The PQQ biosynthetic operons and their transcriptional regulation in Pseudomonas aeruginosa

N Gliese, V Khodaverdi, H Görisch - Archives of microbiology, 2010 - Springer
... 1992), while in **Methylobacterium extorquens** AM1, the pqq genes are clustered in two separate operons (Toyama et al. 1997): the pqqABC/DE operon and the pqqFG genes, which form an operon together with 3 other genes (Zhang and Lidstrom 2003). ...
Cited by 20 Related articles All 11 versions Cite Save

Aging Skin Microbiology

DL Charbonneau, YL Song, CX Liu - Textbook of Aging Skin, 2010 - Springer
... 5]. The community composition of resident skin biota is believed to be as essential to the health of the skin as gut microorganisms are to overall health of the individual [2]. Resident biota promote health through **pathogen** inhibition, immune ... **Methylobacterium**. M. **extorquens**.
Related articles Cite Save More

Construction of a genome-scale kinetic model of mycobacterium tuberculosis using generic rate equations

DA Adiamah, JM Schwartz - Metabolites, 2012 - mdpi.com
The study of biological systems at the genome scale helps us understand fundamental biological processes that govern the activity of living organisms and regulate their interactions with the environment. Genome-scale metabolic models are usually analysed using constraint-based ...
Cited by 5 Related articles All 13 versions Cite Save More

Towards the investigation of microbe-mineral interaction by means of Raman spectroscopy

V Ciobotă - 2013 - d-nb.info
Page 1. Towards the investigation of microbe-mineral interaction by means of Raman spectroscopy Dissertation Zur Erlangung des akademischen Grades doctor rerum naturalium (Dr. rer. nat.) vorgelegt dem Rat der Chemisch ...
Related articles Cite Save More

Shear Rate Moderates Community Diversity

P Gilbert, AH Rickard, AJ McBain, AT Stead - pdfs.semanticscholar.org
... 2.1 198 Mycobacterium mucogenicum 594 99.7 AJ626983 2.2 198 **Methylobacterium** fujisawae 593 97.4 AJ6269849 2.3 198 Variovorax paradoxus 631 99.8 AJ626985 ... 4.7 65 Bacillus sphaericus 668 98.3 AJ627395 4.8 65 **Methylobacterium** fujisawae 593 98.1 AJ627396 ...
Related articles All 2 versions Cite Save More

A new modified ortho cleavage pathway of 3-chlorocatechol degradation by Rhodococcus opacus 1CP: genetic and biochemical evidence

OV Moiseeva, IP Solyanikova... - Journal of ..., 2002 - Am Soc Microbiol
... cycloisomerase YkfB from Bacillus subtilis (AJ002571) were used. For panel D, ORF2 from **Methylobacterium extorquens** AM1 (U72662) and Usf from Aquifex pyrophilus Ko15a (U17575), both with unknown function, were used.
Cited by 81 Related articles All 11 versions Cite Save

Expression of green fluorescent protein fused to magnetosome proteins in microaerophilic magnetotactic bacteria

C Lang, D Schüler - Applied and environmental microbiology, 2008 - Am Soc Microbiol
Cited by 65 Related articles All 11 versions Cite Save

A structural model of anti-anti-σ inhibition by a two-component receiver domain: the PhyR stress response regulator

J Herrou, R Foreman, A Fiebig... - Molecular ..., 2010 - Wiley Online Library
... PhyR consists of an amino-terminal ECF σ-like domain (hereafter referred to as the SL domain) and a carboxy-terminal TCS receiver domain, and was first described in **Methylobacterium extorquens** AM1 as a protein that regulates expression of genes involved in general stress ...
Cited by 43 Related articles All 13 versions Cite Save

Identification of a methanol-inducible promoter from Rhodococcus erythropolis PR4 and its use as an expression vector

Y Kagawa, Y Mitani, HY Yun, N Nakashima... - Journal of bioscience ..., 2012 - Elsevier
The genus Rhodococcus exhibits a broad range of catalytic activity and is tolerant to various kinds of organic solvents. This property makes rhodococci suitable.
Cited by 4 Related articles All 15 versions Cite Save

Detection of legionellae in hospital water samples by quantitative real-time LightCycler PCR

N Wellinghausen, C Frost, R Marre - Applied and Environmental ..., 2001 - Am Soc Microbiol
... all strains (described in Table 1), as well as with Legionella-like amoebal **pathogen** (LLAP) 10 ... 40 PCR cycles was seen with 10 pg of DNA from a **Methylobacterium** sp., isolated ... The target sequences of the 16S rRNA gene primers forMethylobacterium **extorquens** are depicted in ...
Cited by 225 Related articles All 10 versions Cite Save

LABORATORY PROCEDURE

BD Phoenix - Citeseer
... Miniaturized microbiological methods. Academic Press, New York. 6. Sanders, AC, Faber, JE, and Cook, TM 1957. "A Rapid Method for the Characterization of Enteric **Pathogen** Using Paper Discs," Appl. Microbiol. 5:36-40. 7. Synder, ML 1954. ...
Related articles All 7 versions Cite Save More

Phenotypic variation in metabolic functions of Escherichia coli in mixed-substrate environments

N Nikolic - Nela Nikolic, 2013 - e-collection.library.ethz.ch
... Page 116. 108 We also used a natural isolate of Escherichia coli, an enteroaggregative **pathogenic** strain 55989 (CRBIP14. ... Nature 454: 987–990. 8. Bergmiller T, Ackermann M (2011) Pole age affects cell size and the timing of cell division in **Methylobacterium extorquens** AM1. ...
Related articles Cite Save More

Metabolic modeling of a mutualistic microbial community

S Stolyar, S Van Dien, KL Hillesland... - Molecular systems ..., 2007 - msb.embopress.org
Skip to main content. Advertisement. Other Publications: EMBO Press; Molecular Systems Biology (Home); The EMBO Journal; EMBO reports; EMBO Molecular Medicine. Institution: Google Indexer. Login. Search. Search for this keyword. Advanced Search. Journal. ...
Cited by 294 Related articles All 20 versions Cite Save

Construction and optimization of a heterologous pathway for protocatechuate catabolism in Escherichia coli enables bioconversion of model aromatic compounds

SM Clarkson, RJ Giannone... - Applied and ..., 2017 - Am Soc Microbiol
All 4 versions Cite Save

Proteomics in India: the clinical aspect

S Mukherjee, A Bandyopadhyay - Clinical ..., 2016 - clinicalproteomicsjournal. ...
Skip to main content. Advertisement. Biomed Central ...
Cited by 1 Related articles All 11 versions Cite Save More

Metabolic engineering of Corynebacterium glutamicum for methanol metabolism

S Witthoff, K Schmitz, S Niedenführ, K Nöh... - Applied and ..., 2015 - Am Soc Microbiol
... Whereas Gram-negative methylotrophic bacteria such as **Methylobacterium extorquens** employ pyrroloquinoline quinone (PQQ)-dependent and periplasmic methanol dehydrogenases (MDHs) to oxidize methanol (24), Gram-positive thermotolerant Bacillus strains usually use ...
Cited by 17 Related articles All 9 versions Cite Save

Prokaryotic Systems Biology

A Schmid, N Baliga - Systems Biology, 2007 - Springer
... prokaryotes because of its genetic tractability, fast generation time, and medical relevance as a major enteric **pathogen** in human ... 27 Using a similar strategy, metabolic models have been constructed for several other organ- isms, including **Methylobacterium extorquens** AM1, 31 ...
Cited by 1 Related articles All 4 versions Cite Save

Characterization of a two-peptide plantaricin produced by Lactobacillus plantarum MBSa4 isolated from Brazilian salami

MS Barbosa, SD Todorov, IV Ivanova, Y Belguesmia... - Food Control, 2016 - Elsevier
... Ross, & Hill, 2012). Some studies have also reported on activity against unrelated strains, especially those that are **pathogenic** and responsible for food spoilage (Corsetti, Settanni, & Van Sinderen, 2004). Although a variety ...
Cited by 5 Related articles All 3 versions Cite Save

Methylotrophic bacterium for the production of recombinant proteins and other products

M Figueira, L Laramee, D Bourque... - US Patent App. 10/ ..., 2002 - Google Patents

... [0009]. Such methods would include a new non-**pathogenic** prokaryotic microbial system, as an alternative to E. coli, for recombinant peptide or ... [0016]. In another embodiment of the present invention the methylotrophic bacterium is **Methylobacterium extorquens** ATCC 55366. ...

Cited by 1 Related articles All 2 versions Cite Save

Parallelism and Epistasis in the de novo Evolution of Cooperation between Two Species

SM Douglas - 2014 - search.proquest.com

... 7. Wong, A., Rodrigue, N. & Kassen, R. Genomics of adaptation during experimental. evolution of the opportunistic **pathogen** Pseudomonas aeruginosa. ... identifies candidate **pathogenicity** genes. Nat. ... throughput culturing methods for **Methylobacterium extorquens**. PLoS One 8,. ...

Related articles All 5 versions Cite Save More

Frequency and fitness consequences of bacteriophage Φ6 host range mutations

BE Ford, B Sun, J Carpino, ES Chapler, J Ching... - PloS one, 2014 - journals.plos.org

... mutations and their frequency of appearance would be important parameters governing the probability of emergence of a potential human **pathogen**. ... This type of prioritization is critical before allocating resources to interdict potential **pathogenic** viruses before they emerge. ...

Cited by 10 Related articles All 16 versions Cite Save More

Metabolic pathway analysis in biotechnology

S Schuster - Metabolic Engineering in the Post Genomic Era, 2004 - books.google.com

... This is instrumental in increasing the rate and yield of product synthesis, achieving the synthesis of novel products, or suppressing pathways in **pathogenic** organisms, as explained and illustrated in several other chapters in this book. ...

Cited by 12 Related articles All 3 versions Cite Save

Methods for rapid identification of bacillus cereus

CH Chen, TC Chang, HC Ding - US Patent 6,699,679, 2004 - Google Patents

... BACKGROUND OF THE INVENTION Bacillis cereus is gram-positive, spore-forming, motile, aerobic rod which inhibits in soil and has been recognized as an opportunistic food poisoning **pathogen**. ... cloacae. **Methylobacterium**, 11048, 12234, 2, 0, 2. **extorquens**. ...

Cited by 1 Related articles All 4 versions Cite Save

Update and evaluation of 16SpathDB, an automated comprehensive database for identification of medically important bacteria by 16S rRNA gene sequencing

S Yeung, 楊兆恩 - HKU Theses Online (HKUTO), 2013 - hub.hku.hk

... the **pathogenic** role of the pathogens. For example, the invasive Streptococcus iniae infection, which was recognized in North America before, now reported in Asia (Weinstein. et al., 1997, Lau. et al., 2003). By using the conventional phenotypic tests, the rare **pathogen** may be ...

Related articles Cite Save More

Actinomyces oris fimbriae: an adhesive principle in bacterial biofilms and tissue tropism

H Ton-That, A Das, A Mishra - Oral Microbial Communities: ..., 2011 - books.google.com

... HELPFUL WEB RESOURCES • Oral **Pathogen** Sequence Databases (http://www. ... Different type 1fimbrial genes and tropismsof commensal and potentially **pathogenic** Actinomyces spp. ... sortase anchors a class of surface protein during Staphylococcus aureus **pathogenesis**. ...

Cited by 6 Related articles All 2 versions Cite Save

Transport genes and chemotaxis in Laribacter hongkongensis: a genome-wide analysis

SKP Lau, RYY Fan, GKM Wong... - Cell & ..., 2011 - cellandbioscience.biomedcentral. ...

... available (Table 2). Moreover, a homologue of urea transporter responsible for urea uptake (LHK_01044) was also present in L. hongkongensis (Table 2), while this protein was absent in C. violaceum and the **pathogenic** Neisseria spp ... **Methylobacterium extorquens** PA1. ...

Cited by 6 Related articles All 17 versions Cite Save More

A two-component system, an anti-sigma factor and two paralogous ECF sigma factors are involved in the control of general stress response in Caulobacter ...

RF Lourenco, C Kohler, SL Gomes - Molecular microbiology, 2011 - Wiley Online Library

... In fact, a molecular system involved in this response was recently identified in **Methylobacterium extorquens**, Bradyrhizobium japonicum and Sinorhizobium meliloti (Francez-Charlot et al., 2009; Gourion et al., 2009; Bastiat et al., 2010). ...

Cited by 48 Related articles All 13 versions Cite Save

Processes and Rates of Bacterial Evolution

N Delaney - 2013 - search.proquest.com

... 5, I used genome re-sequencing to examine the genetic changes that occurred in a population of **pathogenic** Mycoplasma gallisepticum ... **Methylobacterium extorquens** .....2&KDSWHU. ... **pathogen**, Mycoplasma gallisepticum ...

Related articles All 4 versions Cite Save More

Manuscript

C Lang, D Schüler - ... -specific expression of chimeric proteins in ..., 2008 - academia.edu

... Adv. Appl. Microbiol. 62: 21-62. 3. Bumann, D., and RH Valdivia. 2007. Identification of host-induced **pathogen** genes by differential fluorescence induction reporter systems. Nat. Protoc. 2: 770-777. 4. Ceyhan, B., P. Alhorn, C. Lang, D. Schüler, and CM Niemeyer. 2006. ...

Related articles All 10 versions Cite Save More

Poly (3-hydroxybutyrate) fuels the tricarboxylic acid cycle and de novo lipid biosynthesis during Bacillus anthracis sporulation

MR Sadykov, JS Ahn, TJ Widhelm... - Molecular ..., 2017 - Wiley Online Library
... (Singh et al., 2009), the specific requirements for PHB during sporulation in any given species might reflect adaptations to different life styles, including distinct metabolism-based mechanisms of **pathogenesis** and resistance, as well as specialized morphological features of the ...
Related articles All 3 versions Cite Save More

Costs of antibiotic resistance–separating trait effects and selective effects

AR Hall, DC Angst, KT Schiessl... - Evolutionary ..., 2015 - Wiley Online Library
... resistance. Theory and experiments emphasize the importance of such effects for the distribution of resistance in **pathogenic** populations. ... backgrounds. This is relevant to the management of resistance in **pathogenic** populations. ...
Cited by 12 Related articles All 9 versions Cite Save

Methylotrophic bacterium for the production of recombinant proteins and other products

C Miguez, M Figueira, L Laramee... - US Patent App. 10/ ..., 2002 - Google Patents
... [0011]. Such methods would include a new non-**pathogenic** prokaryotic microbial system, as an alternative to E. coli, for recombinant peptide or ... [0019]. In another embodiment of the present invention the methylotrophic bacterium is **Methylobacterium extorquens** ATCC 55366. ...
Cited by 1 Related articles All 2 versions Cite Save

Applications of cellular fatty acid analysis.

DF Welch - Clinical Microbiology Reviews, 1991 - Am Soc Microbiol
Page 1. CLINICAL MICROBIOLOGY REVIEWS, Oct. 1991, p. 422-438 Vol. 4, No. 4 0893-8512/91/040422-17$02.00/0 Copyright © 1991, American Society for Microbiology Applications of Cellular Fatty Acid Analysis DAVID ...
Cited by 250 Related articles All 15 versions Cite Save

(2S)-Methylsuccinyl-CoA dehydrogenase closes the ethylmalonyl-CoA pathway for acetyl-CoA assimilation

TJ Erb, G Fuchs, BE Alber - Molecular microbiology, 2009 - Wiley Online Library
... We recently described the outlines of the ethylmalonyl-CoA pathway, a new acetyl-CoA assimilation strategy that operates in a number of bacteria such as Rhodobacter sphaeroides, **Methylobacterium extorquens** and streptomycetes and replaces the glyoxylate cycle. ...
Cited by 48 Related articles All 6 versions Cite Save

Building better drugs: developing and regulating engineered therapeutic proteins

C Kimchi-Sarfaty, T Schiller... - Trends in ..., 2013 - Elsevier
Most native proteins do not make optimal drugs and thus a second- and third-generation of therapeutic proteins, which have been engineered to improve product at.
Cited by 39 Related articles All 8 versions Cite Save

Metabolic and stress responses of Acinetobacter oleivorans DR1 during long-chain alkane degradation

C Park, B Shin, J Jung, Y Lee... - Microbial ..., 2017 - Wiley Online Library
... This unexpected result suggests that DR1 cells might have additional alternative pathways to the glyoxylate shunt during alkane metabolism as seen in Rhodobacter spaeroedes and **Methylobacterium extorquens** AM1 (Ensign, 2006). Thus, growth defect of the DaceA mutant ...
Cite Save

A Low-Molecular-Weight Alginate Oligosaccharide Disrupts Pseudomonal Microcolony Formation and Enhances Antibiotic Effectiveness

MF Pritchard, LC Powell, AA Jack... - Antimicrobial Agents ..., 2017 - Am Soc Microbiol
... The opportunistic Gram-negative **pathogen** Pseudomonas aeruginosa is found in a range of chronic human respiratory diseases, including chronic obstructive pulmonary disease and cystic fibrosis (CF) (1). CF is a life-threatening, autosomal recessive genetic disorder affecting ...
All 3 versions Cite Save

Method and system for modeling cellular metabolism

CD Maranas, AP Burgard - US Patent 8,086,414, 2011 - Google Patents
... Another object of the present invention is to provide a method and system for identifying lethal gene deletions. Yet another object of the present invention is to provide a method and system for identifying gene therapeutic candidates for **pathogenic** microbes. ...
Related articles All 5 versions Cite Save

Contribution of silent mutations to thermal adaptation of RNA bacteriophage Qβ

A Kashiwagi, R Sugawara, FS Tsushima... - Journal of ..., 2014 - Am Soc Microbiol

... Recently, whole-genome analysis has been performed for experimental evolution using DNA and RNA viruses, Escherichia coli, **Methylobacterium extorquens**, Saccharomyces cerevisiae, and Drosophila melanogaster (1–16). ...

Cited by 5 Related articles All 7 versions Cite Save

Asymmetric, bimodal trade-offs during adaptation of **Methylobacterium** to distinct growth substrates

MC Lee, HH Chou, CJ Marx - Evolution, 2009 - Wiley Online Library

... Here, we use adaptation of experimental populations of the model methylotroph, **Methylobacterium extorquens** AM1, to C 1 (methanol) or multi-C (succinate) compounds to investigate specialization and trade-offs between these two metabolic lifestyles. ...

Cited by 66 Related articles All 14 versions Cite Save More

Interaction of the Escherichia coli transporter DctA with the sensor kinase DcuS: presence of functional DctA/DcuS sensor units

J Witan, J Bauer, I Wittig, PA Steinmetz... - Molecular ..., 2012 - Wiley Online Library
... Explore this journal >. Molecular Microbiology: Previous article in issue: Control of Staphylococcus aureus **pathogenicity** island excision Previous article in issue: Control of Staphylococcus aureus **pathogenicity** island excision. ...
Cited by 26 Related articles All 7 versions Cite Save

Methods for treating bacterial infections

S Page, S Garg - US Patent App. 15/363,523, 2016 - Google Patents
... enteroaggregative E. coli; EHEC=enterohemonhagic E. coli; EIEC=enteroinvasive E. coli; EPEC=enteropathogenic E. coli; ETEC=enterotoxigenic E. coli; ExPEC=extraintestinal **pathogenic** E. coli ... Methylobacteriaceae:—**Methylobacterium extorquens** group; **Methylobacterium** ...
All 2 versions Cite Save

The dynamics of diverse segmental amplifications in populations of Saccharomyces cerevisiae adapting to strong selection

C Payen, SC Di Rienzi, GT Ong... - G3: Genes, Genomes, ..., 2014 - g3journal.org
Skip to main content. Facebook Twitter YouTube LinkedIn Google Plus. Other GSA Resources: Genetics Society of America; Genetics; Genes to Genomes: The GSA Blog.
Cited by 30 Related articles All 13 versions Cite Save

Modularity of methylotrophy, revisited

L Chistoserdova - Environmental Microbiology, 2011 - Wiley Online Library
... A MDH first characterized in **Methylobacterium extorquens** (Anthony, 1982; 2004) and later detected in most of the model methylotrophs was a heterotetramer consisting of subunits encoded by genes designated mxaFI, contained pyrroloquinoline quinone (PQQ) as cofactor and ...
Cited by 157 Related articles All 6 versions Cite Save More

Methods and compositions for designing vaccines

RN Goldstein - US Patent 6,673,538, 2004 - Google Patents
... The present invention contemplates the establishment of an initial phylogenic analysis of any bacterial **pathogen** of interest, for the purposes of ... On the basis of these two initial criteria, each **pathogenic** microbe will present with several potential candidate molecules that might be ...
Cited by 4 Related articles All 2 versions Cite Save

Untersuchungen zur Interaktion epiphyller Bakterien mit Blattoberflächen und Veränderungen in der Phyllosphäre während der Vegetationsperiode

U Krimm - Mathematisch-Naturwissenschaftlichen Fakultät., ..., 2005 - hss.ulb.uni-bonn.de
... 2002). Arten der Gattung **Methylobacterium**, va **Methylobacterium** mesophilicum können Methanol metabolisieren (Holland et al. ... In der Regel werden antagonistische Organismen auf die Pflanze oder das Erntegut aufgebracht, bevor das **Pathogen** sich ansiedeln kann. ...
Cited by 4 Related articles All 2 versions Cite Save More

Method and system for modeling cellular metabolism

CD Maranas, AP Burgard - US Patent 7,711,490, 2010 - Google Patents
... Another object of the present invention is to provide a method and system for identifying lethal gene deletions. Yet another object of the present invention is to provide a method and system for identifying gene therapeutic candidates for **pathogenic** microbes. ...
Cited by 2 Related articles All 4 versions Cite Save

Parallel mutations result in a wide range of cooperation and community consequences in a two-species bacterial consortium

SM Douglas, LM Chubiz, WR Harcombe, FM Ytreberg... - PloS one, 2016 - journals.plos.org
Multi-species microbial communities play a critical role in human health, industry, and waste remediation. Recently, the evolution of synthetic consortia in the laboratory has enabled adaptation to be addressed in the context of interacting species. Using an engineered bacterial consortium ...
Cited by 1 Related articles All 14 versions Cite Save More

The ability of flux balance analysis to predict evolution of central metabolism scales with the initial distance to the optimum

WR Harcombe, NF Delaney, N Leiby... - PLoS computational ..., 2013 - journals.plos.org
Author Summary The most common method of modeling genome-scale metabolism, flux balance analysis, involves using known stoichiometry to define feasible metabolic states and then choosing between these states by proposing that evolution has selected a metabolic flux that ...
Cited by 43 Related articles All 21 versions Cite Save More

Biological costs and benefits of antibiotic resistance

DC Angst - 2016 - e-collection.library.ethz.ch
... Antibiotic resistance can impair bacterial growth or competi- tive ability in the absence of antibiotics, frequently referred to as a 'costs' of resistance. Theory and experiments emphasize the importance of such effects for the distribution of resis- tance in **pathogenic** populations. ...
Related articles Cite Save More

Investigating the Phylogeny of Hydrogen Metabolism by Comparative Genomics: Horizontal Gene Transfer

S Lal, DV Raje, S Cheema, A Kapley, HJ Purohit... - Microbial Factories, 2015 - Springer
... 56. Pirellula sp. 1. +. +. –. –. –. 57. Pyrobaculum aerophilum str. IM2. +. +. –. –. –. 58. Pyrococcus abyssi. +. +. –. –. –. 59. P. horikoshii. +. +. –. –. –. 60. Sulfolobus solfataricus. +. +. –. –. –. 61. S. tokodaii. +. +. –. –. –. 62. **Methylobacterium extorquens**. +. –. +. –. –. 63.
Cited by 1 Related articles All 5 versions Cite Save More

Current approaches to the prevention of catheter-related infections

B Jansen - INFECTIOUS DISEASE AND THERAPY SERIES, 1997 - books.google.com
... These include the **pathogenesis** and epidemiology as well as patient risk factors and are intensively discussed in the respective chap- ters elsewhere in this book. ... 1), eg, the nature and specific abilities of the **pathogen** involved are important. ...
Cited by 17 Related articles Cite Save

Increasing avermectin production in Streptomyces avermitilis by manipulating the expression of a novel TetR-family regulator and its target gene product

W Liu, Q Zhang, J Guo, Z Chen, J Li... - Applied and ..., 2015 - Am Soc Microbiol
... TFRs have been shown to participate in such important cellular processes as multidrug resistance, antibiotic biosynthesis, morphogenesis, osmotic stress, biofilm formation, catabolic pathways, nitrogen uptake, and **pathogenicity** (19), but the functions of many of them in ...
Cited by 11 Related articles All 6 versions Cite Save

Characterization of microbial populations in the subsurface

MP Buttner, P Cruz, KJ Stetzenbach, AJ Smiecinski - 2006 - digitalscholarship.unlv.edu
Page 1. Publications (YM) Yucca Mountain 12-2006 Characterization of microbial populations in the subsurface Mark P. Buttner University of Nevada, Las Vegas, mark.buttner@unlv.edu Patricia Cruz University of Nevada, Las Vegas, patricia.cruz@unlv.edu ...
All 2 versions Cite Save

Expression bakterieller Gene zur PHA-Synthese in Arxula adeninivorans und Untersuchungen zum Stoffwechsel der Hefe

A Scholz - 2009 - deutsche-digitale-bibliothek.de
... PHB-Synthese aus C. necator wie auch um das PHA-Synthasegen aus **Methylobacterium extorquens**. 3-Hydroxybutyrat 3-Hydroxyvalerat 3-Hydroxy-4-pentenoat 3-Hydroxy-8, 9-epoxy- 5,6-cis-tetradecenoat 3-Hydroxy- 5-cyclohexylvalerat ...
Related articles All 2 versions Cite Save More

A mutational hotspot and strong selection contribute to the order of mutations selected for during Escherichia coli adaptation to the gut

M Lourenço, RS Ramiro, D Güleresi... - PLoS ..., 2016 - journals.plos.org
Author Summary The relative contribution of random loss and migration versus de novo mutation to the overall diversity of the gut microbiota is far from understood. Population sizes of bacterial communities inhabiting the gut can be very large and therefore, both weak and strong ...
Cited by 5 Related articles All 11 versions Cite Save More

RNA-seq Based Transcriptomic Analysis of Single Cyanobacterial Cells

Z Chen, J Wang, L Chen, W Zhang - researchgate.net

Page 1. 4 RNA-seq Based Transcriptomic Analysis of Single Cyanobacterial Cells Zixi Chen1,2,3, Jiangxin Wang1,2,3, Lei Chen1,2,3 and Weiwen Zhang1,2,3* 1Laboratory of Synthetic Microbiology, School of Chemical Engineering ...

Cite Save More

Дія протимікробних препаратів складного походження

ВС Мельник, ВВ Баті, ОБ Левчук, НВ Бойко - 2013 - dspace.uzhnu.edu.ua

Page 1. НАЦІОНАЛЬНА АКАДЕМІЯ НАУК УКРАЇНИ МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ ТОВАРИСТВО МІКРОБІОЛОГІВ УКРАЇНИ ІМ. С.М. ВИНОГРАДСЬКОГО ІНСТИТУТ МІКРОБІОЛОГІЇ І ВІРУСОЛОГІЇ ІМ. Д.К. ...

Related articles Cite Save

Two-tiered histidine kinase pathway involved in heat shock and salt sensing in the general stress response of Sphingomonas melonis Fr1

A Kaczmarczyk, R Hochstrasser, JA Vorholt... - Journal of ..., 2015 - Am Soc Microbiol

Cited by 4 Related articles All 8 versions Cite Save

Умеренно галоалкалофильные аэробные метилобактерии

ЮА Троценко, НВ Доронина, ЦД Ли, АС Решетников - Микробиология, 2007 - elibrary.ru

... Leisingera methylohalidivoransATCC BAA-92 T (AY005463) Methylopila capsulata IM1 ATCC 700716 T (AF004844) Methylorhabdus multivorans ATCC 51890 T (AF004845) **Methylobacterium extorquens** JCM 2802 T (D32224) **Methylobacterium** organophilum NCIMB 11278 ...

Cited by 2 Related articles Cite Save

WrpA is an atypical flavodoxin family protein under regulatory control of the Brucella abortus general stress response system

J Herrou, DM Czyż, JW Willett, HS Kim... - Journal of ..., 2016 - Am Soc Microbiol
... Next Section. ABSTRACT. The general stress response (GSR) system of the intracellular **pathogen** Brucella abortus controls the transcription of approximately 100 genes in response to a range of stress cues. The core genetic ...
Cited by 5 Related articles All 6 versions Cite Save

Extracytoplasmic function Sigma factors in Bacillus Species

T Wecke - 2011 - edoc.ub.uni-muenchen.de
... often extended by a repeating oligosaccharide, called O-antigen (Bos et al., 2007). Lipopolysaccharides can play a role in **pathogenicity** since they are responsible for the ... formation (Branda et al., 2005). The Corynebacterineae, including the important **pathogen** ...
Related articles All 5 versions Cite Save More

Glyoxylate Metabolism in Mycobacterium smegmatis

LN Merkov - 2006 - digitalcommons.rockefeller.edu
... feasible, or easily executable, with **pathogenic** M. tuberculosis. Page 13. 5 ... They are high-GC (~ 65%) and lack **pathogenicity** islands typical of many bacterial pathogens. ... 1998), the clinical isolate CDC1551 (Fleischmann et al., 2002), the animal **pathogen** M. bovis (Garnier et al. ...
Cited by 4 Related articles Cite Save

Newly discovered bacterium in the family acetobacteraceae

SM Holland, DE Greenberg, A Zelazny... - US Patent ..., 2015 - Google Patents
... X75617). The 16S rDNA sequence similarity between the subject's isolate and other commonly encountered **pathogenic** Gram-negative rods was very low (˜80%). A phylogenetic tree of Granulibacter bethesdensis based on its 16S RNA sequence is shown in FIG. 1 . ...
Related articles All 4 versions Cite Save

Adaptive laboratory evolution of antibiotic resistance using different selection regimes lead to similar phenotypes and genotypes

LJ Jahn, C Munck, MMH Ellabaan... - Frontiers in ..., 2017 - ncbi.nlm.nih.gov
Related articles All 8 versions Cite Save

I. Synthesis of anthraquinone derivatives for electron transfer studies in DNA. II. Characterization of the interaction between heme and proteins

Y Cao - 2011 - search.proquest.com
I. Synthesis of anthraquinone derivatives for electron transfer studies in DNA. II. Characterization of the interaction between heme and proteins. Abstract. Anthraquinone (AQ) derivatives with relatively high reduction potentials ...
Related articles All 5 versions Cite Save More

Protein with recombinase activity for site-specific DNA-recombination

F Buchholz, M Karimova - US Patent 9,719,109, 2017 - Google Patents
... EGU56467.1, SEQ ID No. 19, SEQ ID No. 20. Vibrio tubiashii. ATCC 19109. YP_003065675. 1, SEQ ID No. 21, SEQ ID No. 22. **Methylobacterium. extorquens** DM4. YP_003280920.1, SEQ ID No. 23, SEQ ID No. 24. Streptomyces sp. W9. ZP_06822377.1, SEQ ID No. 25, SEQ ID No ...
All 2 versions Cite Save

Protein with recombinase activity for site-specific DNA-recombination

F Buchholz, M Karimova - US Patent 9,428,754, 2016 - Google Patents
... EGU56467.1, SEQ ID No. 19, SEQ ID No. 20. Vibrio tubiashii. ATCC 19109. YP_003065675. 1, SEQ ID No. 21, SEQ ID No. 22. **Methylobacterium. extorquens** DM4. YP_003280920.1, SEQ ID No. 23, SEQ ID No. 24. Streptomyces sp. W9. ZP_06822377.1, SEQ ID No. 25, SEQ ID No ...
Related articles All 4 versions Cite Save

Mycobacterial diagnostics

V Kapur, JP Bannantine, LL Li, Q Zhang... - US Patent ..., 2011 - Google Patents
... The **pathogenesis** of M. paratuberculosis has been recently reviewed by Harris and Barletta (2001, Clin. Microbiol. Rev., 14:489-512). ... During the clinical phase of infection, fecal shedding of the **pathogen** is high and can exceed 10 10 organisms/g of feces. ...
Cited by 8 Related articles All 6 versions Cite Save

Evolutionary consequence of a trade-off between growth and maintenance along with ribosomal damages

BW Ying, T Honda, S Tsuru, S Seno, H Matsuda... - PloS one, 2015 - journals.plos.org
Microorganisms in nature are constantly subjected to a limited availability of resources and experience repeated starvation and nutrition. Therefore, microbial life may evolve for both growth fitness and sustainability. By contrast, experimental evolution, as a powerful approach to ...
Cited by 2 Related articles All 12 versions Cite Save More

Chapitre V

FM Medie, R Ghodbane, B Henrissat, D Raoult... - Le rôle des cellulases ..., 2011 - theses.fr
... A novel **pathogenic** taxon of the Mycobacterium tuberculosis complex, Canetti: characterization of an exceptional ... Lactobacillus reuteri JCM 1112 Lactobacillus reuteri SD2112 **Methylobacterium** dichloromethanicum DM4 **Methylobacterium extorquens** AM1 **Methylobacterium** ...
Related articles All 2 versions Cite Save More

Wearable Computing: Designing a Solution to Enhance User Interactions

K Morgan - UW McNair Scholars Journal, 2014 - researchgate.net
... reduced) NAD (P) NAD+ or NADP+ NAD (P) H NADH or NADPH ATP adenosine triphosphate PHB poly-β-hydroxybutyrate BHB-CoA β-hydroxybutyryl-CoA EMC ethylmalonyl-CoA Gly glycine Glyx glyoxylate Abstract In **Methylobacterium extorquens** AM1, mechanisms to ...
Cited by 1 Related articles All 2 versions Cite Save More

Identification and characterisation of bacterial TIR domains, with particular focus on yersinia pestis: Study Data

AM Spear - 2011 - datacompass.lshtm.ac.uk
Bacterial Results,,,,, GI,Phylum,Family,Genus,Species,Protein ID,Description,E-Value 94970501,Acidobacteria,Acidobacteriaceae,,Acidobacteria bacterium Ellin345,YP_592549.1, Toll-interleukin receptor [Acidobacteria bacterium Ellin345] >gi|94552551|gb|ABF42475.1| Toll ...
All 6 versions Cite Save More

Biochemische und molekularbiologische Untersuchungen zu Lacton-Hydrolasen des bakteriellen Aromaten-und Halogenaromaten-Abbaus

IS Hinner - 1998 - books.google.com
Page 1. Biologie Isabelle-S. Hinner Biochemische und molekular- biologische Untersuchungen zu Lacton-Hydrolasen des bakteriellen Aromaten- und Halogenaromaten-Abbaus Herbert Utz Verlag Wissenschaft Page 2. Page 3. Page 4. Page 5. ...
Cited by 4 Related articles Cite Save More

Accurate microbial genome annotation using an integrated and user-friendly environment for community expertise of gene functions: the microscope platform

E Belda, D Vallenet, C Médigue - ... , Genomic and System Analyses of Pure ..., 2017 - Springer
... into the MicroScope platform, 1,702 are freely available, including several bacterial genomes of interest in the context of hydrocarbon microbiology (Pseudomonas and Acinetobacter species, Acidothermus cellulolyticus, Clostridium species, **Methylobacterium extorquens**, etc.). ...
Cited by 2 Related articles All 2 versions Cite Save More

Compounds and methods of treating infections

S Page, S Garg, M Keenan, A McCluskey... - US Patent App. 14/ ..., 2014 - Google Patents
The invention provides compounds of Formula (I), and methods of treating or preventing a bacterial infection in a subject using a compound of Formula (I). The invention also provides the use of a compound of Formula (I) in the manufacture of a medicament for the treatment of a ...
Cited by 1 Related articles All 2 versions Cite Save

UNIVERSIDAD AUTÓNOMA DEL ESTADO DE MEXICO

DDEA RESIDUALES, QF BIÓLOGO, EM ZARATE - iaea.org
... Otros microorganismos que han demostrado ser también resistentes a la radiación ionizante, se encuentran: Deinococos radiodurans (Wackett, 1998), Deinococos proteolyticus, Pseudomona radiora (Watanabe et al., 1984), **Methylobacterium extorquens** (Nogueira etal., 1998 ...
Related articles All 2 versions Cite Save More

Genetically modified bacteria and methods for genetic modification of bacteria

T Hitchcock, MS Rhee - US Patent App. 14/742,492, 2015 - Google Patents
... 30. The genetically modified bacteria of claim 1 , wherein the nucleic acid encoding a mammalian growth factor or a mammalian cytokine is inserted into all or a part of an endogenous gene encoding a **pathogenic** protein. 31. ...
Cited by 1 Related articles All 2 versions Cite Save

Molecular basis for trimethoprim and sulphonamide resistance in Gram negative pathogens

M Grape - 2006 - openarchive.ki.se

... Integrons can insert and express gene cassettes conferring resistance to various different antibiotics and are thus important tools for spread of resistance in **pathogenic** bacteria. ... Only a limited number of E. coli strains are **pathogenic** ...

