					3.08E-08	1.40E-04		7.91E-13	1.40E-07	71
Liver	Functional	Mibefradil	mL/min	3.63E+01	1.31				Corrected with brain weight	4.90E+02			1.11E+00	4.90E-01					1.31E-04	4.90E-04		1.54E-08	4.90E-07	71
Liver	Functional	Moforotene	mL/min	1.00E+02	1.64				Corrected with brain weight	7.70E+02			1.28E+00	7.70E-01					1.53E-05	7.70E-04		1.84E-10	7.70E-07	71
Liver	Functional	Theophylline	mL/min	3.00E-02	1.71				Corrected with brain weight	4.27E+01			3.18E-04	4.27E-02					2.36E-09	4.27E-05		1.75E-14	4.27E-08	71
Liver	Functional	Tolcapone	mL/min	1.03E+02	1.51				Corrected with brain weight	1.89E+02			1.86E+00	1.89E-01					5.48E-05	1.89E-04		1.62E-09	1.89E-07	71
Liver	Functional	Bromazepam	mL/min						Adjusted from reference weight to 70kg human	6.78E+01														61
Liver	Functional	Clonazepam	mL/min						Adjusted from reference weight to 70kg human	4.28E+02														61
Liver	Functional	Chlordiazepoxide	mL/min						Adjusted from reference weight to 70kg human	4.46E+02														61
Liver	Functional	Antipyrine	mL/min	8.16E+00	0.89								7.76E-01						1.32E-02			2.91E-05		66
Liver	Functional	Phenytoin	mL/min	4.71E+01	0.92								4.13E+00						4.13E+00			7.44E-03		66
Lung																								Lung
Lung	Structural								***averaged values - Reported**								***averaged**							
Lung	Structural	Total Lung Capacity (TLC)	mL	5.35E+01	1.06	70 kg human .25 kg rat				5.50E+03	±	5.00E+02	3.19E+00	5.50E+00		9.50E+00			2.11E-03	5.50E-03		1.39E-06	5.50E-06	72
Lung	Structural	Functional Residual Capacity (FRC)	mL	2.41E+01	1.13	70 kg human .25 kg rat				3.05E+03	±	6.50E+02	1.19E+00	3.05E+00		1.50E+00			4.86E-04	3.05E-03		1.98E-07	3.05E-06	72
Lung	Structural	Tidal Volume	mL	7.69E+00	1.04	70 kg human .25 kg rat				4.50E+02	±	5.00E+01	4.84E-01	4.50E-01		1.65E+00			3.67E-04	4.50E-04		2.79E-07	4.50E-07	72
Lung	Structural	Dead Space	mL	2.76E+00	0.96	70 kg human .25 kg rat				1.50E+02	±	0.00E+00	2.15E-01	1.50E-01		7.90E-01			2.83E-04	1.50E-04		3.73E-07	1.50E-07	72
Lung	Functional	Frequency of Respiration	min-1	5.35E+01	-0.26	70 kg human .25 kg rat				1.65E+01	±	5.50E+00	1.07E+02	1.65E-02		1.06E+02			6.44E+02	1.65E-05		3.88E+03	1.65E-08	72
Lung	Functional	Minute Volume (ml/min)	mL/min	3.79E+02	0.80	70 kg human .25 kg rat				6.50E+03	±	5.00E+02	4.52E+01	6.50E+00		2.00E-01			1.80E-01	6.50E-03		7.16E-04	6.50E-06	72
Lung	Functional	Lung Compliance	mL/cm H2O	2.10E+00	1.08	70 kg human .25 kg rat				1.63E+02	±	3.75E+01	1.19E-01	1.63E-01		4.50E-01			6.84E-05	1.63E-04		3.93E-08	1.63E-07	72
Lung	Functional	Flow Resistance	cm H2O/(L/sec)	2.44E+01	-0.70	70 kg human .25 kg rat				1.40E+00	±	5.00E-01	1.57E+02	1.40E-03		9.50E+01			1.98E+04	1.40E-06		2.49E+06	1.40E-09	72
