Supplementary Information

Limits of aerobic metabolism in cancer cells

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Component	% of cell weight	% of cell dry weight				Energy demand (mol ATP/L cell)		
Water	70		Unit	Unit MW (g/mol)	Unit concentration (M)	Per precursor	From glucose	NADH OxPhos (mol ATP/L cell)
Ref.	[1]			[2]		[2]		
Protein	18	60.0	Amino acids	109	1.10	4.30	4.62	1.57
Lipids	5	16.7	Ac	28	1.19	0.88	1.04	5.95
Polysaccharides	2	6.7	Glucose	180	0.07	0.00	0.15	0.00
RNA	1.1	3.7	Ribonucl.	331	0.02	0.40	0.06	0.06
DNA	0.25	0.8	Deoxyribonucl.	332	0.01	1.37	0.02	0.01
Total	96.4	87.8					6.0	7.6
Synthesis from glucose: (+) produced, (-) consumed								
Molecule	Frequency in precursor	ATP/molecule	ATP/precursor	NADH	glu -> akg	Net NADH produced per precursor unit		
Ref.	[2]	[3]		[3]	[3]			
ala	0.087	1	0.087	1	1	0		
arg	0.055	0	0	2	1	0.055		
asn	0.042	-1	-0.042	1	1	0		
asp	0.052	0	0	1	1	0		
cys	0.021	0	0	2	1	0.021		
glu	0.056	1	0.056	3	0	0.168		
gln	0.047	0	0	3	0	0.141		
gly	0.078	0	0	2	1	0.078		
pro	0.045	0	0	1	0	0.045		
ser	0.062	0	0	2	1	0.062		
amino acids	0.545		0.101			0.570		
AcCoA	1.00	0	0	2	0	2		
polysaccharides	1.00	-2	-2	0	0	0		
purine	0.50	-6	-3	1	0	1		
pyrimidine	0.50	-3	-1.5	1	0	1		
RNA			-2.25			1		
DNA			-2.25			1		
Parameter	Value	Units	Ref.					
Maintenance energy	17	pmol/cell/day	[4]					
Cell volume	3.4	pL	[4]					
Maintenance energy	5	M/h						
Cell specific volume	0.005	L/g	[5]					

Table S1: Biosynthetic demands of cell biomass duplication from glucose.

		r_M		
Cell line/tissue	Cell type	mmol ATP/g mitochondria protein/min	mol ATP/L mitochondria/min	Reference (PMID)
PC-3	prostate cancer	0.11	0.042	[6]
HeLa	cervical cancer	0.13	0.049	[7]
Liver	normal liver	0.18	0.068	[8]
Liver	normal liver	0.25	0.095	[9]
Lateralis	skeletal muscle	0.35	0.133	[10]
Heart	heart muscle	0.40	0.152	[11]
Gastrocnemius medialis	skeletal muscle	0.52	0.198	[12]
Soleus	skeletal muscle	0.70	0.266	[8]
Yeast	microorganism	0.75	0.285	[13]
Heart	heart muscle	0.84	0.319	[8]
Plantaris	skeletal muscle	1.00	0.380	[8]
Glycolysis	muscle	1.20	1.519	[14]
	Specific volume			
Mitochondria specific volume	2.63	mL/g		[15]
Globular proteins specific volume	0.79	mL/g		[16]

Table S2: ATP generating capacity of mitochondria from different tissues and cells lines and from glycolysis.

Reference (PMID)	Cell line	Td (h)	Td Reference (PMID)	ATP production/demand (mol ATP/L/h)		
				Total	Growth	Maintenance
[17]	HeLa	25	[17]	0.55	0.17	0.39
[18]	HCT116	17.4	NCI60	0.40	0.24	0.16
	HT29	19.5	NCI60	0.31	0.21	0.09
[19]	TOV21G	25	[20]	0.73	0.17	0.57
	ES2	19	[20]	0.73	0.22	0.51
	OVCAR3	51	[20]	0.45	0.08	0.37
	DOV13	21.3	[21]	0.43	0.20	0.23
	OVCA433	29.4	[21]	0.52	0.14	0.37
	OVCA429	29.4	[21]	0.49	0.14	0.35
	OVCA420	25.6	[22]	0.34	0.16	0.18
	Average					5.4
	STD					2.6

Table S3: Cell energy maintenance of cancer cells.

Cell line	Doubling time	Mitochondrial volume %
LE:SR	28.7	0.71
BR:HS578T	53.8	2.35
LE:MOLT-4	27.9	2.52
BR:MDA-MB-231	41.9	2.67
ME:SK-MEL-5	25.2	2.68
RE:A498	66.8	2.71
LE:HL-60	28.6	2.84
LE:K-562	19.6	2.86
RE:UO-31	41.7	2.87
CNS:SF-539	35.4	2.89
BR:T-47D	45.5	3.23
ME:SK-MEL-2	45.5	3.30
LE:CCRF-CEM	26.7	3.41
OV:OVCAR-8	26.1	3.49
BR:BT-549	53.9	3.53
LE:RPMI-8226	33.5	3.63
OV:SK-OV-3	48.7	3.69
RE:ACHN	27.5	3.89
RE:CAKI-1	39	3.94
ME:UACC-257	38.5	3.98
CO:HCT-116	17.4	4.06
ME:MDA-MB-435	25.8	4.17
OV:OVCAR-8/ADR	34	4.20
CNS:SF-268	33.1	4.29
CNS:SF-295	29.5	4.31
OV:IGROV1	31	4.42
ME:SK-MEL-28	35.1	4.43
CO:COLO205	23.8	4.60
ME:LOXIMVI	20.5	4.62
RE:786-0	22.4	4.69
CNS:SNB-75	62.8	4.81
LC:NCI-H322M	35.3	5.07
RE:SN12C	29.5	5.07
ME:M14	26.3	5.12
OV:OVCAR-5	48.8	5.15
RE:RXF-393	62.9	5.46
RE:TK-10	51.3	5.57
CO:HT29	19.5	5.72
LC:HOP-62	39	5.79
PR:DU-145	32.3	5.94
ME:MALME-3M	46.2	6.07
CNS:U251	23.8	6.20
LC:NCI-H226	61	6.41
ME:UACC-62	31.3	6.82
CO:HCT-15	20.6	6.99
PR:PC-3	27.1	7.13
CO:SW-620	20.4	7.14
CNS:SNB-19	34.6	7.16
CO:HCC-2998	31.5	7.23
LC:EKVX	43.6	7.41
LC:A549/ATCC	22.9	7.77
OV:OVCAR-3	34.7	7.86
LC:HOP-92	79.5	7.92
LC:NCI-H460	17.8	8.33
CO:KM12	23.7	8.36
BR:MCF7	25.4	8.62
LC:NCI-H522	38.2	8.91
LC:NCI-H23	33.4	9.42
OV:OVCAR-4	41.4	10.47

Table S4: Estimated protein content of the NCI60 cell lines.

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