Cited by 4 Related articles All 2 versions Cite Save More

Bazı Stres Faktörlerinin Aerobik Oksalat Bakterinin Kültüre Edilebilirliği ve Canlılığı Üzerine Etkileri

M Oskay, AÜ Tamer, G Saracaloğlu - dergipark.gov.tr

... Bassalik [3], ilk kez literatürde tanımlanan, oksalatı kullanan **Methylobacterium** sp. ... [3] Basalik, K. Über die verarbeitung der oxalsaure durch Bacillus **extorquens** n sp. Jahrb. Wiss. ... [23] Browne, N.; Dowds, BCA Heat and Salt Stress in the Food **Pathogen** Bacillus cereus. J. Appl. ...

Related articles All 2 versions Cite Save More

The genomic prediction and characterization of transmembrane β-barrels in Gram-negative bacteria

TC Freeman Jr - 2009 - search.proquest.com

The genomic prediction and characterization of transmembrane β-barrels in Gram-negative bacteria. Abstract. Transmembrane β-barrels (TMBB) are a special structural class of proteins predominately found in the outer membranes ...

Related articles All 4 versions Cite Save

Infections associated with urinary catheters

CE Chenoweth, S Saint - Catheter-Related Infections, 2005 - researchgate.net

... **PATHOGENESIS** The normal urinary tract has a number of defense mechanisms that prevent attachment of potential pathogens to the ... Enterococci have remained a significant **pathogen**, especially with the emergence and spread of vancomycin-resistant enterococci (43, 93–95 ...

Cited by 2 Related articles All 4 versions Cite Save More

Aerosol Collection Apparatus and Methods

PC Ariessohn, IV Novesselov... - US Patent App. 13/ ..., 2012 - Google Patents

The lifetime of aerosol monitoring, concentration and collection equipment is extended by acoustic cleaning of accreted particle deposits from internal surfaces where fouling occurs by application of acoustic energy to the particle accretion surface, optionally in combination with a ...

Related articles All 2 versions Cite Save

Tradeoffs, Mobile Genetic Elements and Horizontal Gene Transfers in Microbial Evolution

MC Lee - 2011 - search.proquest.com

... Here we use adaptation of. experimental populations of the model methylotroph, **Methylobacterium extorquens**. AMI, to Ci (methanol) or multi-C (succinate) compounds to investigate. ... The a-proteobacterium **Methylobacterium extorquens** AMI[94], which grows on a. ...

Related articles All 3 versions Cite Save More

Caracterización de la vía de señalización de LOVHK implicada en mecanismos de respuesta a estrés y virulencia en Brucella spp

G Sycz - 2015 - digital.bl.fcen.uba.ar

... They are the causative agent o brucellosis, a zoonotic infection that causes miscarriage and infertility in animals, and a febrile disease in humans. Brucella is a facultative intracellular **pathogen**, which resides in a replicative niche derived from the endoplasmic reticulum. ...

Related articles Cite Save

Evolutionary Trajectories to Daptomycin Resistance in Enterococcus faecalis

C Miller - 2013 - scholarship.rice.edu

... Initially isolated from a stool sample, whole genome sequence analysis suggests Symbioflor 1 can likely trace its lack of **pathogenicity** to large deletions in virulence ... While **pathogenesis** will ... **pathogen** and the patient, the biochemical foundations of antibiotic resistance need not. ...

Related articles Cite Save

Methanocaldococcus jannaschii and the Recycling of S-adenosyl-L-methionine

DV Miller - 2017 - vtechworks.lib.vt.edu

... 630 0.82% Bacteroides fragilis YCH46 0.73% **Methylobacterium extorquens** AM1 0.41% Escherichia coli K12 0.44% Saccharomyces cerevisiae (Baker's yeast) 0.05% Table 2. Kinetic parameters of DadD with 5'-dA, MTA, SAH, and Ad Substrate KM (mM) kcat (s-1) kcat/KM (M ...

Related articles Cite Save

Identificação de genes de isolados clínicos de Porphyromonas gingivalis expressos diferencialmente na formação de biofilme, usando differential display PCR.

D Higashi - teses.usp.br

Page 1. DANIELA HIGASHI IDENTIFICAÇÃO DE GENES DE ISOLADOS CLÍNICOS DE Porphyromonas gingivalis EXPRESSOS DIFERENCIALMENTE NA FORMAÇÃO DE BIOFILME, USANDO DIFFERENTIAL DISPLAY PCR ...

Cite Save More

A New Approach to Controlling Epilepsy

VA Herrera - The McNair Scholars Journal of the University of ..., 2013 - depts.washington.edu

Page 122. 113 A New Approach to Controlling Epilepsy Vicky A. Herrera Abstract Epilepsy is a neurological disease characterized by recurring seizures, and it affects millions. We hypothesize that modulation of p38 mitogen ...

Related articles Cite Save More

Получение трансгенных растений картофеля (Solanum tuberosum L.) и ячменя (Hordeum vulgare L.) с геном Fe-SOD1

АВ Бакулина - timacad.ru

... газотранспортной функцией (ПФД, 5об.%) в чистом виде и в сочетании с инокуляцией каллуса **Methylobacterium extorquens** AM1 ВКМ B-2064 (1×108 кл/мл) позволяет активизировать процессы вторичной дифференцировки и ...

Related articles All 2 versions Cite Save More

Cross-Talk tra Bifidobacterium e intestino umano: impatto sulle attività health promoting

SCF Dipalo - 2010 - amsdottorato.unibo.it

Page 1. Alma Mater Studiorum – Università di Bologna DOTTORATO DI RICERCA IN BIOLOGIA CELLULARE, MOLECOLARE E INDUSTRIALE XXII CICLO Dipartimento di Scienze Farmaceutiche Settore scientifico disciplinare di afferenza: CHIM/11 ...

Related articles All 2 versions Cite Save

Elements of P1B-type ATPase structure and function

M Traverso - 2010 - search.proquest.com

Elements of P1B-type ATPase structure and function. Abstract. P-type ATPases are membrane-bound proteins that couple hydrolysis of ATP to transport a substrate across cellular membranes, often against a gradient. Three ...

Related articles All 2 versions Cite Save More

Staphylococcus aureus osteomyelitis: Characterization of bacterial antigens and utilization as vaccine candidates and imaging targets

R Brady - 2007 - search.proquest.com

... The **pathogenesis** of osteomyelitis has been explored clinically and different types of osteomyelitis ... If antimicrobial therapy directed at the responsible **pathogen** is begun prior to ... are encoded on mobile genetic elements called SaPIs (Staphyloccus aureus **pathogenicity** islands). ...

Related articles All 4 versions Cite Save

Investigation into plasmid replication and partitioning systems in proteobacteria

N Kim - 2012 - etheses.whiterose.ac.uk

Page 1. Investigation+into+plasmid+replication+ and+partitioning+systems+in+ proteobacteria+ Nayoung Kim PhD Department of Biology University of York September 2012 Page 2. ! 2! Abstract+ ! ! ! Thanks to the development ...

Cited by 1 Related articles All 4 versions Cite Save More

The Use of Positional Scanning Synthetic Combinatorial Libraries (PS-SCL) to Study T Lymphocyte Specificity and Degeneracy

V Rubio-Godoy - 2002 - doc.rero.ch

... peptides to the T cells composing the actual repertoire so that all **pathogenic** peptides are recognized by the immune system. Also, the frequency of T lymphocytes that can recognize peptides from **pathogen** origin has to be large enough to assure an efficient ...

Related articles All 2 versions Cite Save More

Optimisation de la production d'acide succinique chez **methylobacterium extorquens** par le biais de petits arn regulateurs

R Imane - 2016 - espace.inrs.ca

... OPTIMISATION DE LA PRODUCTION D'ACIDE SUCCINIQUE CHEZ **METHYLOBACTERIUM EXTORQUENS** PAR LE BIAIS DE PETITS ARN REGULATEURS Par ... CHEZ **METHYLOBACTERIUM EXTORQUENS** PAR LE BIAIS DE PETITS ARN REGULATEURS. et ...

Cited by 1 Related articles All 2 versions Cite Save More

Partitioning of cytochrome c in multicomponent lipid membranes

S Pataraia - 2012 - depositonce.tu-berlin.de

Page 1. Acknowledgment Partitioning of cytochrome c in multicomponent lipid membranes vorgelegt von Salome Pataraia, M.Sc Georgia, Tbilisi Von der Fakultät II - Mathematik und Naturwissenschaften der Technischen Universität ...

Related articles All 5 versions Cite Save

Az anyagcsere szerkezetének hatása a genetikai interakciókra és a genomszerveződésre

K Kovács - 2013 - doktori.bibl.u-szeged.hu

Page 1. Az anyagcsere szerkezetének hatása a genetikai interakciókra és a genomszerveződésre Ph.D. értekezés Kovács Károly Témavezető: Papp Balázs Biológia Doktori Iskola MTA Szegedi Biológiai Kutatóközpont Biokémiai Intézet SZTE TTIK Szeged, 2012 Page 2. 1 ...

Related articles All 3 versions Cite Save More

Az anyagcsere szerkezetének hatása a genetikai interakciókra és a genomszerveződésre

K Károly

Cite Save

Aerosol collection apparatus and methods

PC Ariessohn, IV Novosselov, E Dengler - US Patent 8,539,840, 2013 - Google Patents

An apparatus or device for collecting aerosol particles from a gas stream, having a collector body enclosing a collector channel, a particle trap in the collector channel, and an injection duct for injecting a discrete microdroplet of an elution reagent. The particle trap may be a centrifugal ...

Cited by 3 Related articles All 4 versions Cite Save

Formate metabolism in sulfate reducing bacteria

SIM Silva - 2011 - search.proquest.com

... the ability of some **pathogenic** bacteria, such as Helicobacter pylori or. Salmonella enterica to efficiently use H2 as an energy source. constitutes a virulence factor [75, 76]. This subject is further. discussed in Chapter 6, where the energy metabolism of the. opportunistic **pathogen** ...

Related articles All 2 versions Cite Save

Genetics and physiology of ammonia catabolism by the methane-oxidizing bacterium, Methylococcus capsulatus Bath

A Poret-Peterson - 2009 - search.proquest.com

... 2000). In general, cytochrome P460-like enzymes have been found in denitrifying bacteria and **pathogenic** bacteria, where they are thought to function in protection from host-generated NO (Zumft, 2005; Elmore et al. 2007). ...

Cited by 1 Related articles All 3 versions Cite Save More

Probiotic potential of lactic acid bacteria isolated from rainbow trout (Oncorhynchus mykiss, Walbaum) and rearing environment. Importance in the prevention of fish ...

CAD Araújo - 2016 - search.proquest.com

... Taking into consideration that most LAB are currently considered as safe microorganisms for human and animal consumption (EFSA, 2005a; 2005b; 2007), and that some bacteriocin-producing strains inhibit **pathogenic** microorganisms responsible for human and animal ...

Related articles All 2 versions Cite Save

1395 نیدرورف، 1394دنفسا، مهدراهچ لاس هـحفص 176، 145 هرامش

PCR Tetra-ARMS - researchgate.net

Page 1. 1395 نیدرورف ،1394دنفسا ،مهدراهچ لاس هـحفص 176 ،145 هرامش 145
کیتیسوفنل نمزم یمسول رد ینیلاب و یهاگشیامزآ یاه هزات ناشفا لگ للها بیبح رتکد
)2(ایزسلام سنج هب طوبرم یاه یگژیو یرهق دمحم رتکد)3(اه مسیناگراورکیم ...

Related articles Cite Save More

Evaluación Microbiológica de las aguas termales del balneario las Peñas, cantón Baños, provincia Tungurahua.

PJ Cabrera Aguayo - 2015 - dspace.espoch.edu.ec

... The analysis resulted in a water hole contaminated with Gram negative bacterium corresponding 33% to Cardiobacterium spp and similar **Methylobacterium** mesophylicus percentage. ... Thereby establishing that exist in these waters a predominance of Gram negative **pathogenic** ...

Related articles Cite Save

Evaluación y diseño de bacterias lácticas (BAL) de origen alimentario y de otros hospedadores como factorías celulares de producción de bacteriocinas

JJJ Martínez - 2015 - eprints.ucm.es

... But, with no doubt the progress in the development and evaluation of biological strategies to eliminate, reduce or control in food the presence of food-borne **pathogenic** microorganisms and, specially, Listeria monocytogenes, should rely on the development and evaluation of ...

Related articles All 2 versions Cite Save More

Improving biotechnological processes through automated flow cytometry

AB Gilbert - 2008 - search.proquest.com

Improving biotechnological processes through automated flow cytometry. Abstract. In the cytostat, an automated flow cytometry system is used to monitor and control a continuous culture. Cytostat technology was applied to measure ...

Related articles All 2 versions Cite Save More

Inverse metabolic engineering: a rational approach for efficient and robust microorganism development

CT Trinh - 2008 - search.proquest.com

Inverse metabolic engineering: A rational approach for efficient and robust microorganism development. Abstract. Inverse metabolic engineering based on elementary mode analysis was developed to model and analyze quantitatively ...

Cited by 2 Related articles All 2 versions Cite Save More

System and tools to support a Bayesian approach to improving large-scale metabolic models

X Shi - 2008 - search.proquest.com

... The National Microbial **Pathogen** Database Resource (NMPDR) [29, 94] is a database that collects and curates the knowledge of a set of ... Currently, NMPDR contains the complete genomes of approximately 50 strains of **pathogenic** bacteria as well as more than 500 other ...

Related articles All 3 versions Cite Save More

Modeling molecular mechanisms of mammalian mineralization

JA Horst - 2010 - search.proquest.com

... Between the components of host-**pathogen** and host-commensal interactions, growth factors ... of tissue formation, the potential for human, commensal and **pathogenic** bacterial nsSNPs to ... **Pathogenicity** is discernable from patterns of interactions between a missense mutation, the ...

Related articles All 2 versions Cite Save More

In silico analysis of microbial biosynthetic capabilities at the genome-scale

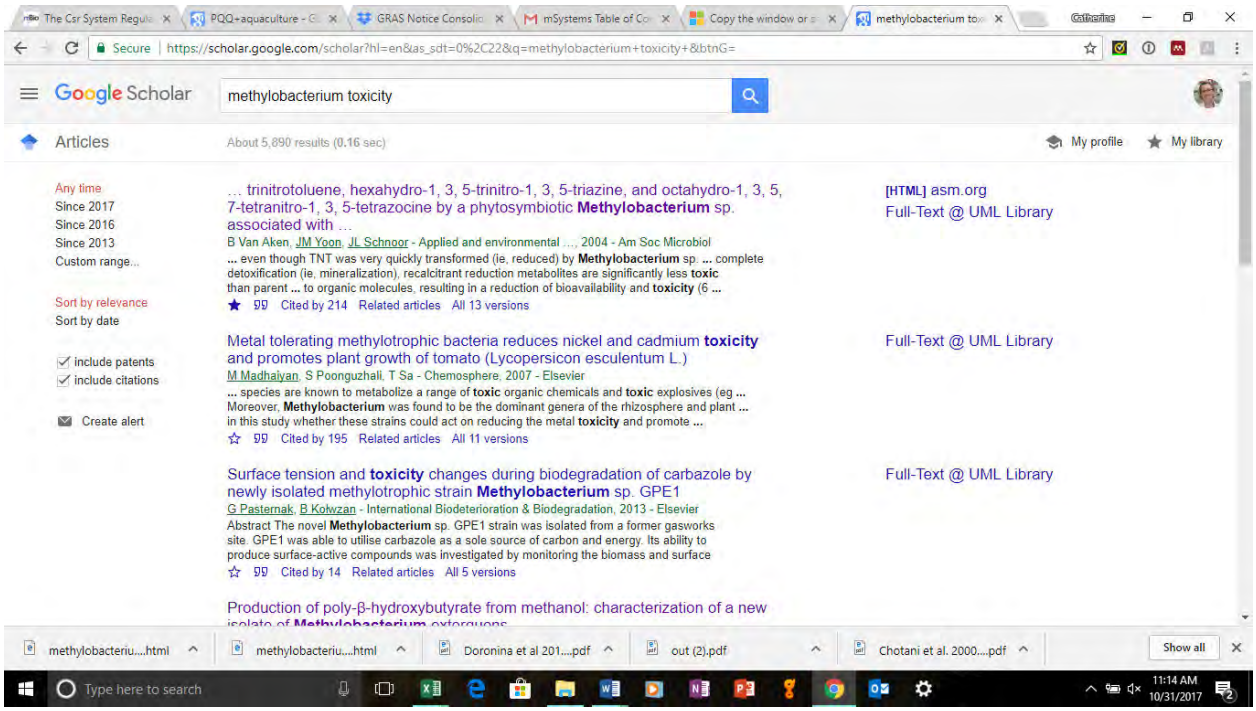
M Imielinski - 2007 - search.proquest.com

... For example, one may identify a critical set of reactions whose knockout disables the production of a **pathogenic** factor or induces the ... analysis of pathway redundancy to identify novel flexibility in in the C3-C4 interconversion pathways of the organism M. **extorquens** and validate ...

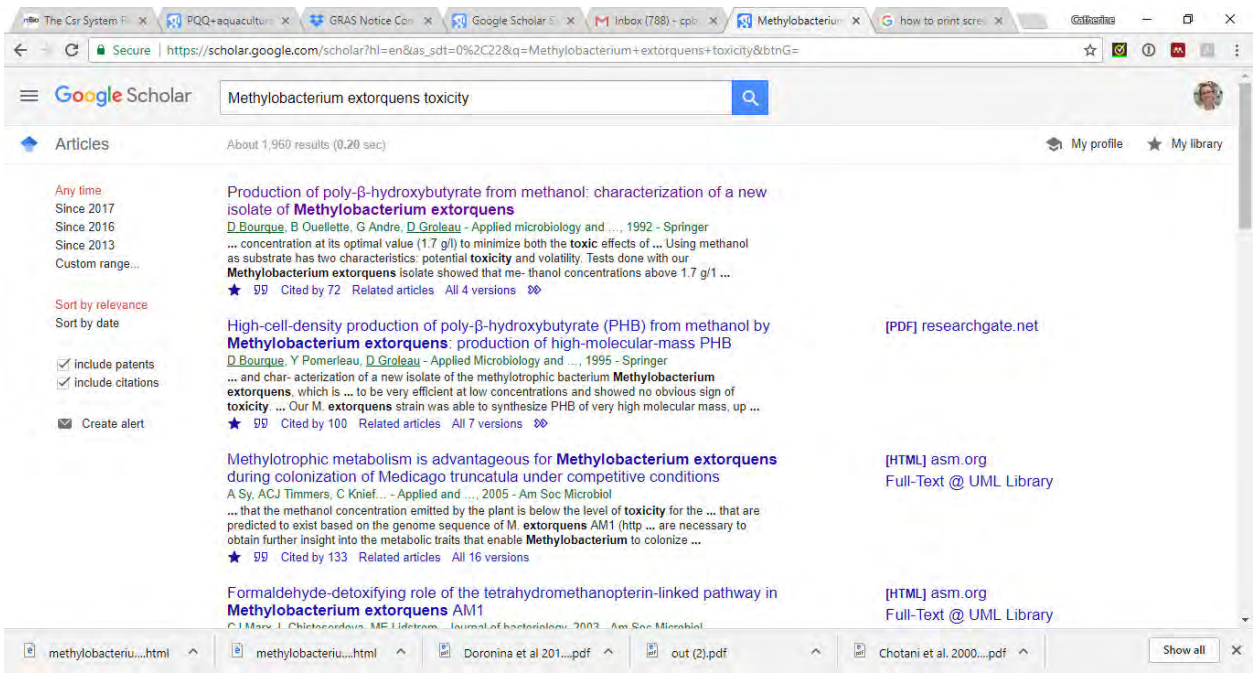
Related articles All 3 versions Cite Save More

Appendix 6-2: Methylobacterium extorquens toxicity

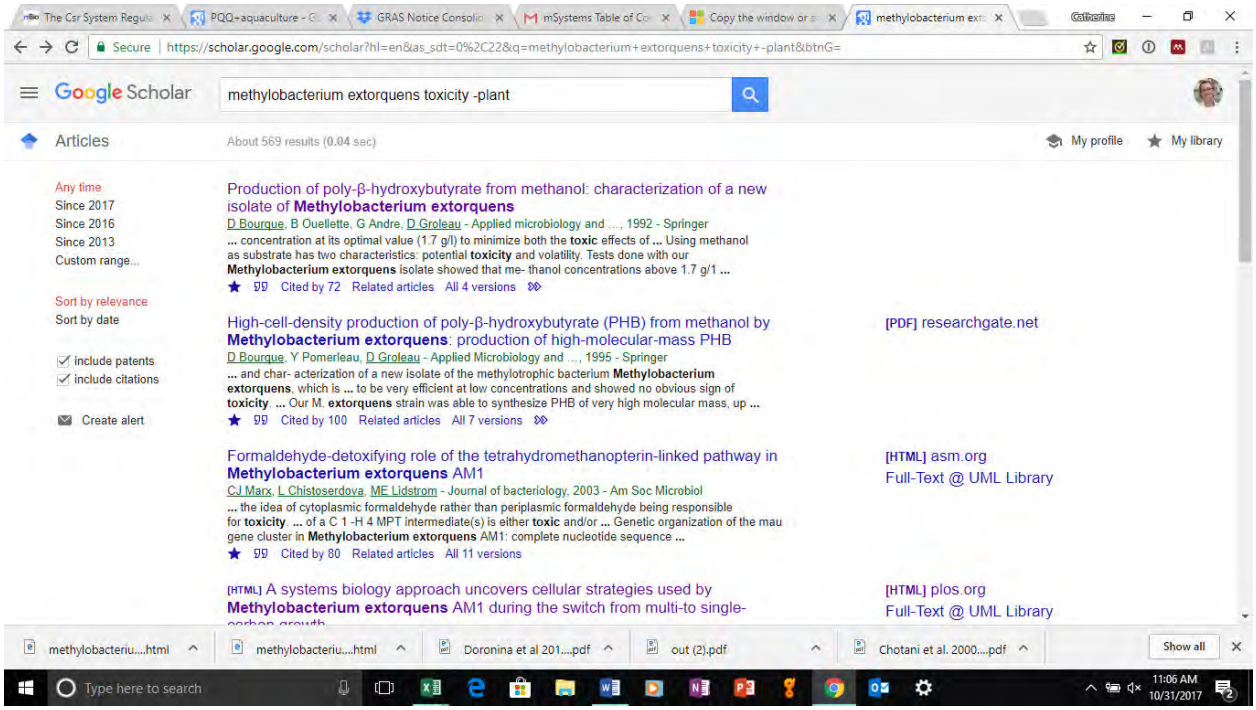
A Google Scholar search “Methylobacterium toxicity” on October 31, 2017 yielded ~5900 hits



A Google Scholar search limiting to the species of Methylobacterium extorquens and toxicity yielded 1960 hits. Most of these papers were related to plant toxicity.



A Google Scholar search “Methylobacterium extorquens toxicity -plant”, yielded 569 hits most of which were not relevant to any alleged toxicity of *Methylobacterium* species (for reasons discussed below), and none of which were relevant to *M. extorquens.* Several papers were already identified in the “pathogenicity” search (**Appendix 6-1**). Among the reasons for ruling out most of the references in this search were that the search picked up references to the toxicity of methanol or formaldehyde, or irrelevant references to other toxic molecules not found in or produced by *Methylobacterium*. In fact, several papers reported that *Methylobacterium* species could reduce the toxicity of metallic waste streams.



Previous Google searches using the same or similar keywords also provided no hits relevant to mammalian or human toxicity. The only reference found by KnipBio that is remotely relevant is *(*Balachandran *et al.*, 2012), who reported a *Methylobacterium* soil isolate which they called *Methylobacterium* sp. (ERI-135), which showed promising antibacterial and cytotoxic activity *in vitro*.

> **Balachandran, C., Duraipandiyan, V. and Ignacimuthu, S., 2012. Cytotoxic (A549) and antimicrobial effects of Methylobacterium sp. isolate (ERI-135) from Nilgiris forest soil, India. *Asian Pacific journal of tropical biomedicine*, *2*(9), pp.712-716.**

Objective To assess the antimicrobial and cytotoxic effects of Methylobacterium sp. isolated from soil sample of Doddabetta forest, Nilgiris, Western Ghats of Tamil Nadu.

Results

Ethyl acetate extract showed activity against bacteria such as *Bacillus subtilis, Klebsiella pneumoniae (K. pneumoniae), Pseudomonas aeruginosa, Salmonella typhimurium, Shigella flexneri, Enterobacter aerogenes, Staphylococcus aureu* and *Staphylococcus epidermidis (S. epidermidis)* and fungi such as, *Candida albicans* and *Trichophyton rubrum.* The lowest minimum inhibitory concentrations were: 250 µg/mL against *S. epidermidis* and 250µg/mL against *K. pneumonia*. The isolate had the ability to produce enzymes such as protease. The exyract showed cytotoxic effect in human adenocarcinoma cancer cell line (A549). GC-MS analysis showed the presence of isovaleric acid (3.64%), 2-Methylbutanoic acid (5.03%), isobutyramide (5.05%), N,N-oimethylformamide-di-t-butylacetal (9.79%), benzeneacetamide (15.56%), octyl butyl phthalate (3.59%) and diisooctyl phthalate (5.79) in the extract.

Conclusions

Methylobacterium sp. (ERI-135) showed promising antibacterial and cytotoxic activity. This is the first report in the antimicrobial and cytotoxic effect of *Methylobacterium* sp."

The following pages list all the 569 references.

Production of poly-β-hydroxybutyrate from methanol: characterization of a new isolate of **Methylobacterium extorquens**

D Bourque, B Ouellette, G Andre, D Groleau - Applied microbiology and ..., 1992 - Springer
... concentration at its optimal value (1.7 g/l) to minimize both the **toxic** effects of ... Using methanol as substrate has two characteristics: potential **toxicity** and volatility. Tests done with our **Methylobacterium extorquens** isolate showed that me- thanol concentrations above 1.7 g/1 ...
Cited by 71 Related articles All 4 versions Cite Save

High-cell-density production of poly-β-hydroxybutyrate (PHB) from methanol by **Methylobacterium extorquens**: production of high-molecular-mass PHB

D Bourque, Y Pomerleau, D Groleau - Applied Microbiology and ..., 1995 - Springer
... and char- acterization of a new isolate of the methylotrophic bacterium **Methylobacterium extorquens**, which is ... to be very efficient at low concentrations and showed no obvious sign of **toxicity**. ... Our M. **extorquens** strain was able to synthesize PHB of very high molecular mass, up ...
Cited by 100 Related articles All 7 versions Cite Save

Formaldehyde-detoxifying role of the tetrahydromethanopterin-linked pathway in **Methylobacterium extorquens** AM1

CJ Marx, L Chistoserdova, ME Lidstrom - Journal of bacteriology, 2003 - Am Soc Microbiol
... the idea of cytoplasmic formaldehyde rather than periplasmic formaldehyde being responsible for **toxicity**. ... of a C 1 -H 4 MPT intermediate(s) is either **toxic** and/or ... Genetic organization of the mau gene cluster in **Methylobacterium extorquens** AM1: complete nucleotide sequence ...
Cited by 77 Related articles All 11 versions Cite Save

A systems biology approach uncovers cellular strategies used by **Methylobacterium extorquens** AM1 during the switch from multi-to single-carbon growth

E Skovran, GJ Crowther, X Guo, S Yang, ME Lidstrom - PLoS One, 2010 - journals.plos.org
... **Methylobacterium extorquens** AM1 is a facultative methylotrophic bacterium capable of growth on single-carbon compounds such as methanol ... must be poised to quickly adapt, capturing available methanol while preventing buildup of its subsequent **toxic** oxidation product ...
Cited by 44 Related articles All 12 versions Cite Save More

Alternative route for glyoxylate consumption during growth on two-carbon compounds by **Methylobacterium extorquens** AM1

Y Okubo, S Yang, L Chistoserdova... - Journal of ..., 2010 - Am Soc Microbiol
... Next Section. ABSTRACT. **Methylobacterium extorquens** AM1 is a facultative methylotroph capable of growth on both single-carbon and multicarbon compounds. ... Since glyoxylate is **toxic** to this bacterium, it seemed likely that a system is in place to keep it from accumulating. ...
Cited by 31 Related articles All 8 versions Cite Save

Heterologous extracellular production of enterocin P from Enterococcus faecium P13 in the methylotrophic bacterium **Methylobacterium extorquens**

J Gutiérrez, D Bourque, R Criado, YJ Choi... - FEMS microbiology ..., 2005 - academic.oup.com
... Article Navigation. Heterologous extracellular production of enterocin P from Enterococcus faecium P13 in the methylotrophic bacterium **Methylobacterium extorquens**. Jorge Gutiérrez Jorge Gutiérrez. Departamento de Nutrición ...
Cited by 29 Related articles All 17 versions Cite Save More

Production and characterization of polyhydroxyalkanoates by recombinant **Methylobacterium extorquens**: combining desirable thermal properties with functionality

P Höfer, P Vermette, D Groleau - Biochemical engineering journal, 2011 - Elsevier
... a model that allowed for on-line estimation of **toxic** co-substrate ... Functionalized polyhydroxyalkanoates; **Methylobacterium extorquens**; Methanol; Alkenoic acid; Automatic substrate feeding; Thermo-mechanical ... bonds are cheaper and generally exhibit less **toxicity** ...
Cited by 28 Related articles All 5 versions Cite Save

... of a heterologous protein, haloalkane dehalogenase, in a poly-β-hydroxybutyrate-deficient strain of the facultative methylotroph **Methylobacterium extorquens** AM1

KA Fitzgerald, ME Lidstrom - Biotechnology and ..., 2003 - Wiley Online Library
... Methanol is a relatively inexpensive (http://www.methanex.com/ methanol/currentprice.htm) substrate, and has the added ad- vantages of high solubility in water and low **toxicity**. ... An attractive strain for this purpose is **Methylobacterium extorquens** AM1. ...
Cited by 29 Related articles All 7 versions Cite Save More

QscR-mediated transcriptional activation of serine cycle genes in **Methylobacterium extorquens** AM1

MG Kalyuzhnaya, ME Lidstrom - Journal of bacteriology, 2005 - Am Soc Microbiol

... The levels of XylE in these mutants declined during longer incubation periods, presumably due to formaldehyde **toxicity**. ... 1993. Genetics of serine pathway enzymes in **Methylobacterium extorquens** AM1: phosphoenolpyruvate carboxylase and malyl coenzyme A lyase. ...

