

Glycerol biosynthetic pathway plays an essential role in proliferation and antioxidative defense in the human enteric protozoan parasite *Entamoeba histolytica*

Ghulam Jeelani¹, Emmanuel Oluwadare Balogun^{1,2}, Afzal Husain³ and Tomoyoshi Nozaki¹

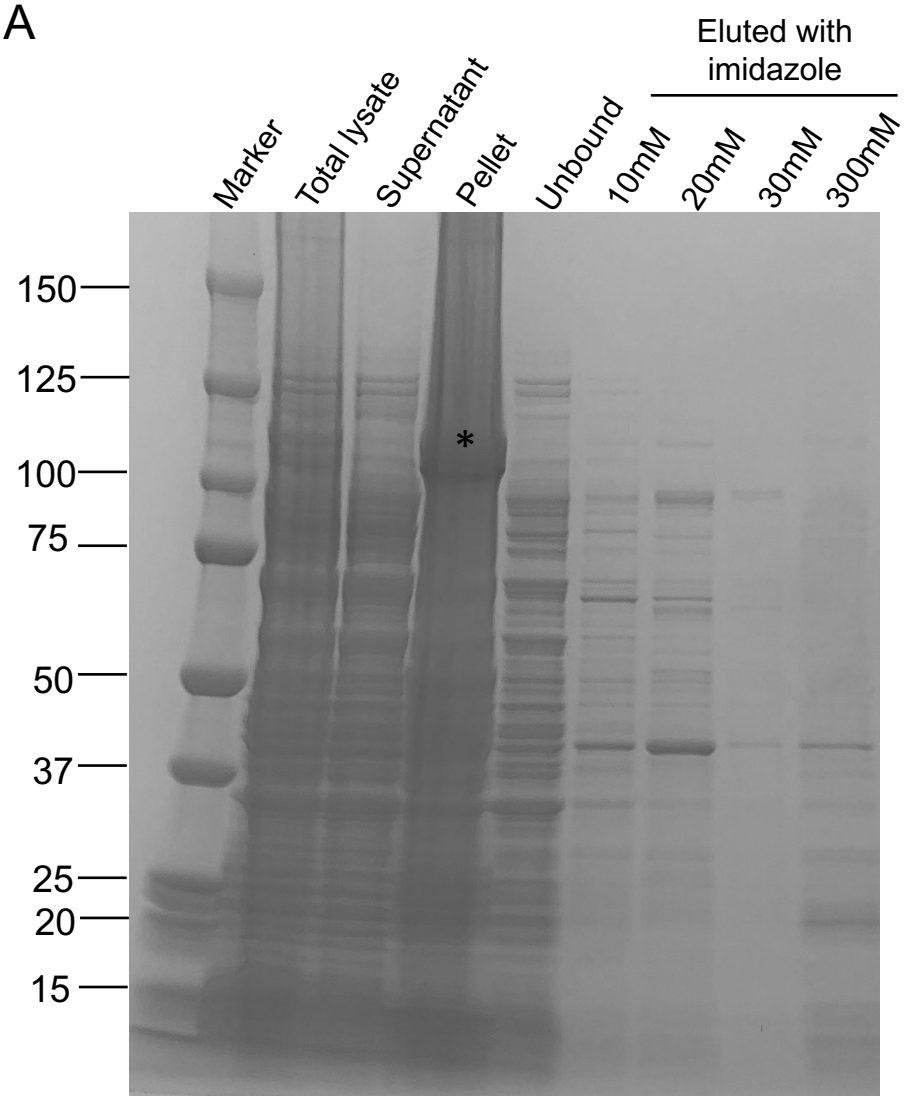
¹Department of Biomedical Chemistry, Graduate School of Medicine, The University of Tokyo, Japan.

²Department of Biochemistry, Ahmadu Bello University, Zaria, Nigeria.

³Department of Biochemistry, Faculty of Life Sciences, Aligarh Muslim University, Aligarh, India.