Lung	Functional	Diffusion Capacity CO	mL/mmHg/min	2.20E-01	1.14	70 kg human .25 kg rat				3.35E+01	±	1.65E+01	1.06E-02	3.35E-02		4.50E-02			4.03E-06	3.35E-05		1.53E-09	3.35E-08	72
Lung	Functional	Power of Breathing	g*cm/min	9.62E+02	0.78	70 kg human .25 kg rat				4.00E+04	±	1.00E+04	1.21E+02	4.00E+01		6.25E+02			5.53E-01	4.00E-02		2.53E-03	4.00E-05	
Lung	Structural	Organ Weight	g	1.13E+01	0.99	70 kg human .25 kg rat				1.00E+03			8.12E-01			1.50E+00			8.70E-04	1.00E-03		9.33E-07	1.00E-06	72
Lung	Structural	Acinar Diameter	cm	4.20E-02	0.17	70 kg human .25 kg rat				2.86E-01			2.66E-02	2.86E-04		7.40E-02			8.10E-03	2.86E-07		2.47E-03	2.86E-10	73
Lung	Structural	Terminal Bronchiole Diameter	cm	5.20E-03	0.21	70 kg human .25 kg rat				4.40E-02			2.97E-03	4.40E-05		4.10E-03			6.97E-04	4.40E-08		1.63E-04	4.40E-11	73

Lung	Structural	Alveolar Diameter	cm	3.10E-03	0.15	70 kg human .25 kg rat	1.82E-02		2.07E-03	1.82E-05	4.48E-03		7.31E-04	1.82E-08	2.58E-04	1.82E-11	73
Lung	Structural	Surface Area Alveolar Epithelium	m^2		X	70 kg human, 20 g mouse	1.02E+02 ± 2.05E+01			1.02E-01	5.00E-02 ± 2.00E-02			1.02E-04		1.02E-07	74
Lung	Structural	Surface Area Type 1 Epithelium	m^2		X	70 kg human, 20 g mouse	9.60E+01 ± 1.91E+01			9.60E-02	5.00E-02 ± 2.00E-02			9.60E-05		9.60E-08	74
Lung	Structural	Surface Area Type 2 Epithelium	m^2		X	70 kg human, 20 g mouse	6.20E+00 ± 1.50E+00			6.20E-03	1.00E-03 ± 2.00E-04			6.20E-06		6.20E-09	74
Lung	Structural	Capillary Endothelium	m^2		X	70 kg human, 20 g mouse	7.23E+01 ± 1.65E+01			7.23E-02	4.00E-02 ± 1.00E-02			7.23E-05		7.23E-08	74
Lung	Structural	Total Alveolar Septal Tissue Volume	cm^3		X	70 kg human, 20 g mouse	2.30E+02 ± 3.80E+01			2.30E-01	6.30E-02 ± 1.20E-02			2.30E-04		1.02E-07	74
Lung	Structural	Type 1 Cell Volume	cm^3		X	70 kg human, 20 g mouse	3.39E+01 ± 3.39E+01			3.39E-02	1.40E-02 ± 3.00E-03			3.39E-05		9.60E-08	74
Lung	Structural	Type 2 Cell Volume	cm^3		X	70 kg human, 20 g mouse	2.23E+01 ± 2.23E+01			2.23E-02	5.00E-03 ± 1.00E-03			2.23E-05		6.20E-09	74
Lung	Structural	Interstitial Cell Volume	cm^3		X	70 kg human, 20 g mouse	3.84E+01 ± 3.84E+01			3.84E-02	1.30E-02 ± 4.00E-03			3.84E-05		7.23E-08	74
Lung	Structural	Interstitial Matrix Volume	cm^3		X	70 kg human, 20 g mouse	8.55E+01 ± 1.06E+01			8.55E-02	7.00E-03 ± 2.00E-03			8.55E-05		2.30E-07	74
Lung	Structural	Endothelial Cell Volume	cm^3		X	70 kg human, 20 g mouse	4.14E+01 ± 1.28E+01			4.14E-02	2.20E-02 ± 3.00E-03			4.14E-05		3.39E-08	74
Lung	Structural	Alveolar Macrophage Volume	cm^3		X	70 kg human, 20 g mouse	8.20E+00 ± 3.10E+00			8.20E-03	1.30E-03 ± 2.00E-04			8.20E-06		2.30E-07	74
Lung	Structural	Total cell number			1.00	69 kg human, 19.2 g mouse	cell number increases proportionally with body mass	1.84E+11 ± 6.40E+10		1.84E+08	1.19E+08 ± 2.70E+07			1.84E+05		1.84E+02	74