Cited by 29 Related articles All 15 versions Cite Save

Determination of the Gene Sequence and the Three-dimensional Structure at 2.4 Å Resolution of Methanol Dehydrogenase fromMethylophilusW3A1

Z Xia, W Dai, Y Zhang, SA White, GD Boyd... - Journal of molecular ..., 1996 - Elsevier

... The refined structure of the quinoprotein methanol dehydrogenase from **Methylobacterium extorquens** at 1.94 å. ... A molecular level mechanism for uranium (VI) **toxicity** through Ca²⁺ displacement in pyrroloquinoline quinone-dependent bacterial dehydrogenase. ...

Cited by 140 Related articles All 6 versions Cite Save

Metabolic engineering of **Methylobacterium extorquens** AM1 for 1-butanol production

B Hu, ME Lidstrom - Biotechnology for biofuels, 2014 - biotechnologyforbiofuels. ...

... **Methylobacterium extorquens** AM1 is a facultative methylotrophic α-proteobacterium capable of using both one-carbon (C1 ... 1-butanol **toxicity** to microorganisms is one of the important factors that limit ... Therefore, the growth rates of M. **extorquens** AM1 wild type in the presence of 1 ...

Cited by 15 Related articles All 14 versions Cite Save More

Novel formaldehyde-activating enzyme inMethylobacterium **extorquens** AM1 required for growth on methanol

JA Vorholt, CJ Marx, ME Lidstrom... - Journal of ..., 2000 - Am Soc Microbiol

... Formaldehyde is **toxic** for all organisms from bacteria to humans due to its reactivity with biological macromolecules. ... In the α-proteobacterium **Methylobacterium extorquens** AM1, we found a previously unknown enzyme that efficiently catalyzes the removal of formaldehyde: it ...

Cited by 145 Related articles All 14 versions Cite Save

Formaldehyde-limited cultivation of a newly isolated methylotrophic bacterium, **Methylobacterium** sp. MF1: enzymatic analysis related to C 1 metabolism

R Mitsui, M Omori, H Kitazawa, M Tanaka - Journal of bioscience and ..., 2005 - Elsevier

... Since formaldehyde is highly **toxic**, it must be oxidized or assimilated immediately ... 6 and 7). This transformant is capable of effectively overcoming the **toxicity** of formaldehyde ... The facultative serine pathway-utilizer, **Methylobacterium extorquens** AM1, has well-devised systems for ...

Cited by 25 Related articles All 13 versions Cite Save

Production of functionalized polyhydroxyalkanoates by genetically modified **Methylobacterium extorquens** strains

P Höfer, YJ Choi, MJ Osborne... - Microbial cell ..., 2010 - microbialcellfactories.biomedcentral. ...

... The proprietary, wildtype strain **Methylobacterium extorquens** ATCC 55366 was used throughout this study [24]. ... The two M. **extorquens** strains (Figure 4A and Figure 5A) continued to grow, although ... addition of the respective carboxylic acid, due to the well-known **toxicity** of such ...

Cited by 19 Related articles All 16 versions Cite Save More

Heterologous expression of heterotrophic nitrification genes

LC Crossman, JWB Moir, JJ Enticknap... - ..., 1997 - mic.microbiologyresearch.org

... Further, when expressed in the methylotroph **Methylobacterium extorquens** AMI, the AM0 endows on this organism the ... The heterotrophic nitrification genes are moderately **toxic** in M. **extorquens**, more **toxic** in Ps. ... **Toxicity** is due to the activity of the gene products in M. **extorquens** ...

Cited by 51 Related articles All 10 versions Cite Save More

Biosynthesis of polyhydroxybutyrate/valerate with different molecular weights during the growth of **Methylobacterium extorquens** G-10 on a methanol-pentanol mixture

VA Ezhov, NV Doronina, YA Trotsenko - Applied biochemistry and ..., 2013 - Springer

... weight (MW) of the polyhydroxybutyrate/valerate (PHBV) copolymer synthesized by **Methylobacterium extorquens** G 10 ... Consequently, the MW of PHB syn thesized by **methylobacteria** depended on the carbon ... of the pentanol concentration on the growth of M. **extorquens** G 10 ...

Cited by 9 Related articles All 9 versions Cite Save

Biochemical characterization of a dihydromethanopterin reductase involved in tetrahydromethanopterin biosynthesis in **Methylobacterium extorquens** AM1
MA Caccamo, CS Malone, ME Rasche - Journal of bacteriology, 2004 - Am Soc Microbiol
... dmrA mutants grow on succinate but not on C 1 compounds, and the mutants are highly sensitive to methanol **toxicity**. ... 2003. Methylotrophy in **Methylobacterium extorquens** AM1 from a genomic point of view. J. Bacteriol. 185:2980-2987. ...
Cited by 14 Related articles All 9 versions Cite Save

... role of the methylene-tetrahydromethanopterin dehydrogenase MtdA in the tetrahydromethanopterin-dependent oxidation pathway in **Methylobacterium extorquens** ...
NC Martinez-Gomez, S Nguyen... - Journal of ..., 2013 - Am Soc Microbiol
... The metabolism of one-carbon compounds in the facultative methylotroph **Methylobacterium extorquens** AM1 (Fig. ... in cell extracts of M. **extorquens**, suggesting that M. **extorquens** has the ... to allow sufficient carbon flux from formaldehyde to formate to avoid formaldehyde **toxicity**. ...
Cited by 11 Related articles All 8 versions Cite Save

Methylobacterium genome sequences: a reference blueprint to investigate microbial metabolism of C1 compounds from natural and industrial sources
S Vuilleumier, L Chistoserdova, MC Lee, F Bringel... - PloS one, 2009 - journals.plos.org
... Loading metrics. Open Access. Peer-reviewed. Research Article. **Methylobacterium** Genome Sequences: A Reference Blueprint to Investigate Microbial Metabolism of C1 Compounds from Natural and Industrial Sources. Stéphane Vuilleumier , ...
Cited by 154 Related articles All 29 versions Cite Save More

Flux analysis uncovers key role of functional redundancy in formaldehyde metabolism
CJ Marx, SJ Van Dien, ME Lidstrom - PLoS biology, 2005 - journals.plos.org
... of a gapped genome sequence for a model methylotrophic bacterium, **Methylobacterium extorquens** AM1, has ... responses is important for assessing and possibly ameliorating **toxicity** problems in ... each metabolic module in methylotrophic metabolism in M. **extorquens** AM1 during ...
Cited by 64 Related articles All 37 versions Cite Save More

Development of improved versatile broad-host-range vectors for use in methylotrophs and other Gram-negative bacteria

CJ Marx, ME Lidstrom - Microbiology, 2001 - mic.microbiologyresearch.org
... **Methylobacterium extorquens** AM1 is an example of an organism for which improved genetic tools are needed. ... expression vector, pCM110, was created that would provide minimal expression in E. coli to allow **toxic** genes to be introduced into M. **extorquens** AM1 (Fig. ...
Cited by 249 Related articles All 10 versions Cite Save

Closed-loop control of bacterial high-cell-density fed-batch cultures: production of mcl-PHAs by Pseudomonas putida KT2442 under single-substrate and cofeeding ...

MB Kellerhals, B Kessler... - Biotechnology and ..., 1999 - Wiley Online Library
... Efficient production of mcl-PHAs on such **toxic** substrates therefore requires control of ... show that this control system is suitable for avoiding substrate **toxicity** and supplying ... the molecular mass of poly(3-hydroxybutyrate) produced by **Methylobacterium extorquens** and Alcaligenes ...
Cited by 56 Related articles All 5 versions Cite Save More

Catheter infection caused by **Methylobacterium** in immunocompromised hosts: report of three cases and review of the literature

KM Kaye, A Macone... - Clinical infectious diseases, 1992 - academic.oup.com
... t Organisms were not identified, but their description was consistent with **Methylobacterium**. ... Our series shows that M. **extorquens** is among the organ- ... Except in the treatment of patients demonstrating se- vere **toxicity**, no evidence supports the addition of a second antibiotic to ...
Cited by 42 Related articles All 9 versions Cite Save More

Use of oligodeoxynucleotide signature probes for identification of physiological groups of methylotrophic bacteria.

HC Tsien, BJ Bratina, K Tsuji... - Applied and ..., 1990 - Am Soc Microbiol
... Some of them are **toxic** chemicals that are on the high priority list of **toxic** environmental pollutants of the Environmental ProtectionAgency (21, 32). Methanotrophs * Corresponding author. ... **Methylobacterium extorquens** 25 Methanol 37 NCIMB ...
Cited by 141 Related articles All 9 versions Cite Save

Dichloromethane metabolism and C1 utilization genes in **Methylobacterium** strains

MF Kayser, Z Ucurum, S Vuilleumier - Microbiology, 2002 - mic.microbiologyresearch.org
... Formaldehyde, the product of dehalogenation, certainly constitutes a **toxic** burden to the methylo- trophic cell ... in both pathways of C " oxidation and assimilation recently discovered in M. **extorquens** AM1 (Chistoserdova et al ... **Methylobacterium**: DCM metabolism and C " utilization ...
Cited by 51 Related articles All 5 versions Cite Save

Development of an optimized medium, strain and high-throughput culturing methods for **Methylobacterium extorquens**

NF Delaney, ME Kaczmarek, LM Ward, PK Swanson... - PLoS ..., 2013 - journals.plos.org
... Peer-reviewed. Research Article. Development of an Optimized Medium, Strain and High-Throughput Culturing Methods for **Methylobacterium extorquens**. ... Development of an Optimized Medium, Strain and High-Throughput Culturing Methods for **Methylobacterium** ...
Cited by 35 Related articles All 13 versions Cite Save More

Formaldehyde damage to DNA and inhibition of DNA repair in human bronchial cells

RC Grafstrom, AJ Fornace, H Autrup, JF Lechner... - ..., 1983 - science.sciencemag.org
... Abstract. Cultured bronchial epithelial and fibroblastic cells from humans were used to study DNA damage and **toxicity** caused by formaldehyde. Formaldehyde caused the formation of cross-links between DNA and proteins, caused ...
Cited by 165 Related articles All 8 versions Cite Save

Characterization of a second methylene tetrahydromethanopterin dehydrogenase from **Methylobacterium extorquens** AM1

CH Hagemeier, L Chistoserdova... - The FEBS ..., 2000 - Wiley Online Library
... The methylotrophic α-proteobacterium **Methylobacterium extorquens** AM1 possesses tetrahydrofolate (H 4 F) and dephospho ... As formaldehyde is a necessary but **toxic** intermediate during growth on C 1 ... Whereas wild-type M. **extorquens** AM1 could grow on succinate in the ...
Cited by 67 Related articles All 5 versions Cite Save

Antioxidant protein 2 prevents methemoglobin formation in erythrocyte hemolysates

KM Stuhlmeier, JJ Kao, P Wallbrandt... - The FEBS ..., 2003 - Wiley Online Library

... Previous article in issue: The tungsten-containing formate dehydrogenase from **Methylobacterium extorquens** AM1: Purification and properties. ... Evolving antioxidant defence systems to protect against O 2 **toxicity** has been a prerequisite for an organism's use of O 2 for efficient ...

Cited by 46 Related articles All 7 versions Cite Save

Electro-biocatalytic production of formate from carbon dioxide using an oxygen-stable whole cell biocatalyst

H Hwang, YJ Yeon, S Lee, H Choe, MG Jang... - Bioresource ..., 2015 - Elsevier

... Electro-biocatalytic CO 2 reduction with 8 species of **Methylobacteria** (1.3 g wet cells, 5 ... Oxygen-stable **Methylobacterium extorquens** AM1 in the electro-biocatalytic CO 2 reduction system (1.3 g wet ... Additionally, the varied concentration of M. **extorquens** AM1 as a whole cell was ...

Cited by 12 Related articles All 7 versions Cite Save

Cofactor-dependent pathways of formaldehyde oxidation in methylotrophic bacteria

JA Vorholt - Archives of microbiology, 2002 - Springer

... A central feature of the metabolism of methylotrophic bacteria is that carbon flow proceeds via the central inter- mediate formaldehyde (Fig.1), which is highly **toxic** due to its nonspecific ... The H4F-dependent pathway and its encoding genes in **Methylobacterium extorquens** AM1 ...

Cited by 155 Related articles All 10 versions Cite Save

Parallel and divergent evolutionary solutions for the optimization of an engineered central metabolism in **Methylobacterium extorquens** AM1

SM Carroll, LM Chubiz, D Agashe, CJ Marx - Microorganisms, 2015 - mdpi.com

... Microorganisms 2015, 3(2), 152-174; doi:10.3390/microorganisms3020152. Article. Parallel and Divergent Evolutionary Solutions for the Optimization of an Engineered Central Metabolism in **Methylobacterium extorquens** AM1. ...

Cited by 5 Related articles All 12 versions Cite Save More

Comprehensive molecular characterization of **Methylobacterium extorquens** AM1 adapted for 1-butanol tolerance

B Hu, YM Yang, DAC Beck... - Biotechnology ..., 2016 - biotechnologyforbiofuels. ...

... The **toxicity** of alcohols is one of the major roadblocks of biological fermentation for biofuels production. **Methylobacterium extorquens** AM1, a facultative methylotrophic α-proteobacterium, has been engineered to generate 1-butanol from cheap carbon feedstocks through a ...

Cited by 4 Related articles All 17 versions Cite Save More

Metabolomics in systems microbiology

ML Reaves, JD Rabinowitz - Current opinion in biotechnology, 2011 - Elsevier

... Elucidation of the methanol assimilation pathway in **Methylobacterium extorquens** AM1. ... needed, both to optimize long-term fluxes and to avoid immediate **toxicity** due to ... the ability to inactivate glutamine synthetase by covalent modification suffers **toxic** metabolic derangements ...

Cited by 94 Related articles All 13 versions Cite Save

Phylogeny poorly predicts the utility of a challenging horizontally transferred gene in **Methylobacterium** strains

JK Michener, S Vuilleumier, F Bringel... - Journal of ..., 2014 - Am Soc Microbiol

... product into its native one-carbon metabolic pathways to minimize any resulting **toxicity** (28). ... transfer of the dcmA gene to two other strains of M. **extorquens**, AM1 and ... addressed these questions by transferring dcmA into a broad range of **Methylobacterium** strains, quantifying ...

Cited by 13 Related articles All 12 versions Cite Save

Growth and formation of poly (hydroxybutyric acid) by **Methylobacterium** rhodesianum at methanol concentrations of above 25 g/l

EJ Bormann, M Leissner, B Beer - Engineering in Life Sciences, 1997 - Wiley Online Library

... poly(hydroxybutyric acid) using **Methylobacterium** organophilum [8], Pseudo - monas K [9], Protomonas **extorquens** [101, **Methylobacterium** rhodesianum Z [l 11 and **Methylobacterium** sp. ... But generally, the main problem results from the **toxicity** of the methanol ...

Cited by 8 Related articles All 3 versions Cite Save More

Asymmetric, bimodal trade-offs during adaptation of **Methylobacterium** to distinct growth substrates

MC Lee, HH Chou, CJ Marx - Evolution, 2009 - Wiley Online Library

... Here, we use adaptation of experimental populations of the model methylotroph, **Methylobacterium extorquens** AM1, to C 1 (methanol) or multi-C (succinate) compounds to investigate specialization and trade-offs between these two metabolic lifestyles. ...

Cited by 66 Related articles All 14 versions Cite Save More

Methylobacterium extorquwns microorganism useful for the preparation of poly-β-hydroxybutyric acid polymers

D Groleau, D Bourque, Y Pomerieau - US Patent 5,302,525, 1994 - Google Patents

... The above mentioned strain of **Methylobacterium extorquens** of the present invention, grows well in a minimal ... achieve this goal since a concentrated culture medium may be (partially) **toxic** to the ... The **toxicity** may be caused either by the high concentration of the carbon source ...

Cited by 10 Related articles All 3 versions Cite Save

Ethylmalonyl coenzyme A mutase operates as a metabolic control point in **Methylobacterium extorquens** AM1

NM Good, NC Martinez-Gomez, DAC Beck... - Journal of ..., 2015 - Am Soc Microbiol

... **Methylobacterium extorquens** AM1 is a facultative methylotroph capable of growth on single-carbon (C 1 ... dynamic growth environment (4, 5). In this niche, M. **extorquens** must acclimate ... substrate availability while preventing the lethal accumulation of the **toxic** methanol oxidation ...

Cited by 3 Related articles All 10 versions Cite Save

Analysis of the 3′-region of the dcmA gene of dichloromethane dehalogenase of **Methylobacterium** dichloromethanicum DM4

YE Firsova, DN Fedorov, YA Trotsenko - Microbiology, 2011 - Springer

... dichloromethanicum DM4 and DCM degraders Methylorhabdus multivorans DM15 and **Methylobacterium extorquens** DM 17 ... DNA of the strains M. dichloromethanicum DM4 (1), M. **extorquens** DM17 (2 ... these genes were expressed during the growth of **methylobacteria** on DCM. ...

Cited by 7 Related articles All 6 versions Cite Save

Overview of bacterial expression systems for heterologous protein production: from molecular and biochemical fundamentals to commercial systems

K Terpe - Applied microbiology and biotechnology, 2006 - Springer

... Enterocin P, a strong antilisterial pediocin-like bacteriocin from Enterococcusfaecium P13, was produced by **Methylobacterium extorquens** (Gutierrez et al. ... Furthermore, the tight repression of the nir promoter upon induction allowed the production of the **toxic** oncoprotein E6. ...

Cited by 700 Related articles All 17 versions Cite Save

Widespread genetic switches and **toxicity** resistance proteins for fluoride

JL Baker, N Sudarsan, Z Weinberg, A Roth... - ..., 2012 - science.sciencemag.org

... of species encode at most 2 fluoride riboswitches, the bacterium **Methylobacterium extorquens** DM4 encodes ... fluoride anions and require a more robust fluoride sensor and **toxicity** mitigation response ... why some species carry sensor and mitigation systems for **toxic** metals such ...

Cited by 180 Related articles All 10 versions Cite Save

MtdC, a novel class of methylene tetrahydromethanopterin dehydrogenases

JA Vorholt, MG Kalyuzhnaya, CH Hagemeier... - Journal of ..., 2005 - Am Soc Microbiol

... 1992. Perspectives on formaldehyde **toxicity**: separating fact from fantasy. Regul. Toxicol. Pharmacol. 16:150-160. ... Chistoserdova, L., S.-W. Chen, A. Lapidus, and ME Lidstrom. 2003. Methylotrophy in **Methylobacterium extorquens** AM1 from a genomic point of view. ...

Cited by 18 Related articles All 15 versions Cite Save

Just add lanthanides

E Skovran, NC Martinez-Gomez - Science, 2015 - science.sciencemag.org

... in the environment (8). Transcription of the mxaFI genes in M. **extorquens** AM1 requires ... M. fumariolicum SolV differed from those previously described for XoxF from **Methylobacterium** species: Methanol ... cleanup of REE mining sites, and to reduce the potential for **toxicity** in our ...

Cited by 15 Related articles All 7 versions Cite Save

Production of 2-Hydroxyisobutyric Acid from Methanol by **Methylobacterium extorquens** AM1 Expressing (R)-3-Hydroxybutyryl Coenzyme A-Isomerizing Enzymes

MT Rohde, S Tischer, H Harms... - Applied and ..., 2017 - Am Soc Microbiol

... A well-studied representative is **Methylobacterium extorquens** AM1, a pink-pigmented, aerobic alphaproteobacterium first ... In addition, a **toxicity** of the mutase proteins has not been previously observed when ... on recombinant AM1 (26, 32, 39–41) or other M. **extorquens** strains (29 ...

Cited by 3 Related articles All 4 versions Cite Save

Calorespirometric feeding control enhances bioproduction from **toxic** feedstocks—Demonstration for biopolymer production out of methanol

MT Rohde, S Paufler, H Harms... - Biotechnology and ..., 2016 - Wiley Online Library

... A methylotrophic model bacterium is the strictly aerobic, facultative methylotroph **Methylobacterium extorquens** AM1. ... a pathway for the production of biofuels in M. **extorquens** (Hu and ... processes has two main shortcomings: its high volatility and **toxicity** for microorganisms. ...

Cited by 4 Related articles All 4 versions Cite Save More

Amperometric detection of methanol with a methanol dehydrogenase modified electrode sensor

Q Liu, JR Kirchhoff - Journal of Electroanalytical Chemistry, 2007 - Elsevier

... An amperometric enzyme electrode was developed by immobilizing the quinoprotein methanol dehydrogenase from **Methylobacterium extorquens** AM1 onto a ... automobile fuel [1]. However, methanol exposure via inhalation and skin absorption may lead to **toxic** effects from ...

Cited by 31 Related articles All 6 versions Cite Save

Detection of dichloromethane with a bioluminescent (lux) bacterial bioreporter

N Lopes, SA Hawkins, P Jegier, FM Menn... - Journal of industrial ..., 2012 - Springer

... Fatal **intoxication** due to DCM inhalation as well as numerous cases of non-fatal ... have reduced the estimated risks but the mechanisms of DCM **toxicity** continue to ... by employing the evolutionary adaptation of the methylotrophic bacterium **Methylobacterium extorquens** (formerly M ...

Cited by 6 Related articles All 14 versions Cite Save

Adaptation of aerobic **methylobacteria** to dichloromethane degradation

ML Torgonskaya, YE Firsova, NV Doronina... - Applied Biochemistry ..., 2007 - Springer
... consumption of DCM by these degraders but not by transconjugants **Methylobacterium extorquens** AM1, expressing ... Our experi- ments showed that **methylobacteria** able to grow on DCM were more ... stress [11, 13], we suggested that faster adaptation of **methylobacterial** cells to ...
Cited by 3 Related articles All 7 versions Cite Save

Metabolomics revealed an association of metabolite changes and defective growth in **Methylobacterium extorquens** AM1 overexpressing ecm during growth ...

J Cui, NM Good, B Hu, J Yang, Q Wang, M Sadilek... - PloS one, 2016 - journals.plos.org
... **Methylobacterium extorquens** AM1 is a facultative methylotroph capable of growth on both single-carbon ... is one of the central assimilatory pathways in M. **extorquens** during growth ... Moreover, glyoxylate, a **toxic** and highly regulated essential intermediate, was determined to be ...
Cited by 2 Related articles All 11 versions Cite Save More

Formaldehyde metabolism in **Methylobacterium extorquens** AM1

CJ Marx - 2003 - digital.lib.washington.edu
... **Methylobacterium extorquens** AM1 possess two pterin-linked C1 transfer pathways that are critical for methylotrophic growth ... metabolism that has elucidated an elegant metabolic loop through which M. **extorquens** AM1 maintains formaldehyde below **toxic** levels while ...
Cited by 1 Related articles All 2 versions Cite Save More

Novel, versatile, and tightly regulated expression system for Escherichia coli strains

YJ Choi, L Morel, T Le François... - Applied and ..., 2010 - Am Soc Microbiol
... The construct of the cumate switch in E. coli described herein is a simplified and more flexible version of the **Methylobacterium extorquens** cumate switch. ... In order to avoid cellular **toxicity** caused by the CymR in M. **extorquens**, expression levels were reduced by integrating ...
Cited by 38 Related articles All 12 versions Cite Save

Effects of DNA-damaging agents on aerobic **methylobacteria** capable and incapable of utilizing dichloromethane

YE Firsova, ML Torgonskaya, NV Doronina... - Applied Biochemistry ..., 2005 - Springer
... way—**Methylobacterium** dichloromethanicum DM4 VKM V-2191 (=DSMZ 6343), **Methylobacterium** extorquensAM1 VKM ... conditions allowed us to find out whether the **methylobacterial** DNA was ... out how efficiently the DNA damage was repaired in the **methylobacteria** capable or ...
Cited by 3 Related articles All 9 versions Cite Save

Proteomic analysis of differentially expressed proteins in human lung cells following formaldehyde treatment

YM Jeon, JC Ryu, MY Lee - Molecular and Cellular **Toxicology**, 2007 - koreascience.or.kr
... CJ, Christoserdova, L. & Lidstrom, ME Formaldehyde- detoxifying role of the tetrahydromethanopterin-linked pathway in **Methylobacterium extorquens** AM1. ... Dowling, VA & Sheehan, D. Proteomics as a route to identification of **toxicity** targets in environmental **toxicology**. ...
Cited by 3 Related articles All 2 versions Cite Save More

Physiological and biochemical analysis of the transformants of aerobic **methylobacteria** expressing the dcmA gene of dichloromethane dehalogenase

YE Firsova, NV Doronina, YA Trotsenko - Microbiology, 2004 - Springer
... Because of its high **toxicity**, carcinogenicity, volatility, solubility in water, and persistence, DCM is included on the list of ... of Aerobic **Methylobacteria** Expressing the dcmA Gene ... DM4 (DM4-2cr–/pME 8220 and DM4- 2cr–/pME8221) and of **Methylobacterium extorquens** AM1 (AM1 ...
Cited by 2 Related articles All 7 versions Cite Save

Genetics and regulation of C1 metabolism in methylotrophs

ME Lidstrom, L Chistoserdova, S Stolyar... - ... Electron Transfer Chains ..., 1998 - Springer
... monophosphate cycle intermediates [2]. In the methylotrophs, the central metabolic intermediate is formaldehyde, a **toxic** compound. ... approach to study formaldehyde production and consumption systems in the a-proteobacterial methylotroph, **Methylobacterium extorquens** AMI. ...
Cited by 3 Related articles Cite Save More

Functionality of the xoxF gene in **Methylobacterium** dichloromethanicum DM4

YE Firsova, ML Torgonskaya, YA Trotsenko - Microbiology, 2015 - Springer
... is required for expression of meth anol dehydrogenase in **Methylobacterium extorquens** AM1, J ... Doronina, NV, and Trotsenko, Yu.A., Adaptation of aerobic **methylobacteria** to dichloromethane ... W., Gruffaz, C., Haugen, E., Hourcade, E., et al., **Methylobacterium** genome sequences ...
Cited by 3 Related articles All 8 versions Cite Save

Aerobic **methylobacteria** as the basis for a biosensor for dichloromethane detection

YV Plekhanova, YE Firsova... - Applied ..., 2013 - search.proquest.com

... Characteristics. **Methylobacterium** dichloromethanicum DM4. relationships presented in Fig. 2 allow one to detect DChM by the **methylobacteria** M. dichloromethani cum DM4, M. **extorquens** DM17, M. helvetica DM6, and A. dichloromethanicus DM16, which use ...

Cited by 2 Related articles All 9 versions Cite Save

Biotechnological potential of the ethylmalonyl-CoA pathway

BE Alber - Applied microbiology and biotechnology, 2011 - Springer

... Other considerations include secretion of products, possible **toxicity**, yields, and downstream processing of the desired ... organisms already considered for biotechnological applications contain the ethylmalonyl-CoA pathway: R. sphaeroides and **Methylobacterium extorquens**. ...

Cited by 50 Related articles All 12 versions Cite Save

Direct immunofluorescence and enzyme-linked immunosorbent assays for evaluating organic contaminant degrading bacteria

RL Brigmon, MM Franck, JS Bray, DF Scott... - Journal of ..., 1998 - Elsevier

... 35069, Methylosinus sporium. 43645, **Methylobacterium extorquens**. SRS cultures. S4A/1Bd, Methanotroph. S3C/2AB, Methanotroph. ... ATCC 35069, Methylosinus sporium, −, −, −, +, −, ATCC 43645, **Methylobacterium extorquens**, −, −, −, +, −, ...

Cited by 18 Related articles All 5 versions Cite Save

Creating auxotrophic mutants in Methylophilus methylotrophus AS1 by combining electroporation and chemical mutagenesis

CS Kim, TK Wood - Applied microbiology and biotechnology, 1997 - Springer
... Although ethyl methanesulphonate has had success in mutating **Methylobacterium extorquens** AM1 (Morris et al. ... mutagenesis treatment for E. coli BK6 since MNNG is much more **toxic** to this ... to no MNNG exposure or electroporation); therefore, there was no increase in **toxicity**. ...
Cited by 5 Related articles All 13 versions Cite Save More

Biosensors and biofuel cells: Research focused on practical application

AN Reshetilov - Applied biochemistry and microbiology, 2015 - search.proquest.com
... interest and are the most promising for assessment of the **toxicity** of goods; the possibility to assess acute and chronic **toxicity** could be ... Out of four strains of **methylobacteria**, **Methylobacterium** dichloromethani cum DM4, **Methylobacterium extorquens** DM17, Methylopila ...
Cited by 4 Related articles All 6 versions Cite Save

Exploring C1-metabolism-shotgun proteomics of the methylotrophic prokaryote **Methylobacterium extorquens** AM1

G Bosch, T Wang, J Miller, E Skovran, G Crowther...
Related articles Cite Save

Anti-alcoholic and anti-narcotic action of Methylobacteriim **extorquens** UCM B-3368

TP Kryshtab, VO Romanovs' ka, NA Stohniĭ... - ... (Kiev, Ukraine: 1993), 2008 - europepmc.org
... Anti-alcoholic and anti-narcotic action of Methylobacteriim **extorquens** UCM B-3368. (PMID:19938614). PMID:19938614. ... Abstract. The paper deals with action efficiency of microbial biomass on characteristic indicators at alcohol and morphine organism **intoxication**. ...
All 2 versions Cite Save More

Functional activity of the modA2 gene in **Methylobacterium** dichloromethanicum DM4

YE Firsova, YA Trotsenko - Microbiology, 2014 - Springer
... Aerobic **methylobacteria** can mineralize DCM due to dichloromethane dehalo genase DcmA, a cytoplasmic ... of DCM dehalogenase, dcmA and dcmR, from the degrader **Methylobacterium** dichloromethanicum DM4 to ... ("DCM island") which is not present in M. **extorquens** AM1 [3 ...
Related articles All 7 versions Cite Save

Physiology and Evolution of Methylamine Metabolism across **Methylobacterium extorquens** strains

DD Nayak - 2014 - search.proquest.com
... homolog that has been suggested to play a regulatory role in M. **extorquens** (Skovran et al ... as seen for H4MPT mutants, may be due to build-up of (potentially **toxic**) C1 intermediates ... basis for these effects, and to determine whether they hold for other strains of **Methylobacterium**. ...
Related articles All 5 versions Cite Save

Synthetic microbial ecology for biofuel production from lignocellulose

M Thommes, A Lubbe, J Lee - orau.gov
... produced by the demethoxylation of lignin monomers can inhibit microbial growth due to its **toxicity**. ... In order to demethoyxlate and cleave complex aromatics, we have genetically engineered M. **extorquens** to express the vanABK operon from **Methylobacterium** nodulans ...
Related articles All 2 versions Cite Save More

GENETICS AND REGULATION OF CI METABOLISM IN METHYLOTROPHS

AJL SPRINGER - ... Electron Transfer Chains: Genetics, Composition, and ..., 1998 - Springer
... monophosphate cycle intermediates [2]. In the methylotrophs, the central metabolic intermediate is formaldehyde, a **toxic** compound. ... approach to study formaldehyde production and consumption systems in the a-proteobacterial methylotroph, **Methylobacterium extorquens** AMI. ...
Related articles Cite Save

ME LIDSTROM, L. CHISTOSERDOVA, S. STOLYAR

AL SPRINGER - ... Chains: Genetics, Composition and Mode of ..., 2012 - books.google.com
... monophosphate cycle intermediates [2]. In the methylotrophs, the central metabolic intermediate is formaldehyde, a **toxic** compound. ... approach to study formaldehyde production and consumption systems in the a-proteobacterial methylotroph, **Methylobacterium extorquens** AM1 ...
Related articles Cite Save

Cloning and characterization of dichloromethane dehalogenase from **Methylobacterium** rhodesianum for dichloromethane degradation

J Yu, Q Liu, L Liu, J Chen - Bioremediation Journal, 2017 - Taylor & Francis

... Functional genomics of dichloromethane utilization in **Methylobacterium extorquens** DM4 ... and biochemical analysis of the transformants of aerobic **methylobacteria** expressing the ... **Methylobacterium** and Hyphomicrobium were isolated from industrial wastewater with DCM as ...