Fig. S1

A



B

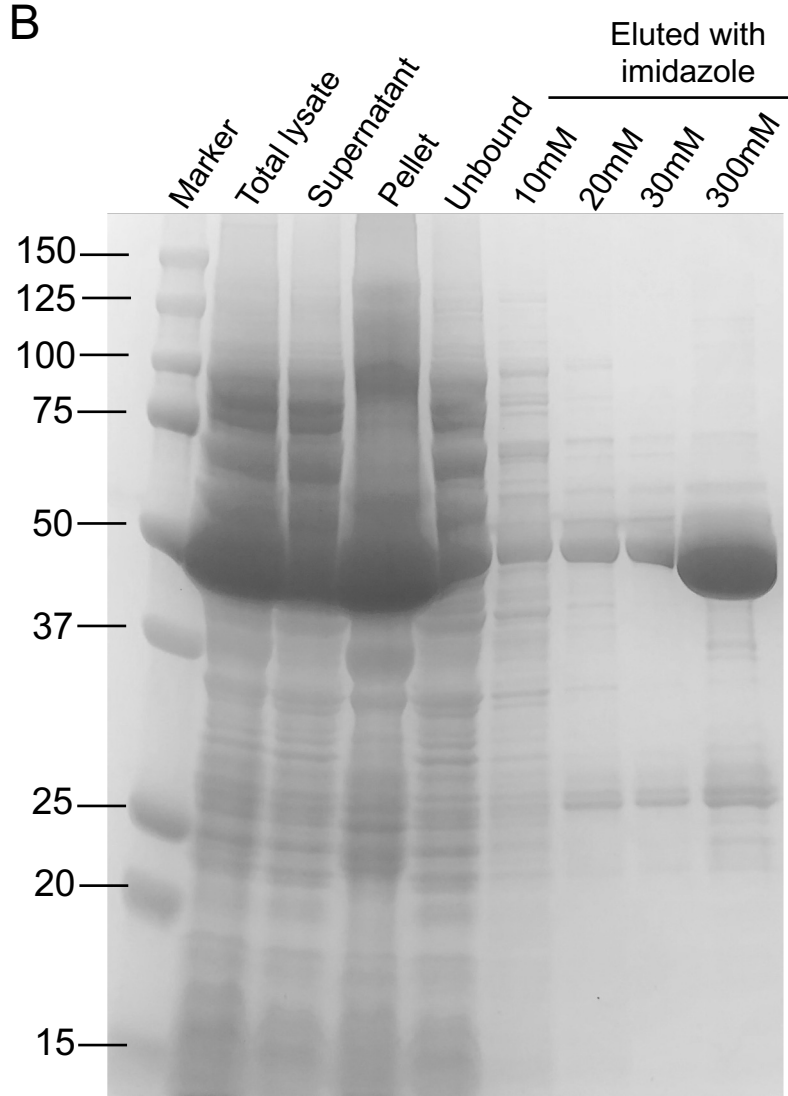


Fig. S2A

<i>E. histolytica</i>	-----	0
<i>G. lamblia</i>	-----MTTAHPLPIQSHTFFDSPQ	19
<i>E. coli glpA</i>	-----	0
<i>E. coli glpB</i>	-----	0
<i>H. sapiens</i>	MAFQKAVKGTILVGGGALATVLGLSQFAHYRRKQMNLAYVKAADCISEPVNRE-PPSREA	59
<i>E. histolytica</i>	-----MSSYDIVIIIGAGCTGACCAMELSKYKNLKIALLEKARDVSTGATSANSNGIVHC	53
<i>G. lamblia</i>	PFAKLASADIYDLAIIGGGISGVSAALEASH-TTLKSILLERGLETSVATTRANSNGIVHC	78
<i>E. coli glpA</i>	--MKTRDSQSSDVIIIGGGATGAGIARDCAL-RGLRVILVER-HDIATGATGRNHGLLHS	56
<i>E. coli glpB</i>	-----METKDLIVIGGGINGAGIAADAAG-RGLSVLMLEA-QDLACATSSASSKLIHG	51
<i>H. sapiens</i>	QLLTLQNTSEFDILVIGGGATGSGCALDAVT-RGLKTALVER-DDFSSGTSSSRSTKLIHG	117
	. *: :*. * . * : * : : * : : . : *	
<i>E. histolytica</i>	GIDTTLETCLKGR-----LV---VRGNTLIHELQPKLNFGLTTCGELMVAKTDEEIPNL-	103
<i>G. lamblia</i>	GVHTTQGTCLKAQ-----LE---QKGRRIFAHLCKSLNVSLRRCGELVIARNEAELNAL-	128
<i>E. coli glpA</i>	GARYAVTD-----AESARECISENQILKRIARHCVEPTNG---LFITLPEDDLSFQ-	104
<i>E. coli glpB</i>	GLRYLEHY-----EFRLVSEALAEREVLLKMAPHIAFPMRF---RMPHRPHLRPAWMI	101
<i>H. sapiens</i>	GVRYLQKAIMKLDIEQYRMVKEALHERANLLEIAPHLSAPLPI---MLPVYKWWQLPY-Y	173
	* . : . :	
<i>E. histolytica</i>	----NKYM----EIAKTKNVPVELWDYEKIHKEEPNLSE-NIKKAIYCPTTSVLDPYEFT	154
<i>G. lamblia</i>	----QELQ----KSCAALDLECSLWGPARGVKEEPLNLAIDSIAGALSIPETSVVNPFEIC	180
<i>E. coli glpA</i>	--ATF-----IRACEEAGISAEADPQQARIIEPAVNPALIGAVKVPD-GTVDPFRLT	154
<i>E. coli glpB</i>	RIGLFMYDHLGKRTSLPGSTG--LRFGAN-----SVLKPEIKRGFEYSD-CWVDDARLV	152
<i>H. sapiens</i>	WVGIKLYDLVAGSNCLKSSYV--LSKSRALHF-PMLQKDKLVGAIVYYD-GQHNDARMN	229
	. . : .. : . :	
<i>E. histolytica</i>	IATCLTAKANGVHIYTSTTVNGIKKIDNGY-EVV----CENGKK-----	193