Lung	Structural	Type 1 Epithelial Cell Number			1.00	69 kg human, 19.2 g mouse	cell number increases proportionally with body mass	1.96E+10 ± 9.00E+03		1.96E+07	1.16E+07 ± 3.60E+06			1.96E+04		1.96E+01	74
Lung	Structural	Type 2 Epithelial Cell Number			1.00	69 kg human, 19.2 g mouse	cell number increases proportionally with body mass	3.29E+10 ± 1.36E+10		3.29E+07	1.48E+07 ± 3.90E+06			3.29E+04		3.29E+01	74
Lung	Structural	Interstitial Cell Number			1.00	69 kg human, 19.2 g mouse	cell number increases proportionally with body mass	5.25E+10 ± 1.18E+10		5.25E+07	2.69E+07 ± 3.60E+06			5.25E+04		5.25E+01	74
Lung	Structural	Endothelial Cell Number			1.00	69 kg human, 19.2 g mouse	cell number increases proportionally with body mass	7.32E+10 ± 2.88E+10		7.32E+07	6.28E+07 ± 1.53E+07			7.32E+04		7.32E+01	74
Lung	Structural	Alveolar Macrophages Number			1.00	69 kg human, 19.2 g mouse	cell number increases proportionally with body mass	5.99E+09 ± 1.90E+09		5.99E+06	2.90E+06 ± 5.00E+05			5.99E+03		5.99E+00	74
Lung	Structural	Tracheal Radius	cm	N/A	0.39		Theoretical: 0.375 Experimental: 0.39	2.50E+00			2.50E-03			2.50E-06		2.50E-09	75
Lung	Structural	Volume of Alveolus	μm^3	N/A	0.25		Theoretical: 0.25 (assuming sphere and radius of 100 um)	4.19E+06			4.19E+03			4.19E+00		4.19E-03	75
Lung	Structural	Number of Alveoli		N/A	0.75		Theoretical: 0.75	4.00E+08 ± 1.00E+08			4.00E+05			4.00E+02		4.00E-01	75
Lung	Structural	Area of Alveolus	μm^2	N/A	0.17		Theoretical: 0.167 (assuming sphere and radius of 100 um)	1.26E+05			1.26E+02			1.26E-01		1.26E-04	75
Lung	Structural	Area of Lungs	m^2	N/A	0.95		Theoretical: 0.92 Experimental: 0.95	7.00E+01			7.00E-02			7.00E-05		7.00E-08	75
Lung	Metabolic	O2 Consumption Rate	mL/hr/g	N/A	0.75		Theoretical: 0.75 Experimental: 0.76	2.00E-01			2.00E-04	8.40E-01		2.00E-07		2.00E-10	75
Blood																	Blood
Blood	Structural	Volume	mL	7.60E-02	1.00		p value<.001	4.85E+03 ± 1.50E+02	5.32E-03	4.85E+00	2.00E+00 ± 5.00E-01	5.32E-06	4.85E-03	5.32E-09	4.85E-06	61;76	
Blood	Structural	Albumin	g/L	5.68E+00	0.30		p value<.01	4.50E+01 ± 1.00E+01	2.59E+00	4.50E+01	2.75E+01 ± 2.50E+00	3.35E-01	4.50E+01	4.33E-02	4.50E+01	61	
Blood	Structural	Creatinine	umol/L	5.83E+01	0.14		p value<.001	8.90E+01 ± 2.90E+01	3.99E+01	8.90E+01	4.86E+01 ± 3.09E+01	1.48E+01	8.90E+01	5.53E+00	8.90E+01	77-79	
Blood	Structural	K+	mmol/L	5.20E+00	-0.03		p value<.001	4.80E+00 ± 1.30E+00	5.66E+00	4.80E+00	6.25E+00 ± 1.25E+00	7.06E+00	4.80E+00	8.81E+00	4.80E+00	77;78;80	
Blood	Structural	Urea	mmol/L	7.30E+00	-0.08		p value<.001	4.10E+00 ± 2.90E+00	9.10E+00	4.10E+00	3.41E+00 ± 2.08E+00	1.62E+01	4.10E+00	2.87E+01	4.10E+00	77-79	
Blood	Structural	Hematocrit	% Volume	4.21E+01	-0.02		p value<.001	5.05E+01 ± 1.15E+01	4.45E+01	5.05E+01	4.40E+01 ± 5.00E+00	5.15E+01	5.05E+01	5.95E+01	5.05E+01	77;78;81	