Related articles Cite Save More

Direct measurement of oxygen consumption rates from attached and unattached cells in a reversibly sealed, diffusionally isolated sample chamber

TJ Strovas, SC McQuaide, JB Anderson... - ... in bioscience and ..., 2010 - ncbi.nlm.nih.gov

... effects of stimuli on cells in the investigation of stress response and **toxicity** studies. ... Measurement of respiration rates of **Methylobacterium extorquens** AM1 cultures by use of a ... Optical oxygen microrespirometry as a platform for environmental **toxicology** and animal model studies ...

Cited by 11 Related articles All 11 versions Cite Save More

Synthesis of high-molecular-mass polyhydroxybutyrate from methanol in Methyloligella halotolerans C2

VA Ezhov, NV Doronina, MN Shmareva... - Applied Biochemistry ..., 2017 - Springer

... condition of PHB biosynthesis from methanol is the maintenance of a low methanol con- centration (to avoid the **toxic** effects of ... An increase in PHB Mm to 900–1800 kDa could be achieved for **Methylobacterium extorquens** via the maintenance of methanol concentration at a low ...

Related articles All 3 versions Cite Save

Effective utilization of dichloromethane by a newly isolated strain **Methylobacterium** rhodesianum H13

DZ Chen, DJ Ouyang, HX Liu, J Chen... - ... Science and Pollution ..., 2014 - Springer

... DCM has a high **toxicity**, has been proven to be carcinogenic, and has ... Among the genus **Methylobacterium**, another DCM-degrading strain **Methylobacterium** dichloromethanicum DM4 was investigated ... In fact, even belonging to the same species M. **extorquens**, strain DM4 and ...

Cited by 3 Related articles All 9 versions Cite Save

Upregulated transcription of plasmid and chromosomal ribulose monophosphate pathway genes is critical for methanol assimilation rate and methanol tolerance in ...

ØM Jakobsen, A Benichou, MC Flickinger... - Journal of ..., 2006 - Am Soc Microbiol

... and the latter compound was proposed to be the major cell-**toxic** agent under ... A similar conclusion has been described for the facultative methylotroph **Methylobacterium extorquens** AM1 metabolizing C 1 ... alter the cell yield on methanol, as well as to reduce methanol **toxicity**. ...

Cited by 56 Related articles All 14 versions Cite Save

Isolation of an unidentified pink-pigmented bacterium in a clinical specimen.

T Odugbemi, C Nwofor, KT Joiner - Journal of clinical ..., 1988 - Am Soc Microbiol

... The patient appeared very ill and **toxic**, with a dry cough and tachypnea. Epiglottitis was diagnosed. ... b Gilardi and Faur (1) described 7 strains of an unnamed taxon that constituted their cluster 2; the 14 strains in their cluster 1 were similar to **Methylobacterium extorquens**. ...

Cited by 21 Related articles All 10 versions Cite Save

Selection maintains apparently degenerate metabolic pathways due to tradeoffs in using methylamine for carbon versus nitrogen

DD Nayak, D Agashe, MC Lee, CJ Marx - Current Biology, 2016 - Elsevier

... Tradeoffs between cellular localization and ammonium **toxicity** lead to selection for this apparent degeneracy as it is ... Methylamine Metabolism in **Methylobacterium extorquens** Strains. ... (B) Methylamine growth mediated by the NMG pathway (blue) in other M. **extorquens** strains. ...

Cited by 1 Related articles All 6 versions Cite Save

Biodegradation of high concentrations of formaldehyde by lyophilized cells of **Methylobacterium** sp. FD1

H Yonemitsu, E Shiozaki, F Hitotsuda... - Bioscience, ..., 2016 - Taylor & Francis

... Formaldehyde is frequently discarded in wastes and causes environmental pollution; therefore, because of its high **toxicity**,1) it should be degraded before dis- carding. ... 16–29) These strains include **Methylobacterium** sp. MF1,16) M. **extorquens**,17,18) **Methylobacterium** sp. ...

Cited by 1 Related articles All 3 versions Cite Save

Fluoride Riboswitch

G Riddihough - Science Signaling, 2012 - stke.sciencemag.org

... The bacterium **Methylobacterium extorquens** DM4, which can use halogenated hydrocarbons as an energy source, was found to encode at ... JL Baker, N. Sudarsan, Z. Weinberg, A. Roth, RB Stockbridge, RR Breaker, Widespread genetic switches and **toxicity** resistance proteins ...

All 2 versions Cite Save More

Characterization and heterologous gene expression of a novel esterase from Lactobacillus casei CL96

YJ Choi, CB Miguez, BH Lee - Applied and environmental ..., 2004 - Am Soc Microbiol

... of recombinant esterase in methylotrophic yeast (Pichia pastoris) and bacteria (**Methylobacterium extorquens**), since the ... has many advantages, such as high solubility in water and low **toxicity**. ... profile of the esterase in the methylotrophic bacterium M. **extorquens** ATCC 55366 ...

Cited by 63 Related articles All 12 versions Cite Save

Genetics of methane and methanol oxidation in Gram-negative methylotrophic bacteria

TM Barta, RS Hanson - Antonie van Leeuwenhoek, 1993 - Springer

... in the pro- duction of useful metabolites, and in bioremediation of **toxic** pollutants (see ... for the lack of success in mutagenesis, such as high mutagen **toxicity**, inap- propriate ... **Methylobacterium extorquens** NR-2 has been success- fully transformed with the plasmid pLA2917 by ...

Cited by 20 Related articles All 5 versions Cite Save More

Methylotrophs: genetics and commercial applications

ME Lidstrom, DI Stirling - Annual Reviews in Microbiology, 1990 - annualreviews.org

... and the vector pLA2917 is useful for constructing overlapping Sau3A genomic banks (1). Subdoning vectors that include lacZ screening are available, such as pRK404 and pRK310 (30), although pRK404 is unstable in some strains such as **Methylobacterium extorquens** AMI . ...

Cited by 98 Related articles All 6 versions Cite Save More

Genomic insights into methanotrophy: the complete genome sequence of Methylococcus capsulatus (Bath)

N Ward, Ø Larsen, J Sakwa, L Bruseth, H Khouri... - PLoS ..., 2004 - journals.plos.org

... We used phylogenomic analysis, gene order information, and comparative analysis with the partially sequenced methylotroph **Methylobacterium extorquens** to detect genes of unknown function likely to be involved in methanotrophy and methylotrophy. ...

Cited by 272 Related articles All 25 versions Cite Save More

A challenge for 21st century molecular biology and biochemistry: what are the causes of obligate autotrophy and methanotrophy?

AP Wood, JP Aurikko, DP Kelly - FEMS microbiology reviews, 2004 - Wiley Online Library

... on thiosulfate [66,69,112]; (2) that organic nutrients were **toxic** or inhibited ... probable in evolutionary terms than organic substrate exclusion or **toxicity**, and would be ... The facultatively heterotrophic methylotroph, **Methylobacterium extorquens**, strain AM1 contains a complete Krebs ...

Cited by 115 Related articles All 14 versions Cite Save

Formatotrophic Production of Poly-β-hydroxybutyric Acid (PHB) from **Methylobacterium** sp. using Formate as the Sole Carbon and Energy Source

DH Cho, MG Jang, YH Kim - Korean Chem. Eng. Res.(화학공학), 2016 - 한국화학공학회

Related articles All 3 versions Cite Save

A directed approach to the selection of bacteria with enhanced catabolic activity

K Heesche-Wagner, T Schwarz... - Letters in applied ..., 2001 - Wiley Online Library

... metabolism within crude cell extracts of the two **methylobacteria** (KH 5 ... and characterization of hydroxypyruvate reductase from the facultative methylotroph **Methylobacterium extorquens** AM 1 ... & Timmis, KN (1997) Bioprotection of microbial communities from **toxic** phenol mixtures ...

Cited by 1 Related articles All 7 versions Cite Save

c-Type cytochromes and manganese oxidation in Pseudomonas putida MnB1

R Caspi, BM Tebo, MG Haygood - Applied and environmental ..., 1998 - Am Soc Microbiol

... Mn(II) oxidation in the soil (35); biological Mn(II) oxidation can be used for the removal of **toxic** contaminants from ... It has been shown that mutants of **Methylobacterium** extorquensand Paracoccus denitrificans deficient in c-type cytochrome biogenesis cannot assemble tryptophan ...

Cited by 92 Related articles All 22 versions Cite Save

Mercurial-resistance determinants in Pseudomonas strain K-62 plasmid pMR68

Y Sone, Y Mochizuki, K Koizawa... - AMB ..., 2013 - amb-express.springeropen.com

... of organomercurials and the subsequent reduction of the resulting mercuric ions to the less **toxic** and more ... more similar (67–84%) to those of a putative mer operon in **Methylobacterium extorquens** AM1, which ... 1) Department of Public Health and Molecular **Toxicology**, School of ...

Cited by 8 Related articles All 12 versions Cite Save More

MtdC, a Novel Class of Methylene

T Dehydrogenases, JA Vorholt, MG Kalyuzhnaya - 2005 - pdfs.semanticscholar.org

... 1992. Perspectives on formaldehyde **toxicity**: separating fact from fantasy. Regul. Toxicol. Pharmacol. 16:150– 160. 5. Chistoserdova, L., S.-W. Chen, A. Lapidus, and ME Lidstrom. 2003. Methylotrophy in **Methylobacterium extorquens** AM1 from a genomic point of view. ...

Related articles All 3 versions Cite Save More

The (d) evolution of methanotrophy in the Beijerinckiaceae—a comparative genomics analysis

I Tamas, AV Smirnova, Z He, PF Dunfield - The ISME journal, 2014 - ncbi.nlm.nih.gov

... SC2, and more distantly with **Methylobacterium extorquens** (Supplementary Figure 8). Other Alphaproteobacteria methylotrophs have very different arrangements (for example, Hyphomicrobium sp. MC1; Vuilleumier et al., 2011), or lack this island entirely. ...

Cited by 27 Related articles All 9 versions Cite Save

Functional analysis of the methylmalonyl-CoA epimerase from Caenorhabditis elegans

J Kühnl, T Bobik, JB Procter, C Burmeister... - The FEBS ..., 2005 - Wiley Online Library

... mitochondrial energy metabolism [5] or whether they are caused by 'metabolic stroke' due to accumulating **toxic** organic acids. ... fixation via the 3-hydroxypropionate pathway and in propionate fermentation [9]. In the methylotrophic bacterium **Methylobacterium extorquens**, MCE is ...

Cited by 25 Related articles All 6 versions Cite Save

Some physicochemical properties of the microbial exopolysaccharide (EPS) ethapolan synthesized by Acinetobacter sp. 12S depended on whether the producer was ...

TA Rodionova, YA Nikolaev, TP Pirog, MA Kovalenko... - Microbiology, 2004 - infona.pl

... The paper deals with a comparative study of the growth of free-living and immobilized predatory bacteria of the genus Bdellovibrio in the presence of **toxic** concentrations of urea and phenol. It was found that the cell wall of bdelloplasts ...

All 2 versions Cite Save More

The role of physiological heterogeneity in microbial population behavior

ME Lidstrom, MC Konopka - Nature chemical biology, 2010 - nature.com

... In a methylotrophic bacterium, **Methylobacterium extorquens**, the expression from a non–growth-rate-regulated promoter involved in methanol metabolism is not correlated with cell-to-cell variations in growth rate 40, 41 , either during steady state or during a response to ...

Cited by 188 Related articles All 7 versions Cite Save

Systematics of methanol-utilizing bacteria

K Komagata - FEMS Microbiology Letters, 1990 - Elsevier

... seoxidans" and related methanol-utilizing bacteria in the beta subdivision (cluster B reported by Hori and Osawa [32]) differ clearl~ from Methy!~ bacterium **extorquens** in the ... Three new **Methylobacterium** species: M. rhodesianum sp. ... 2013, The **Toxicology** of Methanol more. ...

Cited by 4 Related articles All 5 versions Cite Save More

Applications of the NanoDSC

MAA Mathews - 2016 XIX ISBC Conference, 1999 - media.biocalorimetry.org

... However, besides being **toxic**, methanol is highly volatile. ... The calorespirometric control strategy is demonstrated exemplarily for growth and polyhydroxybutyrate formation of the methylotrophic bacterium **Methylobacterium extorquens** on methanol and compared to alternative ...

Related articles Cite Save More

Cloning and sequencing of a novel meta-cleavage dioxygenase gene whose product is involved in degradation of γ-hexachlorocyclohexane in Sphingomonas ...

K Miyauchi, Y Adachi, Y Nagata... - Journal of bacteriology, 1999 - Am Soc Microbiol

... Because of its **toxicity** and long persistence in soil, most countries have prohibited the use of γ-HCH. ... genes and their protein products,pcpA of Sphingomonas chlorophenolica(41) (recently the sequence of PcpA was revised) andorf88' of **Methylobacterium extorquens** AM1 (37 ...

Cited by 105 Related articles All 14 versions Cite Save

Production of Poly (3-hydroxybutyrate-co-3-hydroxyvalerate) from **Methylobacterium** organophilum by potassium-limited fed-batch culture

SW Kim, P Kim, JH Kim - Enzyme and microbial technology, 1999 - Elsevier

... 3HV) mass production have been rarely reported due to the **toxicity** of the ... that P(3HB-co-3HV) production from M. organophilum using **toxic** auxiliary carbon ... methanol and n-amyl alcohol by the methylotrophic bacteria, Paracoccus denitrificans and **Methylobacterium extorquens**. ...

Cited by 15 Related articles All 7 versions Cite Save

Biomaterials approaches to combating oral biofilms and dental disease

JD Bryers, BD Ratner - BMC Oral Health, 2006 - bmcoralhealth.biomedcentral.com

... Tethered or released **toxic** agent(s). Base material degradable. External **toxic** challenge. ... In other experiments, tetraglyme was deposited on glass in a pattern using photolithographic methods before exposure to a suspension of **Methylobacterium extorquens**. ...

Cited by 13 Related articles All 18 versions Cite Save More

International Space Station (ISS) Internal Active Thermal Control System (IATCS) New Biocide Selection, Qualification and Implementation

ME Wilson, HE Cole, T Rector, J Steele... - 41st International ..., 2011 - arc.aiaa.org

... of 400 ppm OPA at pH 9.5 against mixed biofilms consisting of 10 bacteria including **Methylobacterium extorquens** established on ... D. Toxicological Evaluation of OPA Evaluations of the **toxicity** of OPA were conducted by NASA Johnson Space Center **Toxicology** Group and ...

All 4 versions Cite Save More

Methylobacterium bacteremia in AIDS

AL Tmant, R Gulati, O Giger... - Clinical microbiology ..., 1998 - Wiley Online Library

... individual [5]. The genus **Methylobacterium** includes eight species, **Methylobacterium extorquens**, M.fujisawaense, M ... examined for vacuoles, which are present in the **methylobacteria** but absent in ... Empirical therapy for treatment of serious **methylobacterium** infection consists of ...

Cited by 8 Related articles All 7 versions Cite Save

Facultative methanotrophy: false leads, true results, and suggestions for future research

JD Semrau, AA DiSpirito... - FEMS microbiology ..., 2011 - academic.oup.com

We use cookies to enhance your experience on our website. By continuing to use our website, you are agreeing to our use of cookies. You can change your cookie settings at any time. Find out more ...

Cited by 61 Related articles All 8 versions Cite Save More

Corynebacterium glutamicum harbours a molybdenum cofactor-dependent formate dehydrogenase which alleviates growth inhibition in the presence of formate

S Witthoff, L Eggeling, M Bott, T Polen - Microbiology, 2012 - mic.microbiologyresearch.org

... However, a high sequence identity of 46 % also exists with FDH4 from **Methylobacterium extorquens**, which has been characterized as a molybdenum-dependent FDH with an important role in methanol metabolism (Chistoserdova et al., 2007). ...

Cited by 14 Related articles All 5 versions Cite Save

Soluble methane monooxygenase production and trichloroethylene degradation by a type I methanotroph, Methylomonas methanica 68-1

SC Koh, JP Bowman, GS Sayler - Applied and environmental ..., 1993 - Am Soc Microbiol

... **Methylobacterium extorquens** ATCC 14718 - + (= AM1) Methylobactenum organophilum ATCC 27886T _ + (= XX) Methylobactenum rhodesianum ATCC 43882T ND ND ... Methylosinus sporium, **Methylobacterium** organophilum, and Methylobactenium **extorquens**. ...

Cited by 134 Related articles All 10 versions Cite Save

Microflora on the skin of European eel (Anguilla anguilla L., 1758) sampled from Creek Yuvarlakcay, Turkey

A Ugur, F Yılmaz, N Sahin - 2002 - evols.library.manoa.hawaii.edu

... Contamination can occur because pathogenic microorganisms form part of the normal flora of the fish. In other cases, **toxic** substances are introduced through cross- contamination, recontamination or faulty han- dling and processing. ... **Methylobacterium extorquens** 3.44 - + ...

Cited by 9 Related articles All 4 versions Cite Save

Cloning and characterization of corA, a gene encoding a copper-repressible polypeptide in the type I methanotroph, Methylomicrobium albus BG8

O Berson, ME Lidstrom - FEMS microbiology letters, 1997 - academic.oup.com

... copper was added, although in some cases they also grew slowly when copper was added, presumably due to **toxicity**. ... AY. , Chistoserdova, LV, McIntire, WS and Lidstrom, ME (1994.) Genetic organization of the mau gene cluster in **Methylobacterium extorquens** AM1: complete ...

Cited by 32 Related articles All 10 versions Cite Save More

Genetic determination of polyhydroxyalkanoate metabolism in Rhodobacter capsulatus SB1003

P Ulbrich, H Strnad, V Hejkalova... - FOLIA BIOLOGICA- ..., 2002 - researchgate.net

... Compared to tradition- al oil-derived plastics, PHAs have better physical prop- erties and are absolutely non-**toxic**. ... granule formation (phal), a granule-associated protein (pha2) and a gene with homology to PHA depolymerases from **Methylobacterium extorquens** and Ralstonia ...

Related articles All 6 versions Cite Save

DOE: Community Sequencing Program Department of Energy: Community Sequencing Program

L Chistoserdova, B Dreyfus, D Fleischman, P Jourand... - marxlab.org

... involving sequencing of multiple members of the genus **Methylobacterium**, facultative methylotrophs that ... contains the best-studied methylotrophic model organism, M. **extorquens** AM1, as ... with diverse physiological capacities ranging from degradation of **toxic** compounds, high ...

Related articles Cite Save More

Genomics of a phototrophic nitrite oxidizer: insights into the evolution of photosynthesis and nitrification

J Hemp, S Lücker, J Schott, LA Pace... - ISME ..., 2016 - authors.library.caltech.edu

... couples in blue are not considered likely transitional intermediates because they require either complex multi-electron transfer reactions (N 2 +6 H 2 O->2 NO 3 - +10 e - +12 H +), produce **toxic** intermediates (NH ... **Methylobacterium extorquens** AM1, Alphaproteobacteria, 1, 1, 1, 1 ...

Cited by 5 Related articles All 9 versions Cite Save More

Genetic and phenotypic comparison of facultative methylotrophy between **Methylobacterium extorquens** strains PA1 and AM1

DD Nayak, CJ Marx - PloS one, 2014 - journals.plos.org

... or CH 3 OH (methanol) as a sole carbon and energy source [1]–[4]. **Methylobacterium extorquens** AM1 [1] is ... a hypothesis, based on in vitro studies [44], that MDH in M. **extorquens** strains can ... lacking theH 4 MPT pathway were sensitive to methanol because of the **toxic** effects of ...

Cited by 8 Related articles All 13 versions Cite Save More

Archaea and their potential role in human disease

PB Eckburg, PW Lepp, DA Relman - Infection and immunity, 2003 - Am Soc Microbiol

... For example, the presence of intestinal sulfate-reducing bacteria and an increase in potentially **toxic** levels of hydrogen ... the discovery of archaeal genes that encode C1-transfer and methanogenic coenzymes in the aerobic bacterium **Methylobacterium extorquens** (8). Evidence ...

Cited by 182 Related articles All 10 versions Cite Save

Microbial mobilization of rare earth elements (REE) from mineral solids—A mini review

F Barmettler, C Castelberg, C Fabbri, H Brandl - AIMS Microbiology, 2016 - aimspress.com

... Mutant strains of **Methylobacterium extorquens** showed a REE-dependent growth behavior [26]. ... was also observed when treating CRT powder suggesting either a certain **toxicity** of the ... lamps is already mandatory in many different countries, mainly to remove **toxic** mercury form ...

Cited by 6 Related articles All 4 versions Cite Save More

Isolation and properties of methanesulfonate-degrading Afipia felis from Antarctica and comparison with other strains of A. felis

SA Moosvi, CC Pacheco, IR McDonald... - Environmental ..., 2005 - Wiley Online Library

... Nitrobacter hamburgensis, L35502; N. winogradskyi, L11661; Bradyrhizobium japonicum, D11345; Rhodopseudomonas palustris, D14435; **Methylobacterium extorquens**, D32224; Rhizobium ... 500 μM) and dimethylsulfide (tested only at 1–10 μM because of its **toxicity**) were not ...

Cited by 35 Related articles All 12 versions Cite Save More

Isolation and characterization of naphthalene biodegrading **Methylobacterium** radiotolerans bacterium from the eastern coastline of the Kingdom of Saudi Arabia

A Nzila, A Thukair, S Sankara, B Chanbasha... - Archives of ..., 2016 - degruyter.com

... Molecular interaction between **Methylobacterium extorquens** and seedlings: growth promotion, methanol consumption ... corrig., and **Methylobacterium** mesophilicum (Austin and Goodfellow 1979) comb. ... of Environmental Science and Health, Part A, **Toxic**/Hazardous Substances ...

Cited by 2 Related articles All 5 versions Cite Save

The microbiology of metal working fluids

IP Thompson, CJ van der Gast - Handbook of Hydrocarbon and Lipid ..., 2010 - Springer

... However, the inclusion of such **toxic** constituents is under legislative pressure from the EU. ... Flavobacterium mizutaii. 2. A. S. Myroides odoratus. 2. A. S. Alphaproteobacteria. **Methylobacterium extorquens**. 1. A. S. **Methylobacterium** mesophilicum. 1. A. S. **Methylobacterium** ...

Cited by 6 Related articles All 5 versions Cite Save More

Structural biology of the lanthanides—mining rare earths in the Protein Data Bank

K Djinovic-Carugo, O Carugo - Journal of inorganic biochemistry, 2015 - Elsevier

... species [3]. The large majority of the other metals are not only not essential for life but also extremely **toxic**, even at ... been proposed that this is due to a lanthanide-dependent methanol dehydrogenase [15], like the recently reported XoxF1 of **Methylobacterium extorquens** AM1 [16 ...

Cited by 7 Related articles All 3 versions Cite Save

Relations and functions of dye-linked formaldehyde dehydrogenase from Hyphomicrobium zavarzinii revealed by sequence determination and analysis

AC Schwartz, G Gockel, J Groß, B Moritz... - Archives of ..., 2004 - Springer

... in these bacteria, (2) how serious the danger of **toxic** side effects of ... Mutants of **Methylobacterium extorquens** deficient in the formaldehyde-activating enzyme that catalyzes condensation of ... This suggests that the question of formaldehyde **toxicity** deserves special attention, when ...

Cited by 5 Related articles All 10 versions Cite Save

Identification and characterization of the AgmR regulator of Pseudomonas putida: role in alcohol utilization

H Vrionis, A Daugulis, A Kropinski - Applied microbiology and ..., 2002 - Springer

... growth and a solvent phase containing high concentrations of inhibitory or **toxic** substrates that ... otic(s) to the bacterial catalyst(s) to prevent substrate limitation or **toxicity** to the ... a putative sensor-regulator pair required for oxidation of methanol in **Methylobacterium extorquens** AM1 ...

Cited by 17 Related articles All 12 versions Cite Save More

Mutagenesis of the C1 oxidation pathway in Methanosarcina barkeri: new insights into the Mtr/Mer bypass pathway

PV Welander, WW Metcalf - Journal of bacteriology, 2008 - Am Soc Microbiol

... In **Methylobacterium extorquens** AM1 this problem is solved by the presence of the formaldehyde-activating ... intermediate in this bypass pathway, one could imagine that formaldehyde **toxicity** may play ... that the accumulation of this highly reactive compound could be **toxic** for the ...

Cited by 38 Related articles All 12 versions Cite Save

High-throughput phenomics: experimental methods for mapping fluxomes

U Sauer - Current opinion in Biotechnology, 2004 - Elsevier

... for the interpretation of labeling patterns from isotopic tracer experiments can be distinguished: comparative, analytical and integrated (Figure 2). Comparative multivariate statistics may be used to discriminate strains or conditions (eg the presence of **toxic** chemicals) in massive ...

Cited by 256 Related articles All 7 versions Cite Save

Marker Exchange Mutagenesis of mxaF, encoding the large subunit of the Mxa methanol dehydrogenase, in Methylosinus trichosporium OB3b

MFU Haque, W Gu, AA DiSpirito... - Applied and ..., 2016 - Am Soc Microbiol

... dehydrogenase or reduced to methylene tetrahydrofolate. It is speculated that such redundancy for the conversion of formaldehyde exists to control the buildup of this **toxic** intermediate (1–9). What is less readily discerned from ...

Cited by 5 Related articles All 6 versions Cite Save

Repeated, selection-driven genome reduction of accessory genes in experimental populations

MC Lee, CJ Marx - PLoS Genetics, 2012 - journals.plos.org

... increased growth at the upper end of the temperature range of M. **extorquens** AM1 (Figure ... switches, starvation, and the **toxic** effects of an antibiotic and a **toxic** metal. ... likely that they would impart tradeoffs in components of the natural environment inhabited by **Methylobacterium**. ...

Cited by 81 Related articles All 16 versions Cite Save More

A review of bacterial methyl halide degradation: biochemistry, genetics and molecular ecology

IR McDonald, KL Warner, C McAnulla... - Environmental ..., 2002 - Wiley Online Library
... increases the yield and quality of crops without leaving behind **toxic** residues characteristic ... This may reflect the greater **toxicity** of either methyl bromide or the bromide ... were obtained with DNA from the negative controls (Escherichia coli, **Methylobacterium extorquens** AM1 and ...
Cited by 74 Related articles All 7 versions Cite Save More

Bioinformatics classification and functional analysis of PhoH homologs

AE Kazakov, O Vassieva, MS Gelfand... - In silico ..., 2003 - content.iospress.com
... Magnetospirillum magnetotacticum + **Methylobacterium extorquens** + Methylobacillus flagellatus + + ... Rhodobacter sphaeroides* + + + + Magnetospirillum magnetotacticum* + + + + **Methylobacterium extorquens*** + Methylobacillus flagellatus + + + + Burkholderia cepacia + + + + ...
Cited by 33 Related articles All 6 versions Cite Save

Process for producing oxazopyrroloquinolines, novel oxazopyrroloquinolines, and use of oxazopyrroloquinolines

T Urakami, M Oda, C Itoh, H Kobayashi... - US Patent ..., 1995 - Google Patents
... These functions may be damaged by **toxic** substances, medicines, alcohols, radiation and virus ... liver disease inhibitor very low in general **toxicity** and specific **toxicity** to kidney. ... **Methylobacterium extorquens** DSM 1337 (=JCM 2802=NCIB 9399), JCM 2803 (=NCIB 10409), ATCC ...
Cited by 1 Related articles All 2 versions Cite Save

Respiration Rate Determination by Phosphorescence-Based Sensors

TJ Strovas, ME Lidstrom - Handbook of Hydrocarbon and Lipid ..., 2010 - Springer
... This focus stems in part from our work with the facultative methylotroph **Methylobacterium extorquens** AM1. ... in the MLSC, heat-sealed test tubes were used to analyze cultures of M. **extorquens** AM1 (Strovas et ... However, the **toxicity** should be tested before employing these paints. ...
Related articles All 4 versions Cite Save More

Microbial characterization of the Mars Odyssey spacecraft and its encapsulation facility

MT La Duc, W Nicholson, R Kern... - Environmental ..., 2003 - Wiley Online Library
... Gene sequences of Methylococcus sp., Streptococcus gordonii and chloroplasts of Nicotiana tabacum were retrieved only from the spacecraft samples, while **Methylobacterium extorquens** rDNAs were retrieved only from the SAEF-II samples (Table 2). The non-overlapping ...
Cited by 136 Related articles All 7 versions Cite Save More

Mass spectrum selectivity-based chromatogram baseline-shift elimination and its application in metabonomics of liver **toxicity**

JJ Feng, T Lv, L Liu, L Xie, YW Xing, CY Min... - ... and Intelligent Laboratory ..., 2013 - Elsevier
... Cover image Cover image. Mass spectrum selectivity-based chromatogram baseline-shift elimination and its application in metabonomics of liver **toxicity**. ... Baseline-shift has an effect on metabobomics model and evaluation of drug **toxicity**. Abstract. ...
Cited by 5 Related articles All 3 versions Cite Save

Metabolic engineering of Corynebacterium glutamicum for methanol metabolism

S Witthoff, K Schmitz, S Niedenführ, K Nöh... - Applied and ..., 2015 - Am Soc Microbiol
... Whereas Gram-negative methylotrophic bacteria such as **Methylobacterium extorquens** employ pyrroloquinoline quinone (PQQ)-dependent and periplasmic methanol ... also serves as "safety valve" in case of an intracellular accumulation of formaldehyde to **toxic** amounts. ...
Cited by 17 Related articles All 9 versions Cite Save

Oxazopyrroloquinolines and use of oxazopyrroloquinolines

T Urakami, M Oda, C Itoh, H Kobayashi... - US Patent ..., 1993 - Google Patents
... These functions may be damaged by **toxic** substances, medicines, alcohols, radiation and virus ... liver disease inhibitor very low in general **toxicity** and specific **toxicity** to kidney. ... **Methylobacterium extorquens** DSM 1337 (=JCM 2802=NCIB 9399), JCM 2803 (=NCIB 10409), ATCC ...
Cited by 1 Related articles All 2 versions Cite Save

Metabolism of dimethylsulphoniopropionate by Ruegeria pomeroyi DSS-3

CR Reisch, WM Crabb, SM Gifford, Q Teng... - Molecular ..., 2013 - Wiley Online Library
... The enzyme that catalyses the reduction of acryloyl-CoA in R. pomeroyi was recently identified by its ability to confer resistance to acrylate **toxicity** (Todd et al., 2012a). ... It is also implicated in increased resistance to acrylate **toxicity** and acrylate degradation by resting cells. ...
Cited by 17 Related articles All 7 versions Cite Save

Complete sequence and organization of the Sphingobium chungbukense DJ77 pSY2 plasmid

SM Yeon, YC Kim - The Journal of Microbiology, 2011 - Springer

... Strain DJ77 has been further studied for its ability to degrade or transform recalcitrant **toxic** compounds, such as toluene, benzoate, biphenyl ... 14.2 8485 7634 - 282 Universal stress protein UspA [**Methylobacterium extorquens** DM4] YP_003068177.1 5-853 1-282 (282) 73 ...

Cited by 4 Related articles All 8 versions Cite Save

Regulation of methanol and methylamine dehydrogenases in Methylophilus methylotrophus

A Dawson, G Southgate... - FEMS microbiology ..., 1990 - Wiley Online Library

... termined enzymically using a crude extract of methylamine-grown **Methylobacterium extorquens** AMI, prepared according to the method of Tatra and ... state concentration of methanol is high, thus minimising the potential for the overproduction of formaldehyde, the **toxic** product of ...

Cited by 5 Related articles All 7 versions Cite Save More

Biosynthesis of secondary metabolites in methanotrophs: biochemical and genetic aspects

VN Khmelenina, ON Rozova, SY But... - Applied ..., 2015 - search.proquest.com

... phaC and phaCAB did not increase the biopolymer level in **Methylobacterium extorquens** G10, despite an ... absent in a wide and phylogenetically divergent group of **methylobacteria** unable to use ... In order to prevent **toxicity** of products of methanotroph genes, low copy number ...

Cited by 8 Related articles All 8 versions Cite Save More

An Integrated Program in Microbial Genome Sequencing and Analysis

CM Fraser, JE Eisen, W Nierman, K Nelson, H Tettelin... - 2005 - osti.gov

... We used phylogenomic analysis, gene order information, and comparative analysis with the partially sequenced methylotroph **Methylobacterium extorquens** to detect ... environmental roles include degradation of chitin in marine systems, and the breakdown of **toxic** algal blooms. ...

Cite Save More

A glutathione-dependent formaldehyde-activating enzyme (Gfa) from Paracoccus denitrificans detected and purified via two-dimensional proton exchange NMR ...

M Goenrich, S Bartoschek, CH Hagemeier... - Journal of biological ..., 2002 - ASBMB

... Formaldehyde is a highly **toxic** compound due to nonspecific reactivity with proteins and nucleic acids (1). It is liberated as a result of demethylation ... P. denitrificans (DSM413), E. coli DH5α, and **Methylobacterium extorquens** AM1 were cultivated as described previously (4, 10). ...

Cited by 42 Related articles All 9 versions Cite Save

Metabolic and physiological interdependencies in the Bathymodiolus azoricus symbiosis

R Ponnudurai, M Kleiner, L Sayavedra... - The ISME ..., 2017 - ncbi.nlm.nih.gov

... Also, since accumulation of formaldehyde is **toxic** to the cells, the two formaldehyde oxidation pathways may operate as ... In the facultative methylotroph **Methylobacterium extorquens** AM1, odh expression is repressed during growth on C1-compounds (Chistoserdova et al., 2003 ...