<i>G. lamblia</i>	NAMANCAMANGVEISCGSTVTGIRKINRLA-EEDGDALVESAPKVFELRISR-QGSSPV	238
<i>E. coli glpA</i>	AANMLDAKEHGAVILTAHEVTGLIR-----EGATV--C-----GVRIRNHLTGETQ	198
<i>E. coli glpB</i>	LANAQMVVRKGGEVLTRTRA-----T-SARRENGL--W-----IVEAEDIDTGKKY	195
<i>H. sapiens</i>	LAIALTAARYGAATANYMEVVSLLKKTDPQTGKVRV--S-----GARCKDVLGTGQEF	279
	* . *	
<i>E. histolytica</i>	-FIAKVLLNCAGVFASQVSEMLY-P-ADFHITARKGEEYLLDRKLQGMVKHVFPCP--T	248
<i>G. lamblia</i>	YLYAQTVINATGVDAGSVTELLKNA-TPINITKRRGELYVLDKNLKDVVTRVIFSVIPNN	297
<i>E. coli glpA</i>	ALHAPVVVNAAGIWGQHIAEYADLRI--RMFPAKGSLLIMDHRIN---QHVINRCR-KP	251
<i>E. coli glpB</i>	SWQARGLVNATGPVWKQFFDDGMHLPSPYGIRLIKSHIVVPRVHT---QKQAYI--LQN	250
<i>H. sapiens</i>	DVRACVIVINATGPFTDSVRKMDDKDA-AAICQPSAGVHIVMPGYYS---PESMGLLDPAT	335
	* :*:.* . . * : :	
<i>E. histolytica</i>	GVTKGTLIIPTVDGTIMVGPNAIDQDS----YTDATTTSEGLKKVFDL---AKLLVPTIN	301
<i>G. lamblia</i>	ASSKGMLIIPTVDGTVMVGPTAEPLGSTGSNMADIETTEDGRSTIFAH---AHALCPRIV	354
<i>E. coli glpA</i>	SDA--DILVP-GDTISLIGTTSLRIDYNEI--DDNRVTAAEEVDILLREGEK---LAPVMA	303
<i>E. coli glpB</i>	EDKRIVFVIPWMDEFSIIGTTDVEYKGDPK---AVKIEESEINYLNNVYNTH--FKKQLS	305
<i>H. sapiens</i>	SDGRVIFFLPWQK-MTIAGTTDTPDVTHH---PI-PSEEDINFILNEVRNYLSCDVEVR	390
	:*: . : * . . . : :	
<i>E. histolytica</i>	NMDVISAFAGLRPAIIIEHND-----FVIRENEKFPCFIEVVGIQSPGLTASPA	349
<i>G. lamblia</i>	PEEIMYSFASAR-AVIPSND-----FVIRDEDG---FIQCAGIQSPGLTAGPA	398
<i>E. coli glpA</i>	KTRILRAYSGVRPLVASDDDPSGRNVSRGIVLLDHAERDGLDGFITITGGK---LMTYRL	360
<i>E. coli glpB</i>	RDDIVWITYSGVRPLCDDESD-SPQAITRDYTL-DIHDENGKAPLLSVFVGK---LTTYRK	360
<i>H. sapiens</i>	RGDVLAASGIRPLVTDPKSADTQSIISRNHVV-DIS----ESGLITIAGGK---WTTYRS	442
	: : :*: * . . : : * : :	