Blood	Structural	Hemoglobin	g/L	1.44E+02	-0.02		p value<.001	1.53E+02 ± 2.25E+01	1.53E+02	1.53E+02	1.34E+02 ± 3.20E+01	1.81E+02	1.53E+02	2.14E+02	1.53E+02	77;78;81	
Blood	Structural	Glucose	mmol/L	6.40E+00	-0.05		p value<.001	4.95E+00 ± 1.15E+00	7.25E+00	4.95E+00	6.58E+00 ± 3.14E+00	1.00E+01	4.95E+00	1.39E+01	4.95E+00	77-79	
Blood	Structural	Triglycerides	mmol/L	9.00E-01	-0.14		p value<.001	9.00E-01 ± 3.00E-01	1.29E+00	9.00E-01	9.22E-01 ± 2.40E-01	3.27E+00	9.00E-01	8.32E+00	9.00E-01	77-79	
Blood	Structural	Total Protein	g/L	6.43E+01	0.01		p value= 0.011	7.20E+01 ± 1.20E+01	6.21E+01	7.20E+01	5.35E+01 ± 1.85E+01	5.68E+01	7.20E+01	5.19E+01	7.20E+01	77-79	
Blood	Structural	Ca2+	mmol/L	2.60E+00	-0.01		p value=0.034	1.17E+00 ± 1.35E-01	2.67E+00	1.17E+00	2.15E+00 ± 3.70E-01	2.86E+00	1.17E+00	3.07E+00	1.17E+00	77;78	
Blood	Structural	Na+	mmol/L	1.46E+02	0.00		p value=0.039	1.41E+02 ± 6.00E+00	1.47E+02	1.41E+02	1.50E+02 ± 1.00E+01	1.51E+02	1.41E+02	1.55E+02	1.41E+02	77;78	
Blood	Structural	Phospohorus	mmol/L	1.90E+00	-0.02		p value=0.118	1.25E+00 ± 2.50E-01	2.00E+00	1.25E+00	2.41E+00 ± 5.65E-01	2.30E+00	1.25E+00	2.64E+00	1.25E+00	77;78;81	

Blood	Structural	Cl-	mmol/L	1.05E+02	-0.01	p value=0.299	1.03E+02 ± 7.50E+00	1.07E+02	1.03E+02	9.90E+01 ± 1.10E+01	1.13E+02	1.03E+02	1.19E+02	1.03E+02	77;78
Blood	Structural	Total Bilirubin	umol/L	4.20E+00	-0.09	p value=0.528	1.34E+01 ± 1.17E+01	5.32E+00	1.34E+01	7.70E+00 ± 7.70E+00	9.84E+00	1.34E+01	1.82E+01	1.34E+01	77;78;81
Blood	Structural	Mg2+	mmol/L	9.00E-01	-0.03	p value=0.721	1.90E+00 ± 4.00E-01	9.64E-01	1.90E+00	2.35E+00 ± 1.55E+00	1.15E+00	1.90E+00	1.38E+00	1.90E+00	77;78;82
Blood	Structural	Cholesterol	mmol/L	2.70E+00	-0.04	p value=0.774	4.75E+00 ± 1.75E+00	3.00E+00	4.75E+00	2.88E+00 ± 6.70E-01	3.96E+00	4.75E+00	5.22E+00	4.75E+00	77-79
Blood	Functional	Wall Shear Stress Along the Infrarenal Aorta**	dyn/cm^2	2.60E+00	-0.38	p value<.05	4.80E+00 ± 3.00E-01	7.14E+00	4.80E+00	8.76E+01 ± 8.30E+00	9.86E+01	4.80E+00	1.36E+03	4.80E+00	83
Blood	**Functional**	**Oxygen Carriers**	**Relative oxygen capacity**	**α (mL O2/(mL B *atm)) at 37 C**	**Oxygen binding capacity (mL O2/g)**	**Oxygen Diffusivity *10^9 (m^2/s)**									Blood O2 Carriers
Blood	Functional	Water	1	2.39E-02	-	2.89									84;85
Blood	Functional	Hemoglobin	70	3.30E-02	1.37	0.838									85
Blood	Functional	Perfluorocarbon	20	3.50E-01	-	8.29									86;87
Blood	Functional	Blood	70	2.23E-02	-	1.33									85

NOTES

1 In certain cases, the literature values for the allometric scaling laws were for body mass in units other than kg, and hence have been scaled for consistency

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