Cited by 3 Related articles All 7 versions Cite Save More

Marker Exchange Mutagenesis of mxaF, Encoding the Large Subunit of the Mxa Methanol Dehydrogenase, in Methylosinus trichosporium OB3b.

W Gu, AA DiSpirito, JD Semrau - Applied and environmental ..., 2015 - europepmc.org

... It is speculated that such redundancy for the conversion of formaldehyde exists to control the buildup of this **toxic** intermediate (1,–9). ... Formate as the main branch point for methylotrophic metabolism in **Methylobacterium extorquens** AM1. J Bacteriol 190:5057–5062. ...

Related articles Cite Save

Enhancement of the antimicrobial performance of biocidal formulations used for the preservation of white mineral dispersions

N Di Maiuta, P Schwarzentruber, CS Dow - Applied microbiology and ..., 2011 - Springer

... have also been noted to exhibit biocide potential or even **toxicity** towards bacteria. In general, heavy metal ions are more **toxic** than the other classes of ... WMD cultures of Pseudomonas putida (CCOS 31) and facultative methylotrophic **Methylobacterium extorquens** (CCOS 32 ...

Cited by 1 Related articles All 17 versions Cite Save

Evidence for the presence of a CmuA methyltransferase pathway in novel marine methyl halide-oxidizing bacteria

H Schäfer, IR McDonald... - Environmental ..., 2005 - Wiley Online Library

... avoid inhibition resulting from adverse effects of methyl bromide and methyl chloride, which were found to be relatively **toxic**, only small ... but there were also hits with the beta chain of malate-CoA synthetase (=malate thiokinase) from **Methylobacterium extorquens** AM1, another ...

Cited by 62 Related articles All 10 versions Cite Save More

Formaldehyde dehydrogenase preparations from Methylococcus capsulatus (Bath) comprise methanol dehydrogenase and methylene tetrahydromethanopterin ...

EK Adeosun, TJ Smith, AM Hoberg... - ..., 2004 - mic.microbiologyresearch.org

... In methylotrophic bacteria, formaldehyde is an important but potentially **toxic** metabolic intermediate that can be assimilated into biomass or oxidized to ... In M. **extorquens**, in which this pathway is well characterized, the formation of methylene H4MPT is catalysed by a specific ...

Cited by 9 Related articles All 10 versions Cite Save

Microbial synthesis of poly (3-hydroxybutyrate-co-4-hydroxybutyrate) copolymer by Cupriavidus sp. USMAA2-4 through a two step cultivation process

H Chai, R Ahmad, A Yahya, M Majid... - African Journal of ..., 2009 - ajol.info

... than the simple carbon sources, and more importantly it is often also **toxic**. ... fermentation was prohibited in our study in order to avoid **toxicity** occurrence in ... factors influency the molecular mass of polyhydroxybutyrate accumulated by **Methylobacterium extorquens** and Alcaligenes ...

Cited by 14 Related articles All 7 versions Cite Save More

Influence of erythromycin A on the microbial populations in aquaculture sediment microcosms

YH Kim, CE Cerniglia - Aquatic **toxicology**, 2005 - Elsevier
... Aquatic **Toxicology**. ... **Methylobacterium extorquens** DSM 1338, Pseudomonas fluorescens DSM 6506, P. pseudoalcaligenes POB310, P. putida DSM 8368, Ralstonia eutropha JMP134, Sphingomonas paucimobilis DSM 7526 and S. yanoikuyae DSM 6900 were included as ...
Cited by 15 Related articles All 9 versions Cite Save

C1 metabolism in Corynebacterium glutamicum: an endogenous pathway for oxidation of methanol to carbon dioxide

S Witthoff, A Mühlroth, J Marienhagen... - Applied and ..., 2013 - Am Soc Microbiol
... fungi (3), Gram-negative methylotrophic bacteria, such as **Methylobacterium extorquens**, use pyrroloquinoline ... The **toxicity** of formaldehyde arises from nonenzymatic reactions with biological macromolecules ... since virtually all organisms have to cope with **toxic** formaldehyde as ...
Cited by 26 Related articles All 9 versions Cite Save

The copper responding surfaceome of Methylococccus capsulatus Bath

OA Karlsen, Ø Larsen, HB Jensen - FEMS microbiology letters, 2011 - academic.oup.com
We use cookies to enhance your experience on our website. By continuing to use our website, you are agreeing to our use of cookies. You can change your cookie settings at any time. Find out more ...
Cited by 16 Related articles All 8 versions Cite Save More

Multivariable multi-strategy control of a fed-batch fermentation process for the production of poly-/spl beta/-hydroxybutyric acid (PHB)

Y Pomerleau, D Bourque... - Control Applications, 1993 ..., 1993 - ieeexplore.ieee.org
... This control strategy for methanol concentration is essential because methanol, as shown in Figure 2, is **toxic** or inhibitory at oaitotion j ... This was done to avoid **toxic** effects caused by the high salts concentrations needed to obtain high cell density fermentations. ...
Related articles Cite Save More

Recombinant microorganisms comprising stereospecific diol dehydratase enzyme and methods related thereto

AP Mueller, M Koepke - US Patent 9,284,564, 2016 - Google Patents
... including higher specificity, higher yields, lower energy costs and greater resistance to **poisoning**. ... Corynebacterium glutamicum, Trichoderma reesei, Ralstonia eutropha, Cupriavidus necator Pseudomonas putida, Lactobacillus plantarum, **Methylobacterium extorquens**. ...
Related articles All 4 versions Cite Save

Engineering Escherichia coli for methanol conversion

JEN Müller, F Meyer, B Litsanov, P Kiefer, E Potthoff... - Metabolic ..., 2015 - Elsevier
... Moreover, as mentioned above, methylotrophy involves a **toxic** intermediate and thus any ... number of required proteins, their dependency on co-factors and **toxicity** of produced ... Williams, 2003) such as the best characterized enzyme from **Methylobacterium extorquens** AM1 could ...
Cited by 39 Related articles All 11 versions Cite Save

Guidance for engineering of synthetic methylotrophy based on methanol metabolism in methylotrophy

W Zhang, T Zhang, S Wu, M Wu, F Xin, W Dong, J Ma... - RSC Advances, 2017 - pubs.rsc.org
... 11 In **Methylobacterium extorquens** AM1, 15 genes participate in methanol oxidation, and 14 of them ... Although HCHO is an important intermediate in methylotrophic metabolism, it is highly **toxic**. The **toxicity** arises from the high level of nonspecific reactivity of HCHO with proteins ...
Cited by 1 Related articles Cite Save More

A cytochrome c peroxidase from Pseudomonas nautica 617 active at high ionic strength: expression, purification and characterization

T Alves, S Besson, LC Duarte, GW Pettigrew... - ... et Biophysica Acta (BBA ..., 1999 - Elsevier
... Hydrogen peroxide is often produced in living cells and its **toxicity** calls for the existence of particular protection mechanisms. ... Me, MG-Mm, MG-Mf and MG-Pd: methylamine utilization protein MauG precursors from respectively **Methylobacterium extorquens** [37], Methylophilus ...
Cited by 46 Related articles All 8 versions Cite Save

Analyzing bacterial physiology at the single-cell level

TJ Strovas, ME Lidstrom - MICROBE-AMERICAN SOCIETY FOR ..., 2008 - researchgate.net
... It seems likely that these faster- growing cells experience greater initial starvation after the switch and also may temporarily accumulate formal- dehyde, the **toxic** first product of ... Cell to cell heterogeneity in growth rate and gene expression in **Methylobacterium extorquens** AM1. ...
Cited by 6 Related articles Cite Save More

Their diversity, role, structure and mechanism

JA DUINE, A HACISALIHOGLU - Biological Electron Transfer ..., 2012 - books.google.com
... LOCALIZATION In view of the **toxicity** of the products of the amine conversion, it is not ... Conversion of methylamine appears to be a special case since formaldehyde is extremely **toxic** to the cell. ... 2) for that purpose [13] and the Gram-negative **Methylobacterium extorquens** THF [14 ...
Related articles Cite Save

Production of Poly-α-hydroxybutyrate (PHB) from Sago Starch by The Native Isolate Bacillus megaterium PSA10

NA Yanti, L Sembiring, S Margino - Indonesian Journal of ..., 2009 - journal.ugm.ac.id
... PHB is biodegrad- able, water insoluble, non-**toxic**, bio-com- patible and thermoplastic and therefore it is suitable for ... polymer produced by PHB producer such as Alcaligenes eutrophus MTCC 1954, Pseudomonas citronellolis 1191 and **Methylobacterium extorquens** MTCC 298 ...
Cited by 6 Related articles All 2 versions Cite Save More

Microbial Amine Oxidoreductases

JA Duine, A Hacisalihoglu - ... Chains: Genetics, Composition and Mode of ..., 1998 - Springer
... In view of the **toxicity** of the products of the amine conversion, it is not unexpected that ... Conversion of methylamine appears to be a special case since formaldehyde is extremely **toxic** to the cell. ... 2) for that purpose [13] and the Gram-negative **Methylobacterium extorquens** THF [14 ...
Related articles Cite Save More

The Bartonella quintana extracytoplasmic function sigma factor RpoE has a role in bacterial adaptation to the arthropod vector environment

S Abromaitis, JE Koehler - Journal of bacteriology, 2013 - Am Soc Microbiol
... However, hemin can produce reactive oxygen molecules that are potentially **toxic** (12). ... The involvement of the ECF15-associated response regulator in the alphaproteobacterial GSR was first described in 2006, for **Methylobacterium extorquens** (30). ...
Cited by 20 Related articles All 13 versions Cite Save

Methylotrophic bacteria in trimethylaminuria and bacterial vaginosis

AP Wood, FJ Warren, DP Kelly - Handbook of Hydrocarbon and Lipid ..., 2010 - Springer
... These are all ultimately channeled to formaldehyde, which although potentially **toxic**, is a key ... al., 1992; Sanders et al., 2000), but other species (including M. **extorquens**) are also ... rates may be underestimated because of the difficulty of identifying **Methylobacterium** which grows ...
Cited by 5 Related articles All 6 versions Cite Save More

Applications of Metabonomics in Clinical Diagnosis

XJ Zhai, YL Zhang - Medicine and Biopharmaceutical: Proceedings ..., 2016 - World Scientific
Related articles Cite Save More

Expression and Simple Purification Strategy for the Generation of Anti-microbial Active Enterocin P from Enterococcus faecium Expressed in Escherichia coli ...

TN Le, TH Do, TN Nguyen, NT Tran... - Iranian Journal of ..., 2014 - ijbiotech.com
... formation of a well- designed construct that is stably expressed and are non-**toxic** to host ... expressed in its active form in E. coli was believed to indicate **toxicity** to the ... EntP has been expressed in different host strains, such as E. coli, **Methylobacterium extorquens** ATCC 55366, L ...
Related articles All 9 versions Cite Save More

Applied microbiology and biotechnology Volume: 83 ISSN: 1432-0614 ISO Abbreviation: Appl. Microbiol. Biotechnol. Publication Date: 2009 Jun

FW Koopman, JH de Winde, HJ Ruijssenaars - Detail: - biomedsearch.com
... wash-out of the culture, underlining the acute and low-threshold nature of formaldehyde **toxicity**. ... methanol is the preferred auxiliary substrate as it is less **toxic**, easier to ... Methylotrophy in **Methylobacterium extorquens** AM1 from a genomic point of viewJ Bacteriol 2003;185:2980 ...
Related articles Cite Save More

Removal of by-products from crosslinkable preparations

H Misiak, M Krebs, T O'connell, KH Maurer... - US Patent ..., 2011 - Google Patents

... to claim 1 , wherein the by-product is a **toxic**, strongly smelling ... Methanosphaera stadtmanae, Methylobacillus glycogenes, Methylobacillus methanolovorus sp., **Methylobacterium** aminovorans, **Methylobacterium extorquens**, **Methylobacterium** fujisawaense, **Methylobacterium** ...

Related articles All 5 versions Cite Save

Biological Detoxification of Lignocellulosic Hydrolysates for Improved Biobutanol Production.

M Tatyana, S Sergey - Key Engineering Materials, 2016 - search.ebscohost.com

... The method is based on the utilization of **toxic** components by group of isolates: five bacteria related to **Methylobacterium extorquens**, Pseudomonas Sp, Flavobacterium indologenes, Acinetobacter sp., Arthrobacter aurescens and one fungus Coniochaeta lignz'arz'a. These ...

Cited by 1 Related articles All 3 versions Cite Save More

Le métabolisme du dichlorométhane chez **Methylobacterium extorquens** DM4: génomique fonctionnelle et physiologie

E Muller - 2011 - theses.fr

... Titre traduit. Dichloromethane metabolism in **Methylobacterium extorquens** DM4 : functional genomics and physiology. Résumé. **Methylobacterium extorquens** strain DM4 can use dichloromethane (DCM), a **toxic** one-carbon chlorinated solvent, as growth substrate. ...

Cite Save More

ИССЛЕДОВАНИЕ МЕДИАТОРНЫХ СВОЙСТВ 2, 5-ДИБРОМ-Я-БЕНЗОХИНОНА В АМПЕРОМЕТРИЧЕСКОМ БИОСЕНСОРЕ НА ОСНОВЕ ...

ТА КУЗНЕЦОВА, МА ТУЛЕНИНОВА - Известия Тульского ..., 2016 - cyberleninka.ru

... for **toxicity** testing of heavy metals / Xu. ... 2,5-DIBROMO-P-BENZOQUINONE IN AMPEROMETRIC BIOSENSOR BASED ON THE **METHYLOBACTERIA** TA Kuznetsova ... condition of amperometric biosensor based on the recombinant strain **Methylobacterium extorquens** pCM160 as ...

Related articles All 2 versions Cite Save More

антиалкогольна і антинаркотиЧна дія **METHYLOBACTERIUM EXTORQUENS** укм в-3368

ТП Криштаб, ВО Романовська... - Мікробіологічний ..., 2009 - irbis-nbuv.gov.ua

... Health of Ukraine, Kyiv Antl-ALCoHoLIC AnD Antl-nARCotIC ACtIon OF **METHYLOBACTERIUM EXTORQUENS** UCM B-3368 S ummary The paper deals with action efficiency of microbial biomass on characteristic indicators at alcohol and morphine organism **intoxication**. ...

Related articles All 3 versions Cite Save

Degradation of dichloromethane and adaptation to intracellular acid in **Methylobacterium**

É HOURCADE - 2007 - Université Louis Pasteur, Strasbourg

Cite Save

Biosynthesis of ribose-5-phosphate and erythrose-4-phosphate in archaea: a phylogenetic analysis of archaeal genomes

T Soderberg - Archaea, 2005 - hindawi.com

... RuMP pathway for the produc- tion of Ru5P implies the concurrent production of formalde- hyde, which is **toxic** to cells. ... fulgidus) contain members of COG 1795, a formalde- hyde-activating enzyme first characterized in the methylo- troph **Methylobacterium extorquens** (Vorholt et ...

Cited by 64 Related articles All 10 versions Cite Save

Physiology, regulation, and limits of the synthesis of poly (3HB)

W Babel, JU Ackermann, U Breuer - Biopolyesters, 2001 - Springer

... easily by numerous prokaryotes from renewable resources and even from potentially **toxic** waste products ... m C oA 0.084; K m A cA cC o A 0.011; 51, 55 **extorquen** s K ... coenzyme A transferase), as observed in Azotobacter beijerinckii [10] and **Methylobacterium extorquens** [47, 52 ...

Cited by 64 Related articles All 9 versions Cite Save More

Bioremediation potential of formaldehyde by the marine microalga Nannochloropsis oculata ST-3 strain

K Yoshida, H Ishii, Y Ishihara, H Saito... - Applied biochemistry and ..., 2009 - Springer

... Pseudomonas alcaligenes [8], Pseudomonas pseudoalcaligenes [9], Trichosporon penicillatum [2], **Methylobacterium extorquens** [9], and ... **Methylobacterium** strains BIP and ROS1 showed acclimatization to growth at 100ámM ... **Toxicology** and Applied Pharmacology, 67, 246–256 ...

Cited by 17 Related articles All 12 versions Cite Save

Biological treatment of mixtures of toxis compounds emitted from formaldehyde resin-producing industries

ÓJ Prado Rubianes, MC Veiga, C Kennes - 2005 - ruc.udc.es

... TL: **toxic** load; EC: elimination capacity. ... 6 REFERENCES Doronina, NV, Ezhov, VA and Trotsenko, YA (1996) Aerobic biodegradation of formaldehyde, methanol and methylamine by immobilized **Methylobacterium extorquens** cells. Appl. Biochem. Microbiol. 33: 138-141. ...

Related articles Cite Save More

Formaldehyde fixation contributes to detoxification for growth of a nonmethylotroph, Burkholderia cepacia TM1, on vanillic acid

R Mitsui, Y Kusano, H Yurimoto, Y Sakai... - Applied and ..., 2003 - Am Soc Microbiol

... formaldehyde is a highly reactive compound that has a **toxic** effect on ... Apparently, the overexpressed enzymes contribute to the suppression of formaldehyde **toxicity**. ... Novel formaldehyde-activating enzyme in **Methylobacterium extorquens** AM1 required for growth on ...

Cited by 50 Related articles All 11 versions Cite Save

METALS IN BIOLOGY: THE INORGANIC CHEMISTRY OF LIFE; BIOINORGANIC CHEMISTRY GRS

J Mayer - 2015 - osti.gov

... 7:30 pm - 8:00 pm Jeffrey Gralnick (University of Minnesota) "Anaerobic Fe(II) **Toxicity** in a Dissimilatory Metal Reducing ... 9:20 pm Elizabeth Skovran (San Jose State University) "The Role of Lanthanides During Methanol-Dependent Growth in **Methylobacterium Extorquens** AM1" ...

Cite Save More

Core pathways operating during methylotrophy of Bacillus methanolicus MGA3 and induction of a bacillithiol-dependent detoxification pathway upon ...

JEN Müller, F Meyer, B Litsanov, P Kiefer... - Molecular ..., 2015 - Wiley Online Library

... the assimilatory and dissimilatory ribulose monophosphate (RuMP) cycles for conversion of the central but **toxic** intermediate formaldehyde. ... A closed TCA cycle is not essential during methylotrophic growth for other methylotrophs such as **Methylobacterium extorquens** AM1 and ...

Cited by 8 Related articles All 5 versions Cite Save

Metabolic regulation of "Ca. Methylacidiphilum fumariolicum" SolV cells grown under different nitrogen and oxygen limitations

AF Khadem, A Pol, AS Wieczorek... - Frontiers in ..., 2012 - ncbi.nlm.nih.gov

Cited by 8 Related articles All 15 versions Cite Save

Method for enhancing oxidation of methyl bromide with strain IMB-1 (ATCC 202197) during agricultural fumigations

RS Oremland, TL Connell, LG Miller - US Patent 6,013,254, 2000 - Google Patents

... is added to soils in conjunction with chloropicrin ("tear gas") to enhance **toxicity** and to ... microorganisms which are not indigenous to the environment and (2) a non-**toxic** analog of ... and **Methylobacterium extorquens** have been isolated which can grow on methyl chloride (6, 7), but ...

Cited by 4 Related articles All 2 versions Cite Save

Proteomic examination of Ralstonia eutropha in cellular responses to formic acid

SE Lee, QX Li, J Yu - Proteomics, 2006 - Wiley Online Library

... This fact implies that the **toxicity** of formic acid is related to the proteins involved in formate utilization in ... 4.1 Down-regulated routes of **toxic** effects of formic acid in R. eutropha ... affec- ted by formic acid treatment (Table 1). Therefore, formic acid has shown its potent **toxicities** to a ...

Cited by 16 Related articles All 5 versions Cite Save More

Pentanol and benzyl alcohol attack bacterial surface structures differently

T Yano, Y Miyahara, N Morii, T Okano... - Applied and ..., 2016 - Am Soc Microbiol

... However, although CliABC, a resistance-nodulation-cell division (RND) transporter which is responsible for efflux of many chemotherapeutic agents in **Methylobacterium extorquens** DM1, has been reported (32), the functions of membrane proteins are poorly understood in M ...

Related articles All 6 versions Cite Save

The evolution of RecD outside of the RecBCD complex

M Montague, C Barnes, HO Smith, RY Chuang... - Journal of molecular ..., 2009 - Springer

... In six of those (Mycoplasma mobile, Mycoplasma mycoides, Acaryochloris marina, **Methylobacterium extorquens**, Acidiphilium cryptum, and **Methylobacterium** 4-46), the duplicate genes cluster with the other gene of the same organism. ...

Cited by 15 Related articles All 12 versions Cite Save

Role of Metabolic Engineering in Enhancing Hydrogen Yields

C Carere, DB Levinli - State of the Art and Progress in Production ..., 2012 - books.google.com

... catabolic activities for the detoxification, degradation and mineralization of **toxic** chemicals has ... unfavorable energetics, and generally low substrate concentrations and **toxicity** effects. ... hosts (glucose: E. coli and C. acetobutylicum; methanol: **Methylobacterium extorquens**)[73]. ...

Related articles Cite Save

Inducible/regulated gene expression system in E coli

YJ Choi, B Massie, CB Miguez - US Patent 8,318,455, 2012 - Google Patents

... recombinant proteins, mainly due to the high cost and potential **toxicity** of IPTG ... elements from Pseudomonas putida to enable inducible regulation of gene expression in **Methylobacterium extorquens**. ... of the exogenous inducer, eg p-cumate, which is non-**toxic**, inexpensive and ...

Related articles All 5 versions Cite Save

Tungsten Cofactors, Binding Proteins, and Transporters in Biological Systems

B Mukherjee, S Ghosh, SR Chowdhury... - Encyclopedia of ..., 2013 - Springer

... Heterodimeric enzymes with two subunits (α 2 β 2) of 107 kDa and 61 kDa, respectively, are obtained from the α-probacterium **Methylobacterium extorquens**. ... Sodium tungstate has less **toxic** effect on earthworms, but it completely inhibits their reproductive ability. ...

Related articles All 2 versions Cite Save More

C1 compounds as auxiliary substrate for engineered Pseudomonas putida S12

FW Koopman, JH De Winde... - Applied microbiology and ..., 2009 - Springer

... by wash-out of the culture, underlining the acute and low-threshold nature of formaldehyde **toxicity**. ... methanol is the preferred auxiliary substrate as it is less **toxic**, easier to ... L, Chen SW, Lapidus A, Lidstrom ME (2003) Methylotrophy in **Methylobacterium extorquens** AM1 from a ...

Cited by 22 Related articles All 26 versions Cite Save More

Characterization and cloning of a 37.6-kb plasmid carried by Legionella pneumophila recovered from patients and hospital water over a 12-year period

SD Mansfield, GS Bezanson... - Canadian journal of ..., 1997 - NRC Research Press

... of Legionella-specific translation products may have resulted in some sort of "**toxic**" effect on ... for electroporation of the methylotrophic bacteria Hyphornicrobiurn facilis, Hyphomicrobium denitrificans, Methylobacillus glycogenes, **Methylobacterium extorquens**, and Methylophilus ...

Cited by 5 Related articles All 5 versions Cite Save

On the control of molecular weight distribution of polyhydroxybutyrate in Azohydromonas lata cultures

G Penloglou, E Kretza, C Chatzidoukas... - Biochemical ..., 2012 - Elsevier

... 1] and [2]. Polyhydroxyalkanoates (PHAs) is a class of biodegradable polymers that are produced intracellularly by various bacterial species as energy and carbon reserves [3] and [4]. PHAs exhibit excellent biodegradability, biocompatibility and zero-**toxicity** characteristics [5 ...

Cited by 16 Related articles All 8 versions Cite Save

Changes of chlorine isotope composition characterize bacterial dehalogenation of dichloromethane

AM Zyakun, YE Firsova, ML Torgonskaya... - Applied Biochemistry ..., 2007 - Springer

... Dichloromethane (CH2ël2, DCM) is a highly **toxic** persistent solvent, broadly used ... molecules with different chlorine isotopes by aerobic **methylobacteria Methylobacterium** dichloromethanicum DM4 ... extract of strain DM4; and transconjugant lethylobacterium **extorquens** AI1/pME ...

Cited by 3 Related articles All 6 versions Cite Save

Methylobacterium spp. from a patient with multiple sclerosis

RJ Zabransky, T Ellis, D Canaday - Clinical Microbiology Newsletter, 1997 - Elsevier

... pro- vide a strong rationale for the use of IVIG as adjunctive therapy in **toxic** shock pa ... M. **extorquens** and M. mesophilicum may be variants of the same species and were probably the ... The dif- ferentiation of the eight extant species of **Methylobacterium** requires a variety of tests ...

Cited by 3 Related articles All 5 versions Cite Save

Fenton process-driven decolorization of Allura Red AC in wastewater using apolaccase-modified or native nanomagnetite immobilized on silica fume

A Alayli Gungor, H Nadaroglu, E Kalkan... - Desalination and Water ..., 2016 - Taylor & Francis

... These experiments also showed the adsorbent to be reusable, cheap, biocompatible, easy to prepare, non-**toxic** (magnetite nanoparticles, H 2 O 2 , and silica fume), and capable of generating Fenton reaction conditions with or without additional treatment with apolaccase. ...

Related articles All 5 versions Cite Save More

Isolation of Methylophaga spp. from marine dimethylsulfide-degrading enrichment cultures and identification of polypeptides induced during growth on dimethylsulfide

H Schäfer - Applied and environmental microbiology, 2007 - Am Soc Microbiol

... This was done to avoid potential **toxicity** of higher DMS concentrations. ... Previously, mxaF′ knockout mutants of **Methylobacterium extorquens** (similar to xoxF) were not affected in their ability to grow on methanol or methylamine, and a phenotype associated with this gene has ...

Cited by 69 Related articles All 16 versions Cite Save

A molecular basis for uranium **toxicity**

KA Burbank - 2014 - scholarworks.montana.edu

... Consequently, the recent discovery of uranium **toxicity** at submicromolar levels in bacteria provides relevance to serious environmental and public health issues in the light of current EPA ... interest because of its application to nuclear power and military weapons.1 It is a **toxic** ...

Related articles Cite Save More

The outer membrane of **Methylobacterium** organophilum

IANC HANCOCK, KM WILLIAMS - Microbiology, 1986 - mic.microbiologyresearch.org

... 1982) found that the pink facultative methylotroph Pseudomonas **extorquens** grew at ... The **toxicity** of alcohols towards most bacteria increases sharply with increasing size and hydrophobicity ... al., 1983), methanol appeared to enter the cell by passive diffusion in **Methylobacterium** ...

Cited by 10 Related articles All 4 versions Cite Save More

Genetics of bacteria that oxidize one-carbon compounds. Progress report, March 1, 1991--June 30, 1993

RS Hanson - 1993 - osti.gov

... The DNAs in each lane were obtained frombacteria grown on the following carbon sources: Lane 1,**Methylobacterium extorquens** AM1 grown with methanol: Lane 2, M. trichosporium OB3b grown on methane; Lane 3, M. organophilum XX grown in nutrient broth: Lane 4: M ...

Cite Save More

Methanotrophs

TJ Smith, JC Murrell - Encyclopedia of Industrial Biotechnology, 2010 - Wiley Online Library

... **toxic** principal metabolic intermediate and it appears that multiple pathways for metabolism and protection of formaldehyde are common if not universal in methanotrophs and other methylotrophic bacteria. Extensive studies on the methanol utilizer **Methylobacterium extorquens** ...

Cited by 11 Related articles All 3 versions Cite Save More

Chronic formaldehyde-mediated impairments and age-related dementia

J Miao, R He - Neurodegeneration, 2012 - intechopen.com

... Though the concept of "formaldehyde stress" has been mentioned in studies on **Methylobacterium extorquens** AMI (Miller, 2009) and tuberculosis ... dysfunction of this gene is related to abnormal metabolism of FA and causes severe **toxicity** (Duester et ... **Toxicology**,Vol.75,No.1,pp. ...

Cited by 6 Related articles All 4 versions Cite Save More

Molecular analysis of an outer membrane protein, MopB, of Methylococcus capsulatus (Bath) and structural comparisons with proteins of the OmpA family

A Fjellbirkeland, V Bemanian, IR McDonald... - Archives of ..., 2000 - Springer

... insert of the λ clone into pGEM3Zf(+) failed, indicating that the expression of MopB in E. coli is **toxic** to the ... bacter agile A20, Methylobacter capsulatus Y, Methylo- cystis strain M, Methylosinus sporium 5] and four methylo- trophs (**Methylobacterium extorquens** AM1, Methylobac ...

Cited by 11 Related articles All 17 versions Cite Save

Chloromethane utilization gene cluster fromHyphomicrobium chloromethanicum strain CM2T and development of functional gene probes to detect halomethane- ...

C McAnulla, CA Woodall, IR McDonald... - Applied and ..., 2001 - Am Soc Microbiol

... No growth was observed with bromomethane as the sole carbon and energy source, presumably due to the greater **toxicity** of this ... from CM2 T , CM4 T , and IMB-1 and with DNA from several non-chloromethane-utilizing bacteria (E. coli, **Methylobacterium extorquens** AM1, and ...

Cited by 48 Related articles All 12 versions Cite Save

2016 Molecular Basis of Microbial One-Carbon Metabolism GRC/GRS

S Vuilleumier - 2016 - osti.gov

... energy sources, some (eg carbon dioxide and methane) are potent greenhouse gases, and others (eg chlorinated methanes, carbon monoxide, and methanethiol) are **toxic** chemicals, produced ... "Methanol-Based Biotechnology - Engineering **Methylobacterium extorquens** fo ...

Cite Save More

Quinohemoprotein alcohol dehydrogenases: structure, function, and physiology

H Toyama, FS Mathews, O Adachi... - Archives of biochemistry ..., 2004 - Elsevier

... The side chains of Leu556 or Leu547 in MDH from **Methylobacterium extorquens** AM1 or Methylophilus methylophilus, respectively, and Trp557 in qEDH, form a lid-like cover (Fig. 4) to shield the substrate from bulk solvent ...

Cited by 95 Related articles All 8 versions Cite Save

Methylovorus sp. MP688 exopolysaccharides contribute to oxidative defense and bacterial survival under adverse condition

X Ge, W Wang, Y Han, J Wang, X Xiong... - World Journal of ..., 2013 - Springer
... to be a faster and more efficient way of methanol (formaldehyde) removal than oxidation, therefore efficiently converting the **toxic** metabolic intermediate into ... is also supported by the fact that there are no EPS synthesis genes found in **Methylobacterium extorquens** AM1, another ...
Cited by 1 Related articles All 8 versions Cite Save

Isolation and purification of granule-associated proteins relevant for poly (3-hydroxybutyric acid) biosynthesis from methylotrophic bacteria relying on the serine ...