<i>E. histolytica</i>	IAEYTKNIFI-----EAVKKSHPEIVLEEKSDFKYVP-----L-----SKKFRN	388
<i>G. lamblia</i>	IGAYLIELVK-----LRYPSHRMSSIVKPPEAWFWYP-----I-----TSRLCR	437
<i>E. coli glpA</i>	MAEWATDAVCRK-LGNTRPCTTADLALPGSQEPAEV-TLRKVISLPAPLRGSAVYRHGDR	418
<i>E. coli glpB</i>	LAEHALEKLTPY-YQGIGPAWTKESVLPGGAIEGDRDDYAARLRRRYPFLTESLARHYAR	419
<i>H. sapiens</i>	MAEDTINA AVKTHNLKAGPSRTVGLFLQGKDWSP--PTLYIRLVQDYGL-ESEVAQH LAA	499
	:. : :	
<i>E. histolytica</i>	MNDSERAEAA-----KKDAAYSKIVCVCEKVTEGDVNAAIDE-GA-RTVDAIKL	435
<i>G. lamblia</i>	TALDKRHGLI-----EKDLNFSKIVCGCECVTEADIENAI TE-GA-RSITGLKL	484
<i>E. coli glpA</i>	T-----PAWLSEGR LHRSLVCECEAVTAGEVQYAVENLNVNS-LLDLRR	461
<i>E. coli glpB</i>	TYGSNSELL LGNAGTV----SDLGE---DF--GH-EFYEAELKYLVDHEWVRRADDALWR	469
<i>H. sapiens</i>	TYGDKAFEVAKMASVTGKRWP IGV---RLVSEF-PYIEAEVKYGIKE-YACTAVDMISR	554
	. : . : . :	
<i>E. histolytica</i>	RTRAGMGRCQGSYCTPRVMEILSKRLNIPMTAVA-----KNYPG-----	474
<i>G. lamblia</i>	RTRATAGRCQGSFCSSKLRKLLAARLGVSYEQVCRISHNTPMDKAYPS-----	532
<i>E. coli glpA</i>	RTRVGMGTCQGELCACRAAGLLQ-RFNVT TSAQSIEQLSTFLNERWKGVQPIAWGDALRE	520
<i>E. coli glpB</i>	RTKQGMWL-----NADQQS-----RVSQWLVEY TQ	494
<i>H. sapiens</i>	RTRLA-FL-----NVQA AEEALPRIVELMG-----RELNWDDYKKQ	589
	**:	

