# **Glycerolipid and Glycerophospholipid biosynthesis**

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### Introduction

Major constituents of the bacterial cell wall such as Phosphatidylethanolamine (PE), Phosphatidylglycerol (PG), and Cardiolipin (CDL) as well as precursor for fatty acid biosynthesis 1,2 Diacyl-sn-Glycerol are produced via Glycerophospholipid and Glycerolipid pathways (1, 2). Due to the multiple shared intermediates both pathways share a number of enzymes (see the diagram). In particular, both pathways (Glycerolipid and Glycerophospholipid biosynthesis) share two key enzymes, glycerol-3-phosphate O-Acyltransferase and 1-acylglycerol-3-phosphate O-Acyltransferase. Pathway of Glycerolipid formation starts by converting Glycerone Phosphate (glycolysis intermediate) into Glycerol-3-Phosphate, followed by a number of enzymatic conversions to Diacylglycerol (C00641). Pathway of Glycerophospholipid biosynthesis originates from the glycolysis forming numerous constituents of the bacterial cell wall. A number of the microorganisms, such as *Bacillus subtilis* and *Staphylococcus* species, showed the absence of the *plsB* gene, which was shown to be essential in other bacteria(3). This is a *missing gene problem* in this subsystem (4). Both pathways appear to be present in multiple bacteria added to the subsystem.

- 2. Gerhard M. "Biochemical pathways" New York, 1999.
- 3. Athenstaedt K, Daum G. "Phosphatidic acid, a key intermediate in lipid metabolism." *Eur J Biochem*. 1999 Nov;266(1):1-16.
- 4. Osterman A. and Overbeek R. "Missing genes in metabolic pathways: a comparative genomics approach" *Curr Opin Chem Biol*. 2003 Apr;7(2):238-51.

<sup>1.</sup> Raetz CR, Dowhan W. "Biosynthesis and function of phospholipids in Escherichia coli." *J Biol Chem* 1990;265(3);1235-8. PMID: 2404013

### Subsystem diagram



For the list of abbreviations refer to Table 1.

Gene Abbreviation	Functional role in E. coli	EC number	
aldH	Aldehyde dehydrogenase	1.2.1.3	
adh	Alcohol dehydrogenase	1.1.1.1	
glpK	Glycerol kinase	2.7.1.30	
gpsA	Glycerol-3-phosphate dehydrogenase [NAD(P)+]	1.1.1.94	
glpD	Aerobic glycerol-3-phosphate dehydrogenase	1.1.99.5	
glpA	Anaerobic glycerol-3-phosphate dehydrogenase	1.1.99.5	
*glkA	Diacylglycerol kinase	2.7.1.107	
plsB	Glycerol-3-phosphate acyltransferase	2.3.1.15	
plsC	1-acyl-sn-glycerol-3-phosphate acyltransferase	2.3.1.51	
cdsA	Phosphatidate cytidylyltransferase	2.7.7.41	
cdh	CDP-diacylglycerol pyrophosphatase	3.6.1.26	
pssA	CDP-diacylglycerolserine O-phosphatidyltransferase	2.7.8.8	
psd	Phosphatidylserine decarboxylase	4.1.1.65	
pgsA	CDP-diacylglycerolglycerol-3-phosphate 3-phosphatidyltransferase	2.7.8.5	7
pgp	Phosphatidylglycerophosphatase A	3.1.3.27	7
cls	Cardiolipin synthetase	2.7.8	7

#### List Functional roles involved in Glycerolipid/Glycerophospholipid biosynthesis



# Glycerolipid

Glycerophospholipid

\* **NOTE:** The functional role glkA is relevant for Glycerolipid pathway only. It is listed after the plsB and plsC in the spreadsheet to account for physiological order. Please refer to the diagram on Slide 2.