CG Föllner, W Babel... - Canadian journal of ..., 1995 - NRC Research Press
... Calorespirometric feeding control enhances bioproduction from **toxic** feedstocks-Demonstration ... **Methylobacterium** rhodesianum produces poly-3-hydroxybutyrate and after ... associated proteins GA20 .and GA11 inMethylobacterium **extorquens** andMethylobacterium rhodesianum ...
Cited by 17 Related articles All 3 versions Cite Save

Formaldehyde stress responses in bacterial pathogens

NH Chen, KY Djoko, FJ Veyrier... - Frontiers in ..., 2016 - ncbi.nlm.nih.gov
... Formaldehyde is also highly **toxic** to microbes and it has widespread application as a disinfectant for sterilization. ... FIGURE 1 FIGURE 1. Mechanisms of formaldehyde **toxicity**. ... In methanotrophs and methylotrophs such as **Methylobacterium** sp. ...
Cited by 7 Related articles All 10 versions Cite Save

Archaea and Their Potential Role in Human Disease

PBEPW Lepp, DA Relman - journal.9med.net
... For example, the presence of intestinal sulfate-reducing bacteria and an increase in potentially **toxic** levels of hydrogen ... the discovery of archaeal genes that encode C1-transfer and methanogenic coenzymes in the aerobic bacterium **Methylobacterium extorquens** (8). Evidence ...
Related articles Cite Save More

Pseudomonas putida TX2 中辛基苯酚聚氧乙基醇類脫氫酶之初步純化與特性研究

A Tseng - 2010 - ir.lib.ncu.edu.tw
... The refined structure of the quinoprotein methanol dehydrogenase from **Methylobacterium extorquens** at 1.94 A. Structure. 3, 177-87. Giger, W., Brunner, H., Schaffner, C., 1984. 4-Nonylphenol in sewage sludge: accumulation of **toxic** metabolites from nonionic surfactants. ...
Cite Save More

Methane oxidation by an extremely acidophilic bacterium of the phylum Verrucomicrobia

PF Dunfield, A Yuryev, P Senin, AV Smirnova... - Nature, 2007 - search.proquest.com
... These enzymes may remove **toxic** byproducts of competitive ammonia oxidation by pMMO. ... Although we found no homologues to formaldehyde dehydrogenases from Methylococcus capsulatus or **Methylobacterium extorquens**, there were homologues to alcohol ...
Cited by 374 Related articles All 18 versions Cite Save More

[16] Genetics of bacterial quinoproteins

ME Lidstrom - Methods in enzymology, 1995 - Elsevier
... gdh, pqq Klebsiella pneumoniae gdh, pqq Escherichia coli gdh, pqq TTQ M. **extorquens** AM1 mau P ... 7-10 For the MEDH system, a positive selection method exists for **Methylobacterium** strains. ... MEDH activity will convert the allyl alcohol to allyl aldehyde, which is **toxic**, and those ...
Cited by 4 Related articles All 4 versions Cite Save More

Method for producing target substance

R Takeshita, H Yasueda - US Patent 7,160,704, 2007 - Google Patents
... This is because formaldehyde is strongly **toxic** for organisms and therefore cells must rapidly utilize it as a carbon source or energy source or dispose it by detoxification. ... Specifically, MDH of **Methylobacterium extorquens** AM1 strain (Biochim. Biophys. ...
Cited by 11 Related articles All 4 versions Cite Save

The effect of oxygen on methanol oxidation by an obligate methanotrophic bacterium studied by in vivo 13 C nuclear magnetic resonance spectroscopy

C Costa, M Vecherskaya, C Dijkema... - Journal of industrial ..., 2001 - Springer
... Due to this the accumulation of formaldehyde led to a **poisoning** of the cells. ... However, for a methanol-oxidizing methylotrophic bacterium (**Methylobacterium** (former Pseudomonas) **extorquens**) Km and Vmax values for oxygen uptake using methanol, formaldehyde and ...
Cited by 11 Related articles All 14 versions Cite Save

A small, stable RNA induced by oxidative stress: role as a pleiotropic regulator and antimutator

S Altuvia, D Weinstein-Fischer, A Zhang, L Postow... - Cell, 1997 - Elsevier
... transporter (Island et al. 1992), and pqqL, a gene that shows homology to a family of endopeptidases and can complement a defect in pyrroloquinoline quinone synthesis in **Methylobacterium** organophilum (45 and 49). The two other ...
Cited by 451 Related articles All 13 versions Cite Save

Enzymatic manganese (II) oxidation by a marine α-proteobacterium

CA Francis, BM Tebo - Applied and Environmental ..., 2001 - Am Soc Microbiol
... ramosum, X72909; Escherichia coli, M24828; Magnetospirillum gryphiswaldense, Y10109;Mesorhizobium loti, D12791; **Methylobacterium extorquens**, D32224; Paracoccus ... the overall growth yield by providing protection against various harmful agents (eg, **toxic** oxygen ...
Cited by 92 Related articles All 14 versions Cite Save

Peptide Metabolism in Cytoplasm of Brain Cells

NH THOMA, PF LEADLAY, RN PERHAM, PA RECHE... - pdfs.semanticscholar.org
... Molecular structure of an unusual cytochrome c2 determined at 2.0 A; the cytochrome cH from **Methylobacterium extorquens** ... 5232 S233 S234 S235 S236 S237 s23a s239 Page 8. n 0 Suspect Proteins in Neurodegeneration P-Amyloid **toxicity** in rat brain re-aggregate cultures ...
Cite Save More

Principles and practices of pathway modelling

K Raman, P Rajagopalan, N Chandra - Current Bioinformatics, 2006 - ingentaconnect.com
... pathways. Several instances of such applications are available in the literature. For example, Van Dien and co-workers have reconstructed the carotenoid biosynthesis pathway in **Methylobacterium extorquens** AM1. Protein ...
Cited by 7 Related articles All 5 versions Cite Save More

In Search of the Active Site of pMMO Enzyme: Partnership between a K-12 Teacher, a Graduate K-12 Teaching Fellow, and a Research Mentor

KK Bearden, DS Mainardi... - Chemical Engineering ..., 2009 - researchgate.net
... of numerous organic chemicals into valuable products, and their capacity for the bioremediation of **toxic** pollutants have ... K. Harlas, MG Goodwin, and CCF Blake, The Refined Structure of the Quinoprotein Methanol Dehydrogenase from **Methylobacterium Extorquens** at 1.94 Å ...
Cited by 3 Related articles All 7 versions Cite Save More

Methyl chloride utilising bacteria are ubiquitous in the natural environment

C McAnulla, IR McDonald... - FEMS microbiology ..., 2001 - academic.oup.com
... However, 16S rRNA sequencing showed that only two distinct strains, recently designated Hyphomicrobium chloromethanicum CM2 T and **Methylobacterium** chloromethanicum CM4 ... No growth was observed with CH 3 Br, presumably due to the greater **toxicity** of this compound ...
Cited by 57 Related articles All 12 versions Cite Save More

生產聚羥基酯類發酵策略應用於廢水處理之可行性研究

洪昭尹 - 宜蘭大學化學工程與材料工程學系學位論文, 2013 - airitilibrary.com
... High-cell-density production of poly-β-hydroxybutyrate (PHB) from methanol by **Methylobacterium extorquens**: production of high-molecular-mass PHB. ... Revealing interactive **toxicity** of aromatic amines to azo dye decolorizer Aeromonas hydrophila. ...
Cited by 2 Related articles Cite Save

Biodegradation of the cyclic nitramine explosives RDX, HMX, and CL-20

FH Crocker, KJ Indest, HL Fredrickson - Applied microbiology and ..., 2006 - Springer
... **Methylobacterium extorquens**. +. ... Van Aken et al. (2004) also suggested that cometabolism of explosives may be a common trait among **methylobacteria** as they showed that three other **Methylobacterium** species were able to cometabolize HMX, RDX, and TNT. ...
Cited by 102 Related articles All 17 versions Cite Save

Molecular Genetics of the GenusParacoccus: Metabolically Versatile Bacteria with Bioenergetic Flexibility

SC Baker, SJ Ferguson, B Ludwig... - Microbiology and ..., 1998 - Am Soc Microbiol
Cited by 203 Related articles All 16 versions Cite Save

Process for bacterial stabilizing of aqueous ground natural calcium carbonate and/or precipitated calcium carbonate and/or dolomite and/or surface-reacted calcium ...

N Di Maiuta, P Schwarzentruber - US Patent 8,906,968, 2014 - Google Patents

... sp., Methylosinus sp., Hyphomicrobium sp., Methylosulfomonas sp., **Methylobacteria** sp., Pseudomonas ... Pseudomonas pseudoalcaligenes, Pseudomonas entomophila, Pseudomonas syringae, **Methylobacterium extorquens**, **Methylobacterium** radiotolerants, **Methylobacterium** ...

Cited by 1 Related articles All 4 versions Cite Save

Phylogenetic analysis of dichloromethane-utilizing aerobic methylotrophic bacteria

TP Tourova, BB Kuznetsov, NV Doronina... - Microbiology, 2001 - Springer

... marina VKM B-2159T, Ami- nobacter aminovorans NCIB 9059T, **Methylobacterium** organophilum ATCC ... aligned with the respective sequences of bacteria (including **methylobacteria**) of various ... lus glycogenes ATCC 29475T (M95652), Methylobac- terium **extorquens** JCM 2802 ...

Cited by 3 Related articles All 8 versions Cite Save More

Efficient molecular weight control of bacterially synthesized polyesters by alcohol supplementation

NM Thomson, A Hiroe, T Tsuge... - Journal of Chemical ..., 2014 - Wiley Online Library
... of chain transfer agent than the currently preferred PEG, as they achieve the same effect with reduced **toxicity** and are ... D, Effect of carbon source and concentration on the molecular mass of poly(3-hydroxybutyrate) produced by **Methylobacterium extorquens** and Alcaligenes ...
Cited by 6 Related articles All 5 versions Cite Save More

Archaea and Their Potential Role in Human

PB Eckburg, PW Lepp, DA Relman - pdfs.semanticscholar.org
... For example, the presence of intestinal sulfate-reduc- ing bacteria and an increase in potentially **toxic** levels of hydrogen ... discovery of archaeal genes that encode C1-transfer and methanogenic coenzymes in the aero- bic bacterium **Methylobacterium extorquens** (8). Evidence ...
Related articles All 4 versions Cite Save More

L-Serine and glycine

L Eggeling - Amino Acid Biosynthesis~ Pathways, Regulation and ..., 2007 - Springer
... Due to limiting precursor conversion and **toxicity** of C-1 substrates in fermentative l-serine production, another development assayed enzymatic ... M, Rossignol M, Borderies G, Volker U, Vorholt JA (2004) Comparison of the pro- teome of **Methylobacterium extorquens** AM1 grown ...
Cited by 8 Related articles All 3 versions Cite Save More

Physiology and biochemistry of amidase production by Methylophilus methylotrophus.

NJ Silman - 1990 - lra.le.ac.uk
... The usefulness of this enzyme resides In Its ability to hydrolyse acrylamlde to the less **toxic** products ammonia and acrylic acid. ... methylotrophs Is the pink facultative methylotrophs typified by **Methylobacterium extorquens** strain AMI (formerly Pseudomonas AMI). ...
Related articles All 4 versions Cite Save More

A comparison of the microbial production and combustion characteristics of three alcohol biofuels: ethanol, 1-butanol, and 1-octanol

F Kremer, LM Blank, PR Jones... - ... in bioengineering and ..., 2015 - ncbi.nlm.nih.gov
... pathway to alternative host organisms, such as yeast, cyanobacteria, and **methylobacteria**, all with ... Aside from metabolic modifications, extrinsic factors, such as biological **toxicity**, will also ... Metabolic engineering of **Methylobacterium extorquens** AM1 for 1-butanol production. ...
Cited by 6 Related articles All 10 versions Cite Save

Phylogenomic analysis of archaeal domain-An overview

P Chellapandi, C Karthigeyan... - Res Rev J ..., 2007 - researchgate.net
... Metabolisms of methanogenesis, osmo- and thermoregulation, sulfur, and heavy metal **toxicity** are still being exceptionally ... oxi- dative tetrahydromethanopterin-methanofuran-depen- dent proteins in a methylotrophic bacterial species, **Methylobacterium extorquens** AM1[34]. ...
Cited by 4 Related articles Cite Save More

Proteins secreted by filamentous fungi play key roles in different aspects of their biology. The fungus Penicillium purpurogenum, used as a model organism, is able to ...

TK Antal, TE Krendeleva, AB Rubin - Applied Microbiology and ..., 2011 - infona.pl
... The ethylmalonyl-CoA pathway is central to the carbon metabolism of many α-proteobacteria, like Rhodobacter sphaeroides and **Methylobacterium extorquens** as well as actinomycetes, like Streptomyces spp. Its function is ...
Cite Save More

Multienzyme Whole-Cell In Situ Biocatalysis for the Production of Flaviolin in Permeabilized Cells of Escherichia coli

S Krauser, P Kiefer, E Heinzle - ChemCatChem, 2012 - Wiley Online Library
... Alternative precursor molecules not available in living organisms might be applicable, possibly even at conditions that would be **toxic** for living cells ... method was applied for quantification according to Wu et al.23 by using a cell extract of **Methylobacterium extorquens** AM1 grown ...
Cited by 12 Related articles Cite Save More

Development of phylogenetic oligonucleotide probes for screening foodborne bacteria

M Ikeda, N Yamaguchi, K Tani, M Nasu - Journal of health science, 2005 - jstage.jst.go.jp

... United States of America (USA), for example, around 76 million cases of foodborne diseases, resulting in 325000 hospitalizations and 5000 deaths, are esti- mated to occur each year.1) In Japan, 699–1850 cases of food **poisoning** occurred from ... **Methylobacterium extorquens** ...

Cited by 7 Related articles All 7 versions Cite Save

Identification, cloning and sequence analysis of the poly (3-hydroxyalkanoic acid) synthase gene of the Gram-positive bacterium Rhodococcus ruber

U Pieper, A Steinbüchel - FEMS microbiology letters, 1992 - Elsevier

... It employs a mutant of A. eutrophus altered in the amino acid metabolism, thus avoiding the feeding with **toxic** and more expensive propionic acid. RhØococcus ruØr is a naturally occurring bacterium which synthesizes poly(3HB-co-3HV) from various single substrates [11,12]. ...

Cited by 66 Related articles All 6 versions Cite Save More

Method for producing target substance

H Yasueda, R Takeshita - US Patent 7,163,810, 2007 - Google Patents

... This is because formaldehyde is strongly **toxic** for organisms and therefore cells must rapidly utilize it as a carbon source or energy source or dispose it by detoxification. ... Specifically, MDH of **Methylobacterium extorquens** AM1 strain (Biochim. Biophys. ...

Cited by 3 Related articles All 4 versions Cite Save

Analysis of stable isotope assisted metabolomics data acquired by GC-MS

X Wei, B Shi, I Koo, X Yin, P Lorkiewicz, H Suhail... - Analytica Chimica ..., 2017 - Elsevier

... 40292, United States; b Department of Pharmacology & **Toxicology**, University of Louisville, Louisville, KY 40292, United States; c Department of Medicine, University of Louisville, Louisville, KY 40292, United States; d Center ...

Related articles Cite Save

吡咯喹啉醌的生理功能研究进展

徐磊， 张海军， 岳洪源， 齐广海， 武书庚 - 第五届 (2011) 中国蛋鸡行业发展 ..., 2011 - caaa.cn

... Key words: PQQ；Physiological importance；Side effect and **toxicity**；Mechanism ... 和热稳定性，见光易分解[6]。图1 PQQ 的化学结构式 PQQ 广泛存在于革兰氏阴性菌中，如甲基营养菌（**Methylobacterium extorquens**）的甲醇脱氢酶、 ...

Cited by 1 Related articles All 2 versions Cite Save

Pyrroloquinoline–quinone synthesized in Escherichia coli by pyrroloquinoline–quinone synthase of Deinococcus radiodurans plays a role beyond mineral phosphate ...

NP Khairnar, HS Misra, SK Apte - Biochemical and biophysical research ..., 2003 - Elsevier

... Growth characteristics and Rose Bengal mediated cellular **toxicity** studies. ... Optimum concentration of PQQ showed decrease in lipid peroxidation and protein carbonylation in isolated mitochondria and protecting the cells from hydrogen peroxide **toxicity**. ...

Cited by 51 Related articles All 6 versions Cite Save

Escherichia coli PQQ-containing quinoprotein glucose dehydrogenase: its structure comparison with other quinoproteins

M Yamada, MD Elias, K Matsushita, CT Migita... - ... et Biophysica Acta (BBA ..., 2003 - Elsevier

... Such a periplasmic oxidation would be crucial in respect to generating membrane potential without importing substrates into cells, and appears to mostly make **toxic** products. ... c, P16027, **Methylobacterium extorquens**. Quinohaemoproteins. Membrane-bound enzyme, ...

Cited by 41 Related articles All 6 versions Cite Save

Heterogeneity of intracellular replication of bacterial pathogens

S Helaine, DW Holden - Current opinion in microbiology, 2013 - Elsevier

... Thus, heterogeneity is due at least in part to differential exposure or sensitivity to nutritional deprivation or more **toxic** host processes, and the efficiency with which virulence molecules function to avoid, subvert or tolerate host defences. ...

Cited by 30 Related articles All 7 versions Cite Save

Process for bacterial stabilizing of aqueous ground natural calcium carbonate and/or precipitated calcium carbonate and/or dolomite and/or surface-reacted calcium ...

N Di Maiuta, P Schwarzentruber - US Patent 9,006,295, 2015 - Google Patents

... sp., Methylosinus sp., Hyphomicrobium sp., Methylosulfomonas sp., **Methylobacteria** sp., Pseudomonas ... Pseudomonas pseudoalcaligenes, Pseudomonas entomophila, Pseudomonas syringae, **Methylobacterium extorquens**, **Methylobacterium** radiotolerants, **Methylobacterium** ...

Related articles All 4 versions Cite Save

Bioconversion of Methane to Methanol with Methylomonas sp. dh-1 as Biocatalyst

KIM Yujin, JH HAN, KIM Hyeonsoo, P Soohyun... - 한국생물공학회 학술 ..., 2017 - dbpia.co.kr
... 190. Utilization and **toxicity** analysis of formic acid in gram-negative and gram-positive microorganisms Hyeonsoo ... 195. Inhibition of poly 3-hydroxybutyrate (PHB) synthesis by phaR deletion in **Methylobacterium extorquens** AM1 Yujin ...
Cite Save

Methanotrophs

IR McDonald, JC Murrell - Encyclopedia of Bioprocess Technology - Wiley Online Library
... plates, (2) adding excess methanol with DCM to inhibit possible sMMO-mediated activation of DCM to **toxic** products in any ... and cloning of a number of genes involved in methanol oxidation from the Gram-negative methylotrophs **Methylobacterium extorquens** and Paracoccus ...
Related articles All 2 versions Cite Save More

Functional analysis of the genome fragment involved in aerobic dichloromethane degradation by **Methylobacterium** dichloromethanicum DM4

YE Firsova, DN Fedorov, YA Trotsenko - Applied biochemistry and ..., 2012 - Springer
... chloromethanicum CM4 (YP_002421379) **Methylobacterium extorquens** PA1 (YP_001639798) **Methylobacterium extorquens** AM1 (YP_002963395 ... degradation by **methylobacteria** has not been studied in detail. ... the adaptation of bacterial strains tolerant to **toxic** organic solvents ...
Cited by 1 Related articles All 10 versions Cite Save

Metabolic construction strategies for direct methanol utilization in Saccharomyces cerevisiae

Z Dai, H Gu, S Zhang, F Xin, W Zhang, W Dong... - Bioresource ..., 2017 - Elsevier
... Due to its high **toxicity**, formaldehyde has to be simultaneously converted to CO 2 or some central metabolites catalyzed by hexulose 6-phosphate synthase (HPS) and 6-phospho-3 ... Then the **toxic** H 2 O 2 are converted to oxygen and water by catalase (CAT) (Saha et al., 2010). ...
Related articles All 2 versions Cite Save

Влияние нормального компонентного состава рубцовой жидкости на уровень свечения биосенсора

ЕА Дроздова, ИФ Каримов - Вестник Оренбургского ..., 2014 - cyberleninka.ru
... considered. Revealed similar **toxic** effects studied biological fluids, developing in the first minutes of contact. ... Александровна. Читайте также. Генетическая модификация синтеза полигидроксибутирата у **Methylobacterium extorquens** ...
Related articles All 3 versions Cite Save More

Session II. Regulation of gene expression in Prokaryotes

H Bogusz, R Płocińska, J Dziadek - actabp.pl
... Several bacterial species, for instance **Methylobacterium** ex- torquens AM1 and **Methylobacterium extorquens** DM4, also con- tain Mesh-1 homologs. ... Typically, C protein-mediated timing delays expression of the **toxic** REase activity while DNA modification occurs in a new host ...
Related articles Cite Save More

Establishment and validation of new complementing cells for production of E1-deleted adenovirus vectors in serum-free suspension culture

R Gilbert, C Guilbault, D Gagnon, A Bernier... - Journal of virological ..., 2014 - Elsevier
... E1-deleted AdV, also known as first generation AdV, carry viral genes that are expressed at low level after transduction. Leaky viral gene expression induces an immune response that can be **toxic** and that prevents stable long-term transgene expression. ...
Cited by 8 Related articles All 6 versions Cite Save

Building consensus in science: Resources for intertextual dialog in biology research articles

IA Martinez - Journal of English for Academic Purposes, 2008 - Elsevier

Methanol-induced chain termination in poly (3-hydroxybutyrate) biopolymers: molecular weight control

RD Ashby, DKY Solaiman, GD Strahan... - International journal of ..., 2015 - Elsevier
... as a primary feedstock in the synthesis of the co-polymeric poly(3-hydroxybutyrate)-co-(3-hydroxyvalerate) (PHB/V) when **Methylobacterium extorquens** AM1 was ... Although MeOH can be **toxic** to certain bacterial cells, some strains have the capability to survive in the presence of ...
Cited by 7 Related articles All 11 versions Cite Save

Replacement of enzyme-bound calcium with strontium alters the kinetic properties of methanol dehydrogenase

TK Harris, VL Davidson - Biochemical Journal, 1994 - biochemj.org
... **extorquens**, Methylophilus methylotrophus, Hyphomicrobium X (Richardson and Anthony, 1992), **Methylobacterium** glycogenes (Adachi ... it has been shown that mutant strains of M. **extorquens** synthesized an ... of cells occurred during growth, presumably due to the **toxic** effect of ...
Cited by 22 Related articles All 8 versions Cite Save

A real-time control system of gene expression using ligand-bound nucleic acid aptamer for metabolic engineering

J Wang, X Cui, L Yang, Z Zhang, L Lv, H Wang... - Metabolic ..., 2017 - Elsevier
... eg fatty acid-based products in Escherichia coli via a dynamic protein sensor-regulator system (Zhang et al., 2012); unsaturated fatty acids and triglycerides by utilizing Ubxd8 as a sensor (Lee et al., 2010); methanol for mevalonate production in M. **extorquens** AM1 through a ...
Related articles All 2 versions Cite Save

Aging and immortality in unicellular species

M Florea - Mechanisms of Ageing and Development, 2017 - Elsevier
... of aging is not universally agreed upon (see Do symmetrically dividing species age?), this process is more similar to a stress response than to the process of mandatory aging seen in animals, as the growth arrest is caused by high cell density, starvation or **toxic** metabolites and ...
All 2 versions Cite Save

Biodegradation of formaldehyde under saline conditions by a moderately halophilic bacterial consortium

K VEENAGAYATHRI, N VASUDEVAN - Current World Environment, 2010 - cwejournal.org
... It is a highly reactive **toxic** compound which can cause severe action on ... Aerobic biodegradation of Formaldehyde, methanol and methylamine by immobilized **Methylobacterium extorquens** cells ... Lu, Z. and Hegemann, W., Anaerobic **toxicity** and biodegradation of formaldehyde in ...
Cited by 2 Related articles All 2 versions Cite Save

Metabolism and biology of tryptophan

RR Brown - Recent Advances in Tryptophan Research, 1996 - Springer
... Tryptophan auxotypy associated with Staphylococcus aureus that produce **toxic**-shock-syndrome toxin. ... Mutants of **Methylobacterium extorquens** and Paracoccus denitrificans deficient in c -type cytochrome biogenesis synthesize the methylamine-dehydrogenase polypeptides ...
Cited by 32 Related articles All 3 versions Cite Save More

Polyhydroxyalkanoates (PHAs), their Blends, Composites and Nanocomposites: State of the Art, New Challenges and Opportunities

PM Visakh - 2014 - pubs.rsc.org
... 1–3 PHAs containing double bonds can also be produced by recombinant **Methylobacterium extorquens** strains when ... containing double bonds are cheaper and generally exhibit less **toxicity** compared to ... most often they have to contend with the drawback of **toxic** impurities that ...
Cited by 6 Related articles All 4 versions Cite Save More

Chloride-associated adaptive response in aerobic methylotrophic dichloromethane-utilising bacteria

ML Torgonskaya, NV Doronina... - Journal of basic ..., 2011 - Wiley Online Library
... **extorquens** DM4 (a–c), Mp. ... Effects of DNA-damaging agents on aerobic **methylobacteria** capable and incapable of utiliz- ing dichloromethane. Appl. Biochem. ... DNA polymerase I is essential for growth of **Methylobacterium** dichloromethanicum DM4 with dichloromethane. ...
Cited by 14 Related articles All 5 versions Cite Save More

Evidence of a microbial community associated with rock varnish at Yungay, Atacama Desert, Chile

KR Kuhlman, P Venkat, MT La Duc... - Journal of ..., 2008 - Wiley Online Library
By continuing to browse this site you agree to us using cookies as described in About Cookies. Remove maintenance message. ...
Cited by 36 Related articles All 2 versions Cite Save More

L-SerineandGlycine Lothar Eggeling

VF Wendisch - Amino Acid Biosynthesis–Pathways, Regulation ..., 2007 - books.google.com
... Due to limiting precursor conversion and **toxicity** of C-1 substrates in fermentative l-serine production, another development assayed enzymatic ... M, Rossignol M, Borderies G, Volker U, Vorholt JA (2004) Comparison of the pro- teome of **Methylobacterium extorquens** AM1 grown ...
Related articles Cite Save More

Biosynthesis of poly-3-hydroxybutyrate with a high molecular weight by methanotroph from methane and methanol

Y Zhang, J Xin, L Chen, H Song, C Xia - Journal of Natural Gas Chemistry, 2008 - Elsevier
... The cultivation of cells was carried out at 30 C for about 726 h [6]. Culture with methanol: direct addition of methanol at a concentration of 0.1% (v/v) was found to be **toxic** for the growth ... 14] reported that the molecular weight, when using **Methylobacterium extorquens** depends on ...
Cited by 36 Related articles All 10 versions Cite Save

Proteogenomic tools and approaches to explore protein coding landscapes of eukaryotic genomes

D Kumar, D Dash - Proteogenomics, 2016 - Springer
... Discovery of rare protein-coding genes in model methylotroph **Methylobacterium extorquens** AM1. Proteomics, 14(23–24), 2790–2794. ... Editors: Ákos Végvári (1). Editor Affiliations: 1. Department of Pharmacology & **Toxicology**, University of Texas Medical Branch. Authors: ...
Cited by 3 Related articles All 5 versions Cite Save More

Profiling of Intestinal Microbial Diversity by PCR-DGGE Genes Coding for 16S rDNA and Immunity Status of the Orange Spotted Grouper (Epinephelus coioides) ...

AR Purwandari - 2012 - etd.lib.nsysu.edu.tw

Page 1. i 國立中山大學海洋生物研究所 碩士論文 Institute of Marine Biology National Sun Yat-sen University Master Thesis 飼料添加益生菌 Bacillus subtilis 孢子對點帶石斑魚腸道菌相及免疫反應的影響 Profiling of Intestinal Microbial Diversity by PCR-DGGE ...

Related articles All 2 versions Cite Save

Screening and isolation of PHB-producing bacteria in a polluted marine microbial mat

A López-Cortés, A Lanz-Landázuri... - Microbial ecology, 2008 - Springer

... High concentrations of ammonia and organic matter, including lipids, produce **toxic** effects on bacteria communities. ... N, Chistoserdova, L, Lidstrom, ME (2002) Poly-β-hydroxybutyrate biosynthesis in the facultative methylotroph **Methylobacterium extorquens** AM1: identification ...

Cited by 65 Related articles All 14 versions Cite Save

Metabolism of Organosulfur Compounds in Rugeria Pomeroyi DSS-3

W Crabb - 2013 - getd.libs.uga.edu

Page 1. METABOLISM OF ORGANOSULFUR COMPOUNDS IN RUEGERIA POMEROYI DSS-3 by WARREN CRABB (Under the Direction of William B. Whitman) ABSTRACT Dimethylsulfoniopropionate (DMSP) accounts for up to 10% of the carbon fixed by ...

Related articles All 2 versions Cite Save More

Physiological characterization of carbazole degrading bacteria isolated from a former gasworks site

G Pasternak, B Kolwzan... - Environment ..., 2012 - researchgate.net

... Indole is another chemical compound highly **toxic** for aquatic organisms, a source of irritation and damages ... The metabolic pro- file of GPE1 strain was compared with other **Methylobacterium** species presented in ... M. **extorquens** + [7] – [7, 8] – [7, 10] – [7, 10] – [8] NA – [7, 8] V [10 ...

Cited by 1 Related articles All 6 versions Cite Save More

Comparison of expression and regulation of the high-density lipoprotein receptor SR-BI and the low-density lipoprotein receptor in human adrenocortical ...

G Martin, A Pilon, C Albert, M Vallé, DW Hum... - The FEBS ..., 1999 - Wiley Online Library

... The FEBS Journal: Previous article in issue: A methenyl tetrahydromethanopterin cyclohydrolase and a methenyl tetrahydrofolate cyclohydrolase in **Methylobacterium extorquens** AM1 Previous article in issue: A methenyl tetrahydromethanopterin ...

Cited by 62 Related articles All 5 versions Cite Save

Rapid identification of Bacillus cereus based on the detection of a 28.5-kilodalton cell surface antigen

CH Chen, HC Ding, TC Chang - Journal of food protection, 2001 - jfoodprotection.org

... For both types of food **poisoning**, the food involved has usually been heat treated, and surviving spores germinate to produce ... Enterobacter cloacae **Methylobacterium extorquens** Microbacterium ammoniaphilum Micrococcus luteus M. pyogenes M. varians Proteus mirabilis ...

Cited by 18 Related articles All 7 versions Cite Save More

Labrys methylaminiphilus sp. nov., a novel facultatively methylotrophic bacterium from a freshwater lake sediment

JA Miller, MG Kalyuzhnaya... - ... of systematic and ..., 2005 - ijs.microbiologyresearch.org

... concentration of methylamine for growth of JLW10T was 0?05 % and concentrations above 0?5 % were **toxic**. ... a-subclass, at least 12 genera are classified that include well-characterized methylotrophic species: Hyphomicrobium, **Methylobacterium**, Aminobacter, Methylorhabdus ...

Cited by 26 Related articles All 12 versions Cite Save

Biosynthesis of PQQ.

CJ Unkefer - Principles and Applications of Quinoproteins, 1993 - books.google.com

... In addition, these results seem to be in partial conflict with mutant studies carried out in M. **extorquens** AM1 by Lidstrom and coworkers [8] and in **Methylobacterium** organophilum DSM ... Allyl alcohol is oxidized by methanol dehydrogenase to yield acrolein, which is very **toxic**. ...

Cited by 1 Related articles Cite Save

Preliminary characterization of the normal microbiota of the human vulva using cultivation-independent methods

CJ Brown, M Wong, CC Davis... - Journal of ..., 2007 - jmm.microbiologyresearch.org
... 0.9, 0.0 %), Eubacterium desmolans (0.9, 10.6 %), Lactococcus lactis (0.9, 0.0 %), Legionella pneumophila (0.9, 6.6 %), **Methylobacterium extorquens** (0.9, 1.5 ... Prevalence of **toxic** shock syndrome toxin 1- producing Staphylococcus aureus and the presence of antibodies ...
Cited by 55 Related articles All 8 versions Cite Save

Tungsten, the surprisingly positively acting heavy metal element for prokaryotes

JR Andreesen, K Makdessi - Annals of the New York Academy ..., 2008 - Wiley Online Library
... a lack of discrimination by biological systems and, thus, to the **toxicity** of tungstate ... chemical elements, being close to the ions of the heaviest **toxic** heavy metals ... 96 The alphaproteobacterium **Methylobacterium extorquens** AM1 has a tungsten-containing NAD-dependent FDH that ...
Cited by 62 Related articles All 8 versions Cite Save More

Surface layers of methanotrophic bacteria

VN Khmelenina, NE Suzina, YA Trotsenko - Microbiology, 2013 - Springer
Cited by 6 Related articles All 7 versions Cite Save

The pyrroloquinoline quinone biosynthesis pathway revisited: a structural approach

S Puehringer, M Metlitzky... - BMC ..., 2008 - bmcbiochem.biomedcentral.com
... peptide is 23 amino acids in K. pneumoniae [18], 29 amino acids in **Methylobacterium extorquens** [16], 24 ... at a reduced rate, ie, 10–20% of that for the corresponding M. **extorquens** wild type ... that PQQ readily reacts with oxygen to generate free radicals [25], which are **toxic** to the ...
Cited by 57 Related articles All 19 versions Cite Save More

Identification of selected microorganisms from activated sludge capable of benzothiazole and benzotriazole transformation

K Kowalska, E Felis - Acta Biochimica Polonica, 2015 - actabp.pl
... bacterial strains Strain Identification Similarity, % NCBI accestion number 1_O1 **Methylobacterium extorquens** 99 NC_012988 ... Pillard DA, Cornell JS, Dufresne DL, Hernandez MT (2001) **Toxic**-ity of ... X, Chou N, Lupher D, Davis LC (1998) Benzotriazoles: **toxicity** and degradation. ...
Related articles All 8 versions Cite Save More

Distribution of a Nocardia brasiliensisCatalase Gene Fragment in Members of the GeneraNocardia, Gordona, andRhodococcus

L Vera-Cabrera, WM Johnson, O Welsh... - Journal of clinical ..., 1999 - Am Soc Microbiol
... also showed similarity, although to a lesser extent, to catalases fromDrosophila melanogaster, Streptomyces coelicolor,P. aeruginosa, and **Methylobacterium extorquens**. ... This protective effect is carried out by nullifying **toxic** derivatives of oxygen produced by the respiratory burst ...
Cited by 24 Related articles All 10 versions Cite Save

uTS butyrate) impact occurred at an initial MeOH concentration of 0.10%(w/v) where the number average molecular

RD Ashby, DKY Solaiman°, GD Strahan°... - ... Journal of Biological ..., 2015 - naldc.nal.usda.gov
... as a primary feedstock in the synthesis of the co-polymeric poly(3-hydroxybutyrate)-co-(3-hydroxyvalerate)(PHBV) when **Methylobacterium extorquens** AM1 was ... Although MeOH can be **toxic** to certain bacterial cells, some strains have the capability to survive in the presence of ...
Related articles Cite Save

Expression of Pseudomonas stutzeri Zobell cytochrome c-551 and its H47A variant in Escherichia coli

GT Miller, DQ Mackay, MS Standley, SL Fields... - Protein expression and ..., 2003 - Elsevier
... Studies indicating these proteins are not expressed in E. coli due to host-**toxicity** [3] oppose reports where the cytochromes have been expressed as mature ... to believe that we had reached a point where c-551 levels had increased to a point where they had become **toxic** to the ...
Cited by 5 Related articles All 8 versions Cite Save

Plasmid analysis and cloning of the dichloromethane-utilization genes of **Methylobacterium** sp. DM4

R Gäll, T Leisinger - Microbiology, 1988 - mic.microbiologyresearch.org
... The minimal medium used and the cultivation on the **toxic** and volatile substrate DCM have been described elsewhere (Kohler-Staub et al., 1986). Methylamine agar contained (1-l) 0.68 g Page 3. ... M27, **Methylobacterium** sp. AM 1 and Pseudomonas **extorquens**. ...
Cited by 42 Related articles All 6 versions Cite Save More

Biochemistry and applications of alcohol oxidase from methylotrophic yeasts

JR Woodward - Autotrophic microbiology and one-carbon metabolism, 1990 - Springer

... Thus the yeasts contain a vast excess of catalase activity, usually 1000 units per unit of alcohol oxidase activity, and a very effective formaldehyde assimilation pathway (Veenhuis et al. 1983; Large & Bamforth 1988) to avoid the **toxic** effects of the activity of alcohol oxidase. ...