Fig. S2B

<i>E. histolytica</i>	-----TIERKEFDIVVVGGG	526
<i>G. lamblia</i>	-----VQCIHAFDLVVLTGT	594
<i>E. faecalis</i>	-----MKIIVIIGAS	9
<i>S. loihica</i>	-----MKKILIIIGGV	10
<i>B. anthracis</i>	-----MNYVIIGGD	9
	. : : *	
<i>E. histolytica</i>	PSGLAAAKAALETKKDLKVAVIERMervGG---VLLQCIHSGFGLGRYGEELTGPEYAYR	583
<i>G. lamblia</i>	PAGLGAALAAAYDTNPdARILVITKDAYVGG---SLMYALHRSHNAGDGSTALTGPEFAVQ	651
<i>E. faecalis</i>	FAGISAAIASRKKYPQAEISLIDKQATVGYLSSGLSAYFNHTINELHEARYITEEEL-RR	68
<i>S. loihica</i>	AGGASAAARARRLSETAEIIMFERGEYVSFANCGLPYHISGEIAQRSALVLQTPESFKAR	70
<i>B. anthracis</i>	AAGMSAAMQIVRNdenANVVTLEKGEIYSAQCGLPYVISGAIASTEKLIARNVKTFRDK	69
	. * . ** . : :	
<i>E. histolytica</i>	LGEETEAAAGAVLMVNTYVT--DVENK--GEEYVVKAVVYGTAPVEIHAKKCIFTVGCRR	639
<i>G. lamblia</i>	LREDLMKTGVITILNTFIL--DSSYNTSRKLFtVKCMSANVGQLEISAKAVIFCLGSREK	709
<i>E. faecalis</i>	QKIQL-----LLNREVVAMDVENQ----LIAWTRK---EEQQWYSYDKLILATGAS--	112
<i>S. loihica</i>	FNVEV-----RVKHEVVAIDRAK----LVTVRRL-LDGSEYQESYDTLLLSPGAA--	116
<i>B. anthracis</i>	YGIDA-----KVRHEVTKVDTEKK----IVYAEHT-KTKDVFEFSYDRLLIATGVR--	115
	: : : * :	
<i>E. histolytica</i>	SRFGIKVAGTRCAGVMTA---GLAQALVNYKGILPGKKVVIQGGSDIGLIMARRMALEGA	696
<i>G. lamblia</i>	HRFNAAIPGTRPYGVMTA---DAALRSIAFDNVLPgKRVVIFGGSDSGLLAARQISISGG	766
<i>E. faecalis</i>	-QFSTQIRGSQTEKLLKYKFLSGALA--AVPLLENSQTVAVIGAGPIGMEaIDFLVKMKK	169
<i>S. loihica</i>	-PIVPPIPGVDNPLTHSLRNIPDMDRILQTIQMNNVEHATVVGGAIGLEMESLHHLGI	175
<i>B. anthracis</i>	-PVMPEWEGRDlQGVHLLKTIpDAERILKTLETNKVEDVTIIGGAIGLEMAETfVELGK	174
	. * : : : * . : :	
<i>E. histolytica</i>	KVLGVYEILPKIS-----GLQRNVVQCCKDFNIPIHLSEVVTRINGYPRITSVIMTK--	748
<i>G. lamblia</i>	QVLGIYEPESHLV-----GNSQYLDLLTKEFDIPISYNKSISRINGQGVIesVCIAP--	818
<i>E. faecalis</i>	TV-HVFESLENLLPKYFDKEMVAEVQKSLEKQAVIFHFEETVLGIEETA-----	217
<i>S. loihica</i>	KT-TLLELADQVM-TPVDREMAGFAHQAIrDQGVDLRLGTALSEVSyQVQTHVASDAAGE	233
<i>B. anthracis</i>	KV-RMIErNDHIG-TIYDGDMAEYIYKEADKHhIEILTnENVK-----	215
	. : * : :	
<i>E. histolytica</i>	-----CDPKTLAPIAGTEYEIECDCLLSVGLIPLPDLTQQAGHNVQLNPRTRGPIVD	801
<i>G. lamblia</i>	-----VNPLTKGVTADEaETVACDCLVTSLGTLpQMALVKMGCKGV-SSQYCGLLVD	870
<i>E. faecalis</i>	-----NGIVLETSEQEISCDSGIFALNLHPQLAYLD-KKIQRN---LDQTIAV	261
<i>S. loihica</i>	DTAHQHIKGH--LSLTLSNGELLETDLLIMAIGVRPETQLARDAGLAIG---ELGGIKV	287
<i>B. anthracis</i>	-----AFKGNERVEAVETDKGTYKADLVLVSVGVKPNtDFLEGTNIrTN---HKGAIEV	266
	* : : . *	
<i>E. histolytica</i>	GF--RCVEKGIYAAGNQLHVH-----DLADEASNEGAIAGEAAALSLGGEKEAIK	849
<i>G. lamblia</i>	NRCaVASDKLLYAAGGNLHCH-----PSAESSFAEGKLAGFNAAIDVGDTARSYN	920
<i>E. faecalis</i>	DAYLQTSVPNVFAIGDCISVMNEPVAETfYAPLVNNAVRTGLVVANN----LEEKThRFI	317
<i>S. loihica</i>	NAMMQTSdPAIYAVGDAVEEQDFVTGQACLVPLAGPANRQGRMAADN----MFGREERYQ	343
<i>B. anthracis</i>	NAYMQTNVQDVYAAGDCATHYHVIKEIHDHIPiGTTANKQGRLAGLN----MLDKRRaFK	322
	. : * * . : * . . : .	