Cited by 16 Related articles All 4 versions Cite Save

Regulation of methanol oxidation genes in **Methylobacterium extorquens** AM1

M Zhang - 2004 - 202.28.199.34

... The model methylotroph: Methylobacteium **extorquens** AMI The work described in this thesis was performed with **Methylobacterium extorquens** AMI. ... It is known that the metabolism in this organism is through formaldehyde, a **toxic** intermediate, so it is of interest to study how ...

Cited by 1 Related articles All 2 versions Cite Save More

Stabilisation of aqueous mineral preparations by reuterin

P Schwarzentruber, N Di Maiuta - US Patent 8,187,589, 2012 - Google Patents

... as Citrobacter freundii , Bacilli, such as Bacillus firmus and Bacillus subtilis, Desulfovibrio desulfuricans, **Methylobacteria**, such as **Methylobacterium extorquens**. ... making, paints, detergents and cosmetics, and especially in the fields requiring non-**toxic** microbicides, such as ...

Related articles All 5 versions Cite Save

Development and validation of promoter-probe vectors for the study of methane monooxygenase gene expression in Methylococcus capsulatus Bath

H Ali, JC Murrell - Microbiology, 2009 - mic.microbiologyresearch.org

... since the MUG assay is performed on fully grown cells in the absence of DMSO, any such **toxicity** is avoided. ... terminator (trrnB) located upstream of the promoter region and the effectiveness of this terminator was demonstrated in **Methylobacterium extorquens** AM1 (Marx & ...

Cited by 23 Related articles All 9 versions Cite Save

Insights into the physiology of Methylotenera mobilis as revealed by metagenome-based shotgun proteomic analysis

G Bosch, T Wang, E Latypova... - ..., 2009 - mic.microbiologyresearch.org

... likely to play a role in the removal of ammonia produced by the methylamine dehydrogenase reaction to prevent its accumulation to **toxic** levels ... Comprehensive proteomics of **Methylobacterium extorquens** AM1 metabolism under single carbon and non-methylotrophic conditions ...

Cited by 18 Related articles All 11 versions Cite Save

Sample preparation procedures utilized in microbial metabolomics: An overview

M Patejko, J Jacyna, MJ Markuszewski - Journal of Chromatography B, 2017 - Elsevier

... Next discipline involving the analysis of **toxic** compounds produced by bacteria and excreted by them to the environment is foodomics. ... Foodomics studies allow also to get insight into the mechanism of **toxicity**, as well as to answer the question ... Methylbacterium **extorquens**, [9]. ...

Related articles All 4 versions Cite Save

Biorenewables at Mango Materials

A Pieja, A Schauer-Gimenez... - ... A Practical Viewpoint, 2016 - books.google.com

... In addition to legislation restricting the use of nonbiodegradable or **toxic** plastics, some regulations now promote the use of ... have been identified.[31] There is one pathway that has been identified in many species, including the methylotroph **Methylobacterium extorquens**. ...

Related articles All 2 versions Cite Save More

Formation of poly (3-hydroxybutyrate-co-3-hydroxyhexanoate) by PHA synthase from Ralstonia eutropha

D Dennis, M McCoy, A Stangl, HE Valentin... - Journal of biotechnology, 1998 - Elsevier

... For optimization of poly(3HB-co-3HHx) accumulation in recombinant R. eutropha, the influence of fatty acid concentration and nitrogen source was investigated (Table 3). Octanoic acid concentrations higher than 0.4% were found to be **toxic** to the cells. ...

Cited by 79 Related articles All 9 versions Cite Save

Acidophilic microbial communities associated with a natural, biodegraded hydrocarbon seepage

WFM Röling, S Ortega-Lucach... - Journal of applied ..., 2006 - Wiley Online Library

... most closely related to acidophilic micro-organisms belonging to the genera Acidocella, Acidosphaera and Acidiphilium were most frequently encountered in the clone libraries along with the sequences from organisms most closely related to **Methylobacterium extorquens**. ...

Cited by 26 Related articles All 8 versions Cite Save

Methanol Electro-Oxidation by Meth anol Dehydrogenase Enzymatic Catalysts: A Computational Study

NB Idupulapati, DS Mainardi - Theory and Experiment in Electrocatalysis, 2010 - Springer

... able to improve the perfor- mance characteristics of chemical fuel cells since their use avoids the problem of **poisoning** the fuel ... Amino acids labels denote their loca- tion in the sequence obtained from the entry 1W6S (**Methylobacterium Extorquens** W3A136) of the Protein Data ...

Cited by 2 Related articles All 7 versions Cite Save More

The enigmatic planctomycetes may hold a key to the origins of methanogenesis and methylotrophy

L Chistoserdova, C Jenkins... - Molecular biology ..., 2004 - academic.oup.com

... Preliminary sequence data for Methylococcus capsulatus were assessed at http://www.tigr.org/, the draft sequence of Burkholderia fungorum was assessed at http://www.jgi.doe.gov/, and the draft sequence of **Methylobacterium extorquens** was assessed at http://www ...

Cited by 109 Related articles All 13 versions Cite Save

Structures and properties of polyhydroxyalkanoates synthesized by Methyloligella halotolerans C2 and **Methylobacterium extorquens** G10 from a methanol–pentanol ...

TV Galuzina, VA Gerasin, NV Doronina... - Polymer Science Series ..., 2015 - Springer

... tyrate and 3 hydroxyvalerate synthesized with the use of the **methylobacteria Methylobacterium extorquens** G10 and ... The most effi cient cosubstrate for **methylobacteria** is pentanol [8]. Pentanol was added to ... The cultivation time of M. **extorquens** G10 was 92 h. The amount of dry ...

Related articles All 4 versions Cite Save More

Methylotrophy in the thermophilic Bacillus methanolicus, basic insights and application for commodity production from methanol

JEN Müller, TMB Heggeset, VF Wendisch... - Applied microbiology ..., 2015 - Springer

... heat production may cause increased cooling requirements, and careful substrate feeding is needed to avoid **toxic** formaldehyde accumulation in ... While the metabolism and potential of **Methylobacterium extorquens** as another potential platform organism will be presented in a ...

Cited by 16 Related articles All 12 versions Cite Save

C1 metabolism inParacoccus denitrificans: Genetics ofParacoccus denitrificans

N Harms, RJM Van Spanning - Journal of bioenergetics and ..., 1991 - Springer

... Analysis of genes involved in methanol oxidation from **Methylobacterium extorquens** AM 1 revealed ... of the cytochrome catalyzed by MDH in Methylophilus methylotrophus, M. **extorquens** AM1, and ... expression of MDH leading to accumulation of the **toxic** compound formaldehyde ...

Cited by 50 Related articles All 5 versions Cite Save More

高效降解甲醛菌株的分离鉴定及其特性

谢文娟, 王洁, 孙珮石, 邹平 - 微生物学通报, 2011 - journals.im.ac.cn

... Aerobic biodeg- radation of formaldehyde, methanol and methylamine by immobilized **Methylobacterium extorquens** cells[J]. Applied Biochemistry and Microbiology, 1997, 33(2): 138−141. [7] Qu MB, Bhattacharya SK. **Toxicity** and biodegradation of formaldehyde in anaerobic ...

Cited by 8 Related articles All 6 versions Cite Save More

Global genome comparative analysis reveals insights of resistome and life-style adaptation of Pseudomonas putida strain T2-2 in oral cavity

XY Chan, KO Chua, KY How, WF Yin... - The Scientific World ..., 2014 - hindawi.com

... View at Scopus; T. Krell, J. Lacal, ME Guazzaroni et al., "Responses of Pseudomonas putida to **toxic** aromatic carbon ... N. Korotkova, L. Chistoserdova, V. Kuksa, and ME Lidstrom, "Glyoxylate regeneration pathway in the methylotroph **Methylobacterium extorquens** AM1," Journal ...

Cited by 1 Related articles All 11 versions Cite Save More

Aliphatic compounds

MH van Agteren, S Keuning, DB Janssen - Handbook on Biodegradation ..., 1998 - Springer

... Christoserdova, L. 1995. Metabolism of formaldehyde in **Methylobacterium extorquens** AM 1. In: Speaker abstracts of the 8t 1h International Symposium on microbial growth on C 1 compounds, San Diego, California, USA. ... Bacterial **toxicity** and metabolism of hydrazine fuels. ...

Related articles Cite Save More

The physiological role of the ribulose monophosphate pathway in bacteria and archaea

N Kato, H Yurimoto, RK Thauer - Bioscience, biotechnology, and ..., 2006 - Taylor & Francis

... C1 compounds are found at a variety of redox levels in marine hydrothermal vents (eg, methane, CO, and CO2).31–33) If the original habitat of the archaeon is rich in formaldehyde, an enzyme system capable of fixing this **toxic** compound is essential for survival of the organism. ...

Cited by 93 Related articles All 9 versions Cite Save

MxaJ structure reveals a periplasmic binding protein-like architecture with unique secondary structural elements

J Myung Choi, TP Cao, S Wouk Kim... - Proteins: Structure, ..., 2017 - Wiley Online Library

... of bacteria has drawn industrial and environmental attention for the bio-conversion of useful commercial metabolites and **toxic** chemicals ... Anthony C. The molecular structure of an unusual cytochrome c2 determined at 2.0 A; the cytochrome cH from **Methylobacterium extorquens**. ...

Related articles All 3 versions Cite Save More

HxlR, a member of the DUF24 protein family, is a DNA-binding protein that acts as a positive regulator of the formaldehyde-inducible hxlAB operon in Bacillus ...

H Yurimoto, R Hirai, N Matsuno... - Molecular ..., 2005 - Wiley Online Library

... Because formaldehyde is **toxic** to all organisms, metabolic pathways for formaldehyde detoxification are found in a wide variety of organisms. For example, many prokaryotes and eukaryotes possess glutathione-dependent formaldehyde dehydrogenase (Harms et al., 1996). ...

Cited by 38 Related articles All 6 versions Cite Save

Degradation pathway of 2-chloroethanol in Pseudomonas stutzeri strain JJ under denitrifying conditions

JA Dijk, J Gerritse, G Schraa, AJM Stams - Archives of microbiology, 2004 - Springer

... However, since halogenated aldehydes are considered to be very **toxic** (Johnson 1967; McCann et al. ... Toyama H, Chistoserdova L, Lidstrom ME (1997) Sequence analysis of pqq genes required for biosynthesis of pyrroloquinoline in **Methylobacterium extorquens** AM1 and the ...

Cited by 8 Related articles All 14 versions Cite Save

Pre-treatment step with Leuconostoc mesenteroides or L. pseudomesenteroides strains removes furfural from Zymomonas mobilis ethanolic fermentation broth

WJ Hunter, DK Manter - Bioresource technology, 2014 - Elsevier

... Organisms that have been studied include Acinetobacter sp., Arthrobacter aurescens, Flavobacterium indologenes, **Methylobacterium extorquens**, Pseudomonas sp., Ureibacillus ... This is a desirable transformation as the aldehyde group is more **toxic** than is the alcohol group. ...

Cited by 4 Related articles All 11 versions Cite Save

Fragment screening of infectious disease targets in a structural genomics environment

DW Begley, DR Davies, R Hartley... - Methods in ..., 2011 - ncbi.nlm.nih.gov

Cited by 4 Related articles All 8 versions Cite Save More

The MoxR ATPase RavA and its cofactor ViaA interact with the NADH: ubiquinone oxidoreductase I in Escherichia coli

KS Wong, JD Snider, C Graham, JF Greenblatt, A Emili... - PloS one, 2014 - journals.plos.org
... For example, MoxR of the MRP subfamily in Paracoccus denitrificans and **Methylobacterium extorquens** is important for the activation of methanol dehydrogenase (MDH) [3], [4]. NirQ/NorQ, which belong to the CGN subfamily, are necessary for the activity of nitric oxide ...
Cited by 15 Related articles All 13 versions Cite Save More

Dehalogenation of Dichloromethane by Dichloromethane Dehalogenase/GlutathioneS-Transferase Leads to Formation of DNA Adducts

MF Kayser, S Vuilleumier - Journal of bacteriology, 2001 - Am Soc Microbiol
... mediated DCM turnover in **Methylobacterium** in vivo,**Methylobacterium** dichloromethanicum DM4 ... Indeed, preliminary experiments suggest thatMethylobacterium **extorquens** AM1, the genome of ... Vuilleumier S. (1999) Enzyme-mediated dichloromethane **toxicity** and mutagenicity ...
Cited by 30 Related articles All 10 versions Cite Save

Molecular ecology of marine methanotrophs

JC Murrell, AJ Holmes - Molecular Ecology of Aquatic Microbes, 1995 - Springer
... This is based on the ability of MMO to co-oxidise DCM to carbon monoxide which becomes **toxic** to the ... The genes encoding methanol dehydrogenase from the methanol-utilisers **Methylobacterium extorquens** and Paracoccus denitrificans have been extensively studied in the ...
Cited by 10 Related articles All 4 versions Cite Save More

Investigation of plasmid-induced growth defect in Pseudomonas putida

J Mi, A Sydow, F Schempp, D Becher, H Schewe... - Journal of ..., 2016 - Elsevier
... putida, for instance, an interesting microbe for the bioconversion of otherwise **toxic** monoterpenes such ... Using metabolomics, a plasmid-induced growth defect in **Methylobacterium extorquens** could be shown to be ... As we suggested the lack of plasmid **toxicity** of pMiS4 to be the ...
Cited by 2 Related articles All 7 versions Cite Save

Heterogeneity between and within Strains of Lactobacillus brevis Exposed to Beer Compounds

Y Zhao, S Knøchel, H Siegumfeldt - Frontiers in microbiology, 2017 - ncbi.nlm.nih.gov
... membrane fluidity (Asai et al., 2000; Behr, 2008). It is conceivable that this can reduce the intrusion of hop compounds into cells, and thereby reduce the **toxicity** of hop compounds. It also has been demonstrated that hop compounds ...
Related articles All 12 versions Cite Save

Создание плазмиды pRAD для оценки алкилирующего повреждения ксенобиотиками генома клетки

ИА Лавриненко - Сибирский научный медицинский журнал, 2007 - cyberleninka.ru
... Now the problem of rocket fuel **toxic** influence on an environment is actual for USA, Russia, France, China and other countries using 1,1-dimethylhydrazine (heptyl) at start heavy ... А. Генетическая модификация синтеза полигидроксибутирата у **Methylobacterium extorquens** ...
Related articles All 2 versions Cite Save More

Compositions and methods for biological production of lactate from C1 compounds using lactate dehydrogenase transformants

RM Saville, S Lee, DD Regitsky... - US Patent App. 14/ ..., 2014 - Google Patents
... In other embodiments, the C 1 metabolizing microorganism of the present invention is a methylotroph which is a genetically modified cell from one or more of the species **Methylobacterium extorquens**, **Methylobacterium** radiotolerans, **Methylobacterium** populi, ...
Cited by 3 Related articles All 2 versions Cite Save

Real-time detection of actively metabolizing microbes by redox sensing as applied to methylotroph populations in Lake Washington

MG Kalyuzhnaya, ME Lidstrom... - The ISME ..., 2008 - search.proquest.com
... cytometric analysis of cells of Methylococcus capsulatus, Methylobacillus flagellatus and **Methylobacterium extorquens** stained with ... range of the organisms tested: M. flagellatus and M. **extorquens** can oxidize ... **Toxic** effects on bacterial metabolism of the Redox Dye 5-cyano-2,3 ...
Cited by 67 Related articles All 9 versions Cite Save

Methanol oxidation mutants in **Methylobacterium extorquens** AM1: identification of new genetic complementation groups

AL Springer, HH Chou, WH Fan, E Lee... - ..., 1995 - mic.microbiologyresearch.org

... Two-hundred-and-eight new **Methylobacterium extorquens** AM1 methanol oxidation (Mox) mutants were isolated ... methanol oxidation in the facultative methanol-utilizing bacterium Metkylobacterium **extorquens** AM1. ... oxidued by MDH but the product, allyl aldehyde, is **toxic** to the ...

Cited by 18 Related articles All 7 versions Cite Save More

Biosynthesis and characterization of poly (3-hydroxybutyrate-co-3-hydroxyvalerate) copolymer from wild-type Comamonas sp. EB172

MR Zakaria, H Ariffin, NAM Johar, S Abd-Aziz... - Polymer Degradation ..., 2010 - Elsevier

... A study using sodium valerate as precursor for P(3HB-co-3HV) copolymer production was also carried out. Sodium valerate was used in this study due to the fact that valerate in the salt form is less **toxic** in comparison to acidic form [16]. Despite the ability of Comamonas sp. ...

Cited by 42 Related articles All 6 versions Cite Save

Including metabolite concentrations into flux balance analysis: thermodynamic realizability as a constraint on flux distributions in metabolic networks

A Hoppe, S Hoffmann... - BMC systems ..., 2007 - bmcsystbiol.biomedcentral.com

Skip to main content. Advertisement. Biomed Central ...

Cited by 159 Related articles All 9 versions Cite Save More

METABOLISMAND BIOLOGY OF

RR Brown - ... Advances in Tryptophan Research: Tryptophan and ..., 2012 - books.google.com

... Tryptophan auxotypy associated with Staphylococcus aureus that produce **toxic**-shock-syndrome toxin ... Mutants of **Methylobacterium extorquens** and Paracoccus denitrificans deficient in c-type cytochrome biogenesis synthesize the methylamine-dehydrogenase polypeptides but ...

Related articles Cite Save

Synonymous mutations as a cause of human genetic disease

ZE Sauna, C Kimchi-Sarfaty - eLS, 2013 - Wiley Online Library

... role in the so-called absorption, distribution, metabolism, excretion and **toxicity** system which ... associated with the expression of misfolded proteins which can be **toxic** (Gusella and ... two extreme variants of the key enzyme-coding gene in **Methylobacterium extorquens** (Agashe et ...

Cited by 6 Related articles Cite Save More

Cytochrome c peroxidase from Methylococcus capsulatus Bath

JA Zahn, DM Arciero, AB Hooper, JR Coats... - Archives of ..., 1997 - Springer

... 294-6019 e-mail: aland@iastate.edu JA Zahn · JR Coats · AA DiSpirito Graduate Program in **Toxicology**, Iowa State ... of the mauG open reading frame from the methylamine dehydrogenase operon in the methylotrophic bacte- ria, **Methylobacterium extorquens** (Chistoserdov et al ...

Cited by 47 Related articles All 9 versions Cite Save More

代谢物生物传感器: 微生物细胞工厂构建中的合成生物学工具

周益康， 吴亦楠， 王天民， 郑翔， 邢新会， 张翀 - 生物技术通报, 2017 - html.rhhz.net

... TAL) [21, 22] 和四氢嘧啶 [23] ,为基于转录因子的代谢物生物传感器的应用提供了更多的潜力。此外, 通过对传感器元件的改造,还可实现传感器的跨种属应用。例如,来源于E.coli的甲羟戊酸传感器通过改造已经成功应用于扭脱甲基杆菌(**Methylobacterium extorquens**,M. **extorquens**) AM1 ...

Related articles All 7 versions Cite Save More

An integrated proteomics/transcriptomics approach points to oxygen as the main electron sink for methanol metabolism in Methylotenera mobilis

DAC Beck, EL Hendrickson, A Vorobev... - Journal of ..., 2011 - Am Soc Microbiol

... involved in nitrogen species interconversions was NO dioxygenase (Mmol_1063), a detoxification enzyme that converts the **toxic** NO into ... 2008. Comprehensive proteomics of **Methylobacterium extorquens** AM1 metabolism under single carbon and nonmethylotrophic conditions ...

Cited by 17 Related articles All 14 versions Cite Save

Engineering Pseudomonas putida S12 for efficient utilization of D-xylose and L-arabinose

JP Meijnen, JH de Winde... - Applied and ..., 2008 - Am Soc Microbiol

... P. putida S12 is exceptionally tolerant to organic solvents (1), which makes this strain an excellent host for the production of chemicals that are generally **toxic** to other bacterial ... A rapid method for the purification of methanol dehydrogenase from **Methylobacterium extorquens**. ...

Cited by 61 Related articles All 16 versions Cite Save More

Investigation of mutants of Methylophilus methylotrophus which are defective in methanol oxidation

A Dawson, PM Goodwin - Microbiology, 1990 - mic.microbiologyresearch.org

... been isolated using the suicide substrate allyl alcohol, which is oxidized by methanol dehydrogenase to the highly **toxic** compound acrolein ... In **Methylobacterium extorquens** AM 1 at least fourteen genes are required for the production of a functional methanol oxidation system ...

Cited by 4 Related articles All 4 versions Cite Save More

Method Validation for Progesterone Determination in Poly (methyl methacrylate) Nanoparticles Synthesized via Miniemulsion Polymerization

O Fogolari, AC Felippe, FV Leimann... - International Journal of ..., 2017 - hindawi.com

... al. [28] when evaluating in vivo **toxicity** in albino rats. Authors did ... biochemical parameters. PMMA nanoparticles have also demonstrated lower **toxicity** in vitro assays with human cell cultures (K562 [29], TPH1 e A549 [26]). Techniques ...

All 4 versions Cite Save More

The Multiple Scientific Disciplines Served by EcoCyc

PD Karp - Systems Biology and Biotechnology of Escherichia coli, 2009 - Springer

... production of bioproducts such as amino acids and vitamins, to produce pharmaceuticals, and to degrade **toxic** pollutants (Bailey ... SJ, Strovas T, Lidstrom ME (2003) Quantification of central metabolic fluxes in the facultative methylotroph **Methylobacterium extorquens** AM1 using ...

Related articles All 5 versions Cite Save More

Investigation of Methanol and Formaldehyde Metabolism in Bacillus methanolicus

A Bozdag - 2013 - search.proquest.com

... Bacillus sp. Acetobacter methanolicus MB58. Serine Pathway. Methylosinus sp. **Methylobacterium extorquens** AM1. Hyphomicrobium. 5. ... 9. Putative genes encoding for these enzymes were also identified in the M.**extorquens** AM1 genome (Vuilleumier et. ... Formaldehyde **toxicity**. ...

Cited by 1 Related articles All 3 versions Cite Save More

Metabolite profiling uncovers plasmid-induced cobalt limitation under methylotrophic growth conditions

P Kiefer, M Buchhaupt, P Christen, B Kaup... - PLoS ..., 2009 - journals.plos.org

... One example of **toxic** effects of an antibiotic resistance protein is Serratia marcescens lactamase bla SME-1 , whose signal sequence ... **Methylobacterium extorquens** AM1 is a model methylotrophic bacterium that is able to grow in the presence of methanol and methylamine. ...

Cited by 26 Related articles All 11 versions Cite Save More

The ribulose monophosphate pathway substitutes for the missing pentose phosphate pathway in the archaeon Thermococcus kodakaraensis

I Orita, T Sato, H Yurimoto, N Kato, H Atomi... - Journal of ..., 2006 - Am Soc Microbiol

... The R1P can then be converted into R5P by phosphopentomutase (13) and then flow into the general pathway for nucleotide synthesis. As HPS and PHI have been found to function in Ru5P synthesis, this also results in the generation of **toxic** formaldehyde. ...

Cited by 100 Related articles All 13 versions Cite Save

Overexpression of the methanol dehydrogenase gene mxaF in **Methylobacterium** sp. MB200 enhances L-serine production

H Chao, B Wu, P Shen - Letters in applied microbiology, 2015 - Wiley Online Library

... FJ973617), which shares 99% identity to the large alpha subunit of methanol dehydrogenase of **Methylobacterium extorquens** AM1 (Vuilleumier et al. ... step in the catabolism of a compound is often the rate-limiting step, which can avoid the accumulation of **toxic** substances (Berg ...

Related articles All 6 versions Cite Save More

Crystal structures of SULT1A2 and SULT1A1* 3: Insights into the substrate inhibition and the role of Tyr149 in SULT1A2

J Lu, H Li, J Zhang, M Li, MY Liu, X An, MC Liu... - Biochemical and ..., 2010 - Elsevier

... In some cases, however, the sulfuric esters derived from benzylic and allylic alcohols or aromatic hydroxylamines may be chemically reactive toward nucleophilic sites on DNA, RNA, and proteins, inducing **toxic** effects or mutations thereby leading to carcinogenic response [4], [5 ...

Cited by 15 Related articles All 9 versions Cite Save

Evolution of Escherichia coli to 42 C and subsequent genetic engineering reveals adaptive mechanisms and novel mutations

TE Sandberg, M Pedersen, RA LaCroix... - Molecular biology ..., 2014 - academic.oup.com

We use cookies to enhance your experience on our website. By continuing to use our website, you are agreeing to our use of cookies. You can change your cookie settings at any time. Find out more ...

Cited by 35 Related articles All 16 versions Cite Save

Metabolism of methyl bromide and dimethyl sulfide by marine bacteria isolated from coastal and open waters

SE Hoeft, DR Rogers, PT Visscher - Aquatic Microbial Ecology, 2000 - int-res.com

... In addition, trimethy- lamine (TMA) enrichments were carried out, because DMS enrichments are often unsuccessful due to **toxic**- ity of this volatile organosulfur compound ... Methylobactenum **extorquens** AM1 (kindly provided by Dr Mary Lidstrom) was used as a positive control. ...

Cited by 19 Related articles All 6 versions Cite Save

Dégradation du dichlorométhane et adaptation à la production intracellulaire d'acide chez Méthylobacterium

E Hourcade - 2007 - scd-theses.u-strasbg.fr

... 16 Figure I.3 Observation de la souche DM4 sous microscope à phase inverse et inclusions de poly-β-hydroxybutyrate chez DM4 21 Figure I.4 Métabolisme méthylotrophe chez **Methylobacterium extorquens** AM1 24 Figure I.5 Représentation schématique du mécanisme ...

Cited by 4 Related articles All 2 versions Cite Save More

Automated quantification of DNA demethylation effects in cells via 3D mapping of nuclear signatures and population homogeneity assessment

A Gertych, KA Wawrowsky, E Lindsley... - Cytometry Part ..., 2009 - Wiley Online Library
... texture. For example Strovas et al. normalized the intensity of a variant of green fluorescent protein from methylotrophy promoter (P mxaF) of single cells to their size, in **Methylobacterium extorquens** AM1 culture. This served ...
Cited by 17 Related articles All 9 versions Cite Save

Identifying conditions for inducible protein production in E. coli: combining a fed-batch and multiple induction approach

MG Aucoin... - Microbial cell ..., 2006 - microbialcellfactories.biomedcentral. ...
... the start of protein production can be distinctively separated from the growth phase [3]. This also helps if the protein is **toxic** or detrimental ... However, its use in large-scale production is scarce because of its high cost and its **toxicity** towards humans [5]. Lactose is also used as an ...
Cited by 27 Related articles All 17 versions Cite Save More

Elements of P1B-type ATPase structure and function

M Traverso - 2010 - search.proquest.com
... cells will still be unable to neither transfer copper into essential enzymes in the Golgi apparatus nor to recover from copper **toxicity**. ... When ATP7B is deactivated, copper builds to **toxic** levels in the liver while also spreading unchaperoned throughout the blood stream, in both ...
Related articles All 2 versions Cite Save More

Design and Statistical Analysis of Multidrug Combinations in Preclinical Studies and Phase I Clinical Trials

MT Tan, HB Fang, H Huang, Y Yang - ... Selected Papers from the 2015 ICSA ..., 2016 - Springer
... 2008, 2015, 2016; Calzolari et al. 2008) as well as adaptive phase I clinical trial designs that attempt to identify the best possible maximum tolerated doses through modeling of the joint dose-**toxicity** relationship (see, eg, Yuan and Yin 2008; Yin and Yuan 2009a, b; Yang et al. ...
Related articles All 3 versions Cite Save More

The ATPases CopA and CopB both contribute to copper resistance of the thermoacidophilic archaeon Sulfolobus solfataricus

C Völlmecke, SL Drees, J Reimann... - ..., 2012 - mic.microbiologyresearch.org
... organism has developed effective mechan- isms to withstand **toxic** concentrations of ... thermophilus Acidiphilum multivorum Nitrobacter hamburgensis Oligotropha carboxidovorans **Methylobacterium extorquens** Afipia sp ... The high **toxicity** of copper to the DcopA mutant is obvious ...
Cited by 17 Related articles All 7 versions Cite Save

Stealth adaptation of viruses: Review and updated molecular analysis on a stealth adapted African green monkey simian cytomegalovirus (SCMV)

W John Martin - J Hum Virol Retrovirol, 2014 - researchgate.net
... Recovery from the CPE in Cultures of Stealth Adapted Viruses Under routine virus culture conditions, the early CPE caused by cultured stealth adapted viruses can be mistaken for non-specific **toxicity**, especially since it tends not to progress and commonly disappears in ...
Cited by 15 Related articles All 2 versions Cite Save More

... OF THE TETRAHYDROMETHANOPTERIN-DEPENDENT FORMALDEHYDE-ACTIVATING ENZYME (Fae) FROM **METHYLOBACTERIUM EXTORQUENS** AM1

P Acharya, M Goenrich, CH Hagemeier... - Journal of Biological ..., 2005 - ASBMB
... we describe the structure of the formaldehyde-activating enzyme Fae from **Methylobacterium extorquens** AM1 with ... rather than with the shorter H 4 MPT from M. **extorquens** AM1 (7 ... but it also provides insights into the mechanism of how the highly **toxic** intermediate formaldehyde ...
Cited by 21 Related articles All 7 versions Cite Save

Molecular characterization of Pseudomonas sp. LDC-5 involved in accumulation of poly 3-hydroxybutyrate and medium-chain-length poly 3-hydroxyalkanoates

K Sujatha, A Mahalakshmi, R Shenbagarathai - Archives of microbiology, 2007 - Springer
... used for generating multiple sequence alignment: P50176-PHA synthase of Rhizobium meliloti; Q52728-PHA synthase of Rhizobium meliloti; O66392-PHA synthase of Azorhizobium caulinodans; P52070-PHA synthase of **Methylobacterium extorquens**; P23608-PHA synthase ...
Cited by 7 Related articles All 11 versions Cite Save

An efficient design strategy for a whole-cell biosensor based on engineered ribosome binding sequences

Q Yu, Y Li, A Ma, W Liu, H Wang, G Zhuang - Analytical and bioanalytical ..., 2011 - Springer
... widely as simple and practical approaches to the detection of a variety of agents, including heavy metals, **toxic** cellular organics ... D, Morel L, Groleau D, Miguez CB (2006) Multicopy Integration and Expression of Heterologous Genes in **Methylobacterium extorquens** ATCC 55366. ...
Cited by 6 Related articles All 13 versions Cite Save

Jonas EN Müller, Tonje MB Heggeset, Volker F. Wendisch

JA Vorholt, T Brautaset - academia.edu
... heat production may cause increased cooling requirements, and careful substrate feeding is needed to avoid **toxic** formaldehyde accumulation in ... While the metabolism and potential of **Methylobacterium extorquens** as another potential platform organism will be presented in a ...
Related articles All 2 versions Cite Save More

Respiration Rate Determined by Phosphorescence-Based Sensors

M Konopka - ... and Lipid Microbiology Protocols: Activities and ..., 2017 - Springer
... The **toxicity** of potential oxygen sensors, including any compounds they may be in solution with, is an important consideration. ... Dragavon JM, Hankins TJ, Callis JB, Burgess LW, Lidstrom ME (2006) Measurement of respiration rates of **Methylobacterium extorquens** AM1 cultures ...
Related articles All 2 versions Cite Save More

Distribution of abundant prokaryotic organisms in the water column of the central Baltic Sea with an oxic–anoxic interface

M Labrenz, G Jost, K Jürgens - Aquatic microbial ecology, 2007 - int-res.com
... **Methylobacterium extorquens** DSM13060 (AF267912) **Methylobacterium** sp. GK101 (D25305) FD 37 Uncultured marine proteobacterium BY-75 (AJ298361) FD 20 Sulfate-reducing bacterium strain mXyS1(AJ006853) Uncultured bacterium clone:12ws (AB154443) FD 33 ...
Cited by 76 Related articles All 7 versions Cite Save

Genome sequence analysis of the emerging human pathogenic acetic acid bacterium Granulibacter bethesdensis

DE Greenberg, SF Porcella, AM Zelazny... - Journal of ..., 2007 - Am Soc Microbiol

... CGD is a rare genetic disease of the phagocyte NADPH oxidase system characterized by defective production of **toxic** oxygen metabolites ... has several methanol dehydrogenase genes that appear to have been acquired recently from **Methylobacterium extorquens**, an organism ...