<i>E. histolytica</i>	V-----IPAPELLYCVPERVVISDKKQKLSFRFRQDFGSAHVIAKIG	891
<i>G. lamblia</i>	PP-----SVNLTSE--TNRSDIKYFMPQSITLSKRPTDK-----SG	955
<i>E. faecalis</i>	GSLRTMGTKVGDYYLASTGLTETEGLEFF-----PQTLA-----	350
<i>S. loihica</i>	GTQGTAICKVFDLAVGATGKNEKQLKQA-----GIAFE-----	376
<i>B. anthracis</i>	GTLGTGIIKFMNLTARTGLNEKEAKGL-----HIPYK-----	355

:

<i>E. histolytica</i>	ETIIIGEEEIEHAIPAEMGHVWVIPKDCQIGQEVTTLTVIPKAHEEVTEQKEGE-IVKHMNC	950
<i>G. lamblia</i>	ETFIY-----FKTTRAMANVRVTVSTTSTGKVLATE----KFREVSPTVVTRMVVSNSAF	1006
<i>E. faecalis</i>	-----SVIV-----RQPA	358
<i>S. loihica</i>	-----KVYV-----HTASHA	386
<i>B. anthracis</i>	-----TVKV-----DSTNMA	365

* *

<i>E. histolytica</i>	IVCPRGCPIEVKIDAKSNEITSIKGNSCPRGAAYVRQE-----	988
<i>G. lamblia</i>	QDLVPGVNITLKLDFPHEF-----SVKV-----	1031
<i>E. faecalis</i>	PPLQHGTEILGKLIYDKVTQRVLGAQLCSKNNCLEKINTLALSIQTGQTLTDLQKDYFY	418
<i>S. loihica</i>	SYYPGAEVVSFKLLFDPVKGTIFGAQAVGKDGDIDKRIDVMAVAQRAGMTVEQLQHLELSY	446
<i>B. anthracis</i>	GYYPNAKPLYLKLLYRSDTKQLLGGQVIGEEGVDKRIDVIAMALFNKMSIHDLEDVDLSY	425

. : *: :

<i>E. histolytica</i>	-----HIEPFRVFSTTL-----PVE-GGNLIRVPVKLT	1015
<i>G. lamblia</i>	-----DNRLLGVFSTAI-----PVL-NGAKPHVIVKNK	1058
<i>E. faecalis</i>	QPSLTNIYDITNLMGASAYWRENDES-----	444
<i>S. loihica</i>	APPYGSAKDVINQAAFVASNIIKGDATPIHFDQIDNLSEDQLLLDVRNPGELQNGGLEGA	506
<i>B. anthracis</i>	APPYNSVWDPIQQAARRAE-----	444

. :

<i>E. histolytica</i>	KPVPRSKIFEVMEIIHKQS--PIKAPINK-GQVL-VKI----PKMTDIVACYPVVALEE-	1066
<i>G. lamblia</i>	TPVPVDRMSSVLKELNATPAIQVEAPVSA-GQTVLRNV----AGQTDVFACENIPAMK--	1111
<i>E. faecalis</i>	-----	444
<i>S. loihica</i>	VNIPVDELRRDMHELPHKDKKEIIIFCQVGLRGNVAYRQLVNNGYRARNLIGGYRTYKFASV	566
<i>B. anthracis</i>	-----	444

Fig. S3