Cited by 48 Related articles All 12 versions Cite Save

Comparative proteomic analysis reveals insights into anoxic growth of Methyloversatilis universalis FAM5 on methanol and ethanol

H Lu, M Kalyuzhnaya... - Environmental ..., 2012 - Wiley Online Library

... et al., 2012) and are also required for the expression of the methanol dehydrogenase (mxaFI) genes in **Methylobacterium extorquens** AM1 (Skovran et al ... The product of methanol oxidation, formaldehyde, is a **toxic** intermediate The genome of M. universalis FAM5 predicts three ...

Cited by 17 Related articles All 7 versions Cite Save More

Cloning and genetic analysis of six pyrroloquinoline quinone biosynthesis genes in **Methylobacterium** organophilum DSM 760

F Biville, E Turlin, F Gasser - Microbiology, 1989 - mic.microbiologyresearch.org

... In some facultative methylotrophic bacteria such as M. **extorquens** strain AM1, the ability to ... In a previous paper, we showed that methylamine utilization in **Methylobacterium** organophilum is ... expression of active MDH (MDH oxidizes allyl alcohol to the **toxic** compound acrolein ...

Cited by 40 Related articles All 5 versions Cite Save More

Photomixotrophic growth of Rhodobacter capsulatus SB1003 on ferrous iron

SH Kopf, DK Newman - Geobiology, 2012 - Wiley Online Library

... It could reflect a requirement for ligand-bound Fe(II) to be recognized for efficient uptake into the cell, and/or result from a **toxic** effect of the free metal ion, as suggested by Poulain and Newman (2009). ... in **Methylobacterium extorquens** AM1 from a genomic point of view. ...

Cited by 10 Related articles All 11 versions Cite Save More

The microbial degradation of azimsulfuron and its effect on the soil bacterial community

A Valle, G Boschin, M Negri... - Journal of applied ..., 2006 - Wiley Online Library

... Introduction. Sulfonylureas are widely used herbicides, as they are characterized by high crop selectivity, low application rates and very low acute and chronic animal **toxicity** (Beyer et al. ... (III), Sphingomonas sp. (IV), **Methylobacterium extorquens** (V), Corynebacterium sp. ...

Cited by 38 Related articles All 11 versions Cite Save

Metabolomics in molecular microbiology

ML Reaves - 2013 - search.proquest.com

... Figure 2. Elucidation of the methanol assimilation pathway in **Methylobacterium extorquens**. ... both to optimize long-term fluxes and to avoid immediate **toxicity** due to ... lacking the ability to inactivate glutamine synthetase by covalent modification suffer **toxic** metabolic derangements ...

Related articles All 2 versions Cite Save

A new modified ortho cleavage pathway of 3-chlorocatechol degradation by Rhodococcus opacus 1CP: genetic and biochemical evidence

OV Moiseeva, IP Solyanikova... - Journal of ..., 2002 - Am Soc Microbiol

... 1). In this case, the enzymes had to evolve the ability to avoid formation of the **toxic** protoanemonin which is generated ... For panel D, ORF2 from **Methylobacterium extorquens** AM1 (U72662) and Usf from Aquifex pyrophilus Ko15a (U17575), both with unknown function, were ...

Cited by 81 Related articles All 11 versions Cite Save

Purification of the formate-tetrahydrofolate ligase from **Methylobacterium extorquens** AM1 and demonstration of its requirement for methylotrophic growth

CJ Marx, M Laukel, JA Vorholt... - Journal of ..., 2003 - Am Soc Microbiol

... In the facultative methylotroph **Methylobacterium extorquens** AM1, the formaldehyde produced from the primary ... be other aldehyde dehydrogenases that are present in M. **extorquens** AM1 (17 ... however, indicated that the intracellular concentration of this **toxic** intermediate would ...

Cited by 41 Related articles All 8 versions Cite Save

Rapid bacteria identification from environmental mining samples using MALDI-TOF MS analysis

IR Avanzi, LH Gracioso, MPG Baltazar... - ... Science and Pollution ..., 2017 - Springer
... are as follows: Burkholderia cepacia DDS7H-2, Escherichia coli ATCC8739, **Methylobacterium extorquens** ATCC23326, Pseudomonas ... Despite the **toxicity** of copper, some microbial species are known to resist and to ... Scholar. Baby J, Raj J, Biby E et al (2011) **Toxic** effect of ...
Cited by 1 Related articles All 5 versions Cite Save

An experimental study on molecular weight of poly-3-hydroxybutyrate (PHB) accumulated in Methylosinus trichosporium IMV 3011

J Xin, Y Zhang, J Dong, H Song, C Xia - African Journal of Biotechnology, 2011 - ajol.info
... Direct addition of methanol at a concentration of 0.10 % (v/v) was found to be **toxic** for the growth of strain IMV 3011 ... From the study in the Mw of PHB produced by M. **extorquens** in shake-flask culture (Taidi et al., 1994), it has been found that the Mw of PHB was dependent on the ...
Cited by 14 Related articles All 8 versions Cite Save

Characterization of the genes encoding the three-component membrane-bound alcohol dehydrogenase from Gluconobacter suboxydans and their expression in ...

K Kondo, S Horinouchi - Applied and environmental microbiology, 1997 - Am Soc Microbiol
... alcohol, showing that, due to the lack of ADH activity in the transformants, allyl alcohol was not converted to the corre- sponding aldehyde, which is **toxic** to the ... Nucleotide sequence of the **Methylobacterium extorquens** AM1 moxF and moxJ genes involved in methanol oxidation. ...
Cited by 68 Related articles All 10 versions Cite Save

Prospects of bacterial poly [(R)-3-hydroxyalkanoates]

GJM de Koning - 1993 - pure.tue.nl
... Generally, synthetic polymers are relatively inert and hardly pose any **toxic** danger to the environment. Being xenobiotic rnaterials, however, they do not degrade easily and therefore accumulate as 'visual pollution'. ... 12 , Pseudomonas **extorquens**, **Methylobacterium** sp. 17 ...
Cited by 19 Related articles All 4 versions Cite Save More

Metagenomic analyses of the autotrophic Fe (II)-oxidizing, nitrate-reducing enrichment culture KS

S He, C Tominski, A Kappler, S Behrens... - Applied and ..., 2016 - Am Soc Microbiol
... lacks nitric oxide and nitrous oxide reductase genes and may partner with flanking populations capable of complete denitrification to avoid **toxic** metabolite accumulation, which may explain its resistance to growth in pure culture. ...
Cited by 7 Related articles All 7 versions Cite Save

On the unfounded enthusiasm for soft selective sweeps

JD Jensen - Nature Communications, 2014 - search.proquest.com
... producing plants, Zhen et al.45 also noted repeated bouts of parallel evolution for dealing with this **toxicity** not only ... replicated populations of **Methylobacterium extorquens** identifying as many as 17 simultaneous benecial mutations existing in a population which may rise in ...
Cited by 41 Related articles All 13 versions Cite Save

Chloromethane-induced genes define a third C1 utilization pathway in **Methylobacterium** chloromethanicum CM4

A Studer, C McAnulla, R Büchele... - Journal of ..., 2002 - Am Soc Microbiol
... of M. dichloromethanicum (14); P mxaF (AM1) , methanol dehydrogenase promoter of M. **extorquens** AM1 (2); P mxaF (XX) , methanol dehydrogenase promoter of **Methylobacterium** organophilum XX ... This suggested a **toxic** effect of chloromethane dehalogenation in this mutant ...
Cited by 46 Related articles All 12 versions Cite Save

Characterization of the general stress response in Bartonella henselae

N Tu, A Lima, Z Bandeali, B Anderson - Microbial pathogenesis, 2016 - Elsevier
... to determine the transcription of badA and hbps when the bacteria are assaulted with a **toxic** concentration of ... Bh), Bartonella quintana (Bq), Brucella abortus (Ba), Bradyrhizobium diazoefficiens (Bd), Caulobacter crescentus (Cc), **Methylobacterium extorquens** (Me), Rhizobium ...
Cited by 6 Related articles All 6 versions Cite Save

Expression of a novel bacteriocin—the plantaricin Pln1—in Escherichia coli and its functional analysis

F Meng, H Zhao, C Zhang, F Lu, X Bie, Z Lu - Protein expression and ..., 2016 - Elsevier

... In addition, a number of other bacteriocins were expressed in lactic acid bacteria [31], [32] and [33], **Methylobacterium extorquens** [34], Saccharomyces cerevisiae [35], Leuconostoc mesenteroides [36], and Carnobacterium piscicola [15]. ...

Cited by 4 Related articles All 7 versions Cite Save

Genome-guided insight into the methylotrophy of Paracoccus aminophilus JCM 7686

L Dziewit, J Czarnecki, E Prochwicz... - Frontiers in ..., 2015 - ncbi.nlm.nih.gov

... Moreover, their ability to utilize pesticides and insecticides, including the highly **toxic** chlorpyrifos, 3,5,6-trichloro-2-pyridinol, methyl ... In many methylotrophs (eg, **Methylobacterium extorquens**) the reduction process is performed by the sequential action of two enzymes: CH 2 ...

Cited by 8 Related articles All 10 versions Cite Save

Qing Yu, Yan Li, Anzhou Ma, Weifeng

HW Liu, G Zhuang - Anal Bioanal Chem, 2011 - researchgate.net

... widely as simple and practical approaches to the detection of a variety of agents, including heavy metals, **toxic** cellular organics ... D, Morel L, Groleau D, Miguez CB (2006) Multicopy Integration and Expression of Heterologous Genes in **Methylobacterium extorquens** ATCC 55366. ...

Related articles Cite Save More

A new methanol-feeding strategy for the improved production of β-galactosidase in high cell-density fed-batch cultures of Pichia pastoris Mut+ strains

A Maghsoudi, S Hosseini, SA Shojaosadati... - Biotechnology and ..., 2012 - Springer

... The accumulation of formaldehyde, as a **toxic** metabolite, may also result in the decrease of β-gal production rate ... and A. Heidarzadeh-Vazifekhoran (2009) Effect of feed composition on PHB production from methanol by HCDC of **Methylobacterium extorquens** (DSMZ 1340). ...

Cited by 12 Related articles All 11 versions Cite Save More

Purification and properties of the formate dehydrogenase and characterization of the fdhA gene of Sulfurospirillum multivorans

RPH Schmitz, G Diekert - Archives of microbiology, 2003 - Springer
... M, Chistoserdova L, Lidstrom ME, Vorholt JA (2003) The tungsten-containing formate dehydrogenase from **Methylobacterium extorquens** AM1: Purification ... 295CrossRefGoogle Scholar. Zehnder AJB, Wuhrmann K (1976) Titanium (III) citrate as a non-**toxic**, oxidation-reduction ...
Cited by 10 Related articles All 12 versions Cite Save

РАЗНООБРАЗИЕ ГЕНОВ ПОЛИКЕТИДСИНТАЗ (PKS) В МЕТАГЕНОМНОМ СООБЩЕСТВЕ ПРЕСНОВОДНОЙ ГУБКИ Lubomirskia baicalensis

ОВ Калюжная, НВ Кулакова, ВБ Ицкович - Молекулярная биология, 2012 - elibrary.ru
... 74 1d KSLb (JQ771598) **Methylobacterium extorquens** DSM 13060 (EHP84300) 66 ... 26. Fewer DP, Österholm J., Rouhiainen L., Jokela J., Wahlsten M., Sivonen K. 2011. Nostophycin biosyn thesis is directed by a hybrid PKS NRPS in the **toxic** cyanobacterium Nostoc sp. 152. ...
Cited by 1 Related articles Cite Save

Transfer of a Catabolic Pathway for Chloromethane in **Methylobacterium** Strains Highlights Different Limitations for Growth with Chloromethane or with ...

JK Michener, S Vuilleumier, F Bringel... - Frontiers in ..., 2016 - ncbi.nlm.nih.gov
... a level that gives the appearance of essentiality or lead to increased accumulation of one or more **toxic** intermediates ... also explain our inability to productively transfer the cmu operon from its best-studied host, M. **extorquens** CM4, into closely related **Methylobacterium** strains ...
Cited by 1 Related articles All 12 versions Cite Save

Poly-3-hydroxybutyrate metabolism in the type II methanotroph Methylocystis parvus OBBP

AJ Pieja, ER Sundstrom, CS Criddle - Applied and environmental ..., 2011 - Am Soc Microbiol
Cited by 43 Related articles All 9 versions Cite Save

1. Methane-production pathways

L Nazaries, JC Murrell, P Millard, L Baggs, BK Singh - researchgate.net
... due to its Cu-chelating properties: 1) Cu shuttle; 2) regulation of MMO activity; and 3) reduction of Cu **toxicity** (Choi et al ... Korotkova, N., Chistoserdova, L., Kuksa, V., and Lidstrom, ME (2002) Glyoxylate regeneration pathway in the methylotroph **Methylobacterium extorquens** AM1. ...
Related articles All 2 versions Cite Save More

Formaldehyde as a carbon and electron shuttle between autotroph and heterotroph populations in acidic hydrothermal vents of Norris Geyser Basin, Yellowstone ...

JJ Moran, LM Whitmore, NG Isern, MF Romine... - Extremophiles, 2016 - Springer
... The reverse RuMP pathway can produce relatively high concentrations of formaldehyde which, due to its inherent **toxicity**, must be removed to ... These heterotrophs, by consuming the formaldehyde as a carbon and energy source, reduce any **toxic** effects of its production on the ...
Related articles All 10 versions Cite Save

Unfamiliar metabolic links in the central carbon metabolism

G Fuchs, IA Berg - Journal of biotechnology, 2014 - Elsevier
The central carbon metabolism of all organisms is considered to follow a well established fixed scheme. However, recent studies of autotrophic carbon fixation i.
Cited by 7 Related articles All 4 versions Cite Save

АНАЛИЗ 3-ОБЛАСТИ ГЕНА ДИХЛОРМЕТАНДЕГАЛОГЕНАЗЫ DCMA **METHYLOBACTERIUM** DICHLOROMETHANICUM ДМ4

ЮЕ Фирсова, ДН Федоров, ЮА Троценко - Микробиология, 2011 - elibrary.ru
... штамма M. dichloromethanicum ДМ4 и деструкторов ДХМ Methylorhabdus multivorans ДМ15 и **Methylobacterium extorquens** ДМ17, в ... М; ПЦР с ге номной ДНК штаммов M. dichloromethanicum ДМ4 (1), M. **extorquens** ДМ17 (2 ... 4. Dhillon S., Von Burg RJ **Toxicology** update. ...
Cited by 1 Related articles Cite Save

Immobilization of Acetobacter sp. CGMCC 8142 for efficient biocatalysis of 1, 3-propanediol to 3-hydroxypropionic acid

J Li, H Zong, B Zhuge, X Lu, H Fang, J Sun - Biotechnology and bioprocess ..., 2016 - Springer
... Beyond that range, however, substrate would bring negative factors such as osmotic pressure and **toxicity** of 3-HP so ... Structure of the quinopro- tein glucose dehydrogenase of Escherichia coli modelled on that of methanol dehydrogenase from **Methylobacterium extorquens**. ...
Related articles All 4 versions Cite Save

Carbon monoxide-dependent energy metabolism in anaerobic bacteria and archaea

E Oelgeschläger, M Rother - Archives of microbiology, 2008 - Springer
... However, the concentration of CO is held below **toxic** levels by microorganisms utilizing it ... Also, the requirement for more elaborate laboratory equipment due to the **toxicity** of CO and long adaptation periods often prevents assessment of carboxidotrophic capabilities of laboratory ...
Cited by 130 Related articles All 11 versions Cite Save

Challenges Associated to the Multi-Scale Modeling of Fuel Electro-Oxidation for Fuel Cell Applications

KK Fung, P Kharidehal, DS Mainardi - Design and Applications of ..., 2014 - Springer
... frac{1}{2}{{O}_{2}}+2{{e}^{-}2{{H}^{+}leftrightarrow {{H}_{2}}O $$. Although pure hydrogen gas is highly desired as fuel to avoid catalyst **poisoning** with carbon monoxide, it is not readily available and typically undergoes a reforming step. ...
Related articles All 4 versions Cite Save More

Profiling of cytosolic and peroxisomal acetyl-CoA metabolism in Saccharomyces cerevisiae

Y Chen, V Siewers, J Nielsen - PLoS One, 2012 - journals.plos.org
... biomass was observed. Although MLS1 was deleted, isocitrate lyase was still active in these cells producing glyoxylate, which has been reported to be a **toxic** intermediate for mammalian cells [25] and bacteria [26]. To test the ...
Cited by 52 Related articles All 13 versions Cite Save More

Cobalt: its role in health and disease

K Yamada - Interrelations between Essential Metal Ions and Human ..., 2013 - Springer
... group. Crystal structures of the MeaB protein from **Methylobacterium extorquens** AM1 [50] and the human MMAA protein [51] have been reported. The ... μM). **Toxicity** of high doses of CoCl 2 has been recently reviewed [125]. Moreover ...
Cited by 39 Related articles All 4 versions Cite Save More

Biosynthesis and lipase-catalysed hydrolysis of 4-hydroxybutyrate-containing polyhydroxyalkanoates from Delftia acidovorans

DHE Ch'ng, WH Lee, K Sudesh - Mal J Microbiol, 2012 - mjm.usm.my
... this study. It was not possible to use sodium propionate as 3HV precursors since it displayed **toxicity** to the bacterial cells and contributed to subsequent reduction of terpolymer production (results not shown). Previous reports ...
Cited by 9 Related articles All 4 versions Cite Save More

Thermoplastic Biopolymer Production (PHB, Poly 3-Hydroxybutyric acid) using Secondary Carbon Source Bioreactor Based on Nitrogen Fixation Biotechnology

M Sadeghi Pour Marvi - 2011 - bioresonline.org
... They are ubiquitously present contaminants which are **toxic**, mutagenic and carcinogenic. ... agilis, AZ. insigne, macrocytogenes, AZ. beijerinckii., Chromobacterium violaceum, **Methylobacterium** organophilum, Protomonas **extorquens**, Pseudomonas oleovorans ...
Related articles Cite Save More

A mutational hotspot and strong selection contribute to the order of mutations selected for during Escherichia coli adaptation to the gut

M Lourenço, RS Ramiro, D Güleresi... - PLoS ..., 2016 - journals.plos.org
Author Summary The relative contribution of random loss and migration versus de novo mutation to the overall diversity of the gut microbiota is far from understood. Population sizes of bacterial communities inhabiting the gut can be very large and therefore, both weak and strong ...
Cited by 5 Related articles All 11 versions Cite Save More

Recovering from a bad start: rapid adaptation and tradeoffs to growth below a threshold density

CJ Marx - BMC evolutionary biology, 2012 - bmcevolbiol.biomedcentral.com

... an unwavering exponential process fully captured by an internal capacity for expansion, such as accumulation of **toxic** products, changes ... involves the fortuitous discovery of a density threshold for growth for a metabolically engineered strain of **Methylobacterium extorquens** AM1 ...

Cited by 10 Related articles All 19 versions Cite Save More

Methods for treating bacterial infections

S Page, S Garg - US Patent 9,539,223, 2017 - Google Patents

... drugs such as colistin with narrow spectrum and considerable potential for **toxic** side-effects. ... wolffii; Leptospira yanagawae.—Leptotrichiaceae:—Leptotrichia buccalis; Streptobacillus moniliformis.—Methylobacteriaceae:—**Methylobacterium extorquens** group; **Methylobacterium** ...

Related articles All 4 versions Cite Save

Effect of agave fiber content in the thermal and mechanical properties of green composites based on polyhydroxybutyrate or poly (hydroxybutyrate-co-hydroxyvalerate ...

EV Torres-Tello, JR Robledo-Ortiz... - Industrial Crops and ..., 2017 - Elsevier

... Natural fibers like flax, hemp, jute, kenaf, abaca, sisal and agave as reinforcements offer some advantages compared to synthetic fibers such as low density, renewability, biodegradability and low cost; in addition they are non-**toxic** and have good physical and mechanical ...

Cited by 1 Related articles All 2 versions Cite Save

Experimental Study to Remediate Acid Fuchsin Dye Using Laccase-Modified Zeolite from Aqueous Solutions.

E Kalkan, H Nadaroglu, N Celebi, H Celik... - Polish Journal of ..., 2015 - pjoes.com

Page 1. Introduction The release of colored effluents to the aquatic environ- ment without adequate treatment causes public concern, legislative problems, and is a serious challenge to environ- mental scientists. Synthetic origin ...

Cited by 3 Related articles All 5 versions Cite Save More

Use of the yeast Pichia pastoris as an expression host for secretion of enterocin L50, a leaderless two-peptide (L50A and L50B) bacteriocin from Enterococcus ...

A Basanta, B Gómez-Sala, J Sánchez... - Applied and ..., 2010 - Am Soc Microbiol

... organization of at least four genes, which are closely associated in one or two operon-like structures: (i) the structural gene encoding the prebacteriocin; (ii) a gene encoding the dedicated protein, which confers producer self-protection (immunity) against the **toxicity** of the ...

Cited by 29 Related articles All 10 versions Cite Save

The genetics and molecular biology of methanol-utilizing bacteria

ME Lidstrom - Methane and methanol utilizers, 1992 - Springer

... alcohol, to the corresponding aldehyde (Anthony, 1986). The product of allyl alcohol oxidation, allyl aldehyde (acrolein), is **toxic** and kills the cells. ... Two Mox systems have been studied in detail, in M. **extorquens** AMI and **Methylobacterium** organophilum XX; in addition, the ...

Cited by 25 Related articles All 3 versions Cite Save More

Predicting Multi-Drug Inhibition Interactions based on Signaling Networks and Single Drug Dose-Response Information

HB Fang, H Huang, R Clarke, M Tan - J Comp Sys Bio, 2016 - researchgate.net

... Synergistic drug combinations, which are more effective than predicted from summing the effects of individual drugs, often achieve increased efficacy with lower doses and have reduced **toxicity** [2]. Since many molecularly-targeted agents exhibit synergy when used in ...

Cite Save More

Methanotrophs and copper

JD Semrau, AA DiSpirito, S Yoon - FEMS microbiology reviews, 2010 - academic.oup.com

Cited by 356 Related articles All 11 versions Cite Save More

Microfabricated platforms to quantitatively investigate cellular behavior under the influence of chemical gradients

M Elitas, S Sadeghi, H Karamahmutoglu, D Gozuacik... - 2017 - iopscience.iop.org

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy. ...

Related articles Cite Save

Bioreactor comprising immobilized enzyme, method for improving activity of immobilized enzyme, and biofuel cell

K Noriko, T Kusumegi, Y Onochi... - US Patent App. 14/ ..., 2013 - Google Patents

... of the imidazole compound is above such range, the imidazole compound might become **toxic** to the ... of PQQ dehydrogenases that can be used include: PQQ alcohol dehydrogenases from Acetobacter pasteurianus, **Methylobacterium extorquens**, Paracoccus denitrificans ...

Related articles All 2 versions Cite Save

Use of nuclear magnetic resonance to design ligands to target biomolecules

SW Fesik, PJ Hajduk, ET Olejniczak - US Patent 5,891,643, 1999 - Google Patents

... target. False negatives typically occur in assays that use concentrations of test compounds that are either too high (resulting in **toxicity**) or too low relative to the binding or dissociation constant of the compound to the target. Another ...

Cited by 37 Related articles All 2 versions Cite Save

Sequence and functional analysis of an Escherichia coli DNA fragment able to complement pqqE and pqqF mutants from **Methylobacterium** organophilum

E Turlin, F Gasser, F Biville - Biochimie, 1996 - Elsevier

... can be drawn with regard to PQQ biosynthesis since disruption of this ORF is apparently **toxic** for the ... Isolation, phenotypic characterization, and complementation analysis of mutants of **Methylobacterium extorquens** AM1 unable to synthesize pyrroloquinoline quinone and ...

Cited by 7 Related articles All 7 versions Cite Save

Methods for treating bacterial infections

S Page, S Garg - US Patent App. 15/363,523, 2016 - Google Patents

... for multidrug resistant (MDR) bacterial infections, forcing clinicians to consider older generation drugs such as colistin with narrow spectrum and considerable potential for **toxic** side-effects. ... Methylobacteriaceae:—**Methylobacterium extorquens** group; **Methylobacterium** ...

All 2 versions Cite Save

Pathways of carbon assimilation and ammonia oxidation suggested by environmental genomic

SJ Hallam, TJ Mincer, C Schleper, CM Preston... - 2006 - openwetware.org
... 6.4.1.3 accC þ ZP_00148271 Methanococcoides burtonii 1.00 3 10 À 128 AACY01042731 0 accB þ AAO24624 **Methylobacterium extorquens** 9.00 3 10 À 9 AACY01150397 8.00 3 10 À 40 pccB þ NP_280337 Halobacterium salinarum 1.00 3 10 À 166 AACY01042731 0 2,3 ...
Related articles All 6 versions Cite Save More

Использование отношений распространенностей изотопов ^{35}Cl и ^{37}Cl в дихлорметане для характеристики его микробного дехлорирования

МЛ Торгонская, КС Лауринавичюс... - Известия Тульского ..., 2013 - cyberleninka.ru
... vitro ассоциативными аэробными метилотрофными бактериями **Methylobacterium extorquens** D10, образующими ... during dechlorination by intact **Methylobacterium** dichloromethanicum DM4 ...
Keywords: dichloromethane biodegradarion, aerobic **methylobacteria**, 35Cl-and ...
Related articles All 3 versions Cite Save More

Interactions of TolB with the translocation domain of colicin E9 require an extended TolB box

SL Hands, LE Holland, M Vankemmelbeke... - Journal of ..., 2005 - Am Soc Microbiol
Cited by 24 Related articles All 13 versions Cite Save

Respiration in methylotrophic bacteria

IJ Higgins - Diversity of bacterial respiratory systems, 1980 - Florida, USA: CRC Press
Cited by 9 Related articles Cite Save

The histidine kinase PdhS controls cell cycle progression of the pathogenic alphaproteobacterium Brucella abortus

C Van der Henst, F Beaufay, J Mignolet... - Journal of ..., 2012 - Am Soc Microbiol
... n = 93 and a deletion probability of 7/106). The low frequency of pdhS deletion in the presence of pBBR1MCS-pdhS is probably due to the **toxicity** of pdhS overexpression. The absence of deletants for the strain harboring the ...
Cited by 17 Related articles All 15 versions Cite Save

Metabolic modelling in the development of cell factories by synthetic biology

P Jouhten - Computational and structural biotechnology journal, 2012 - Elsevier
... like high tolerance (L-valine tolerant uncommon E. coli engineered to a platform strain [29]; solvent tolerant Pseudomonas putida S12 engineered to an L-tyrosine producing platform strain [30]; Bacillus subtilis able to modify the cell wall in response to **toxicity** [31]), ability to ...
Cited by 9 Related articles All 9 versions Cite Save

Improvement of RNA-SIP by pyrosequencing to identify putative 4-n-nonylphenol degraders in activated sludge

O Zemb, M Lee, ML Gutierrez-Zamora, J Hamelin... - Water research, 2012 - Elsevier
Nonylphenols (NP) have estrogenic potential because of their phenolic ring, but the organisms involved in the degradation of this alkylated phenol remain uniden.
Cited by 16 Related articles All 14 versions Cite Save

Degradation of Acetaldehyde and Its Precursors by Pelobacter carbinolicus and P. acetylenicus

A Schmidt, M Frensch, D Schleheck, B Schink... - PloS one, 2014 - journals.plos.org
Pelobacter carbinolicus and P. acetylenicus oxidize ethanol in syntrophic cooperation with methanogens. Cocultures with Methanospirillum hungatei served as model systems for the elucidation of syntrophic ethanol oxidation previously done with the lost “Methanobacillus ...
Cited by 9 Related articles All 16 versions Cite Save More

Prokaryotic Systems Biology

A Schmid, N Baliga - Systems Biology, 2007 - Springer
... 27 Using a similar strategy, metabolic models have been constructed for several other organ- isms, including **Methylobacterium extorquens** AM1, 31 ... nearly 500 microarray experiments were conducted in response to UV and gamma irradi- ation, 56, 57 metal **toxicity**, 59 and ...
Cited by 1 Related articles All 4 versions Cite Save

Archaea-like genes for C1-transfer enzymes in Planctomycetes: phylogenetic implications of their unexpected presence in this phylum

M Bauer, T Lombardot, H Teeling, NL Ward... - Journal of molecular ..., 2004 - Springer

... In **Methylobacterium extorquens**, fae and the genes encoding the H 4 MPT-dependent enzymes have been ... the product of one of the genes present in the M. **extorquens** cluster, orf4 ... that produces energy from C 1 -substrates and/or detoxifies the **toxic** intermediate formaldehyde ...

Cited by 46 Related articles All 13 versions Cite Save

Dimethylsulfone as a growth substrate for novel methylotrophic species of Hyphomicrobium and Arthrobacter

E Borodina, DP Kelly, FA Rainey... - Archives of ..., 2000 - Springer

... Potentially **toxic** substrates (formal- dehyde, dimethylsulfoxide and dimethylsulfide) were added in se- quential 0.5, 1, or 2 mM ... DSM 11073, DSM 11104, Paracoccus versutus strain DSM 582, Xanthobacter tagetidis strain DSM 11105, or **Methylobacterium** thiocyanatum strain ...

Cited by 57 Related articles All 14 versions Cite Save

Mapping the fitness landscape of gene expression uncovers the cause of antagonism and sign epistasis between adaptive mutations

HH Chou, NF Delaney, JA Draghi, CJ Marx - PLoS genetics, 2014 - journals.plos.org
... mutations that altered enzyme levels in the central metabolism of **Methylobacterium extorquens** to uncover ... relationship between s and ε for previous datasets from M. **extorquens** and E ... of formaldehyde production, this threshold phenomenon may be explained by **toxic** effects of ...
Cited by 30 Related articles All 17 versions Cite Save More

Identification of a methanol-inducible promoter from Rhodococcus erythropolis PR4 and its use as an expression vector

Y Kagawa, Y Mitani, HY Yun, N Nakashima... - Journal of bioscience ..., 2012 - Elsevier
... 10., 11. and 14.. Although Escherichia coli is not particularly tolerant to solvents, it has been used for whole-cell bioconversion in the presence of **toxic** solvents because of its ease of handling (15). Nevertheless, rhodococci ...
Cited by 4 Related articles All 15 versions Cite Save

Genome Sequence Analysis of the

EHPA Acid - J. Bacteriol, 2007 - Citeseer
... GbCGDNIH1_0344 shows a best BLAST hit to the methanol dehydrogenase gene of another methylotrophic bacterium, **Methylobacterium extorquens** AM1, and shares a locational context identical to that of orthologous clusters in both M. **extorquens** AM1 and Paracoccus ...
Related articles Cite Save More

Engineering the biological conversion of methanol to specialty chemicals in Escherichia coli

WB Whitaker, JA Jones, RK Bennett, JE Gonzalez... - Metabolic ..., 2017 - Elsevier
... In both cases, oxidation of methanol yields the **toxic** product formaldehyde, which must then be assimilated into central ... Recently, the serine pathway methylotroph, **Methylobacterium extorquens**, has been engineered to produce butanol from ethylamine, but not from methanol ...
Cited by 8 Related articles All 6 versions Cite Save

Probing the active site tryptophan of Staphylococcus aureus thioredoxin with an analog

M Englert, A Nakamura, YS Wang, D Eiler... - Nucleic acids ..., 2015 - academic.oup.com
We use cookies to enhance your experience on our website. By continuing to use our website, you are agreeing to our use of cookies. You can change your cookie settings at any time. Find out more ...
Cited by 1 Related articles All 10 versions Cite Save

Protein Engineering of POO Glucose Dehydrogenase

S Igarashi, K Sode - Enzyme Functionality: Design: Engineering, ..., 2003 - books.google.com
... 4.2 Application of POOGDH for DNA Sensors DNA sensing has become very important since it is a powerful tool for detection of the **toxic** microorganisms in food (or the environment) and may also be used for fundamental studies in molecular biology (94). ...
Cited by 2 Related articles Cite Save

Optimization of gene expression through divergent mutational paths

HH Chou, CJ Marx - Cell Reports, 2012 - Elsevier
... enzyme production decelerates flux, which may lead to a build-up of **toxic** metabolites and ... optimization during adaptation of an engineered strain of Methylobacterium **extorquens** AM1 (EM ... In order to grow on methanol, **Methylobacterium** must oxidize formaldehyde into formate. ...
Cited by 38 Related articles All 10 versions Cite Save

Current trends in polyhydroxyalkanoates (PHAs) biosynthesis: insights from the recombinant Escherichia coli

YK Leong, PL Show, CW Ooi, TC Ling, JCW Lan - Journal of biotechnology, 2014 - Elsevier
... is biocompatible and complete biodegradable, enantiomerically pure, non-**toxic**, exhibit piezoelectricity ... scale production, which are C. necator, **Methylobacterium** organophillum, Pseudomonas olovorans, A. latus, Protomonas **extorquens**, Azotobacter vinelandii ...
Cited by 41 Related articles All 9 versions Cite Save

Comprehensive genomic analyses of the OM43 clade, including a novel species from the Red Sea, indicate ecotype differentiation among marine methylotrophs

F Jimenez-Infante, DK Ngugi, M Vinu... - Applied and ..., 2016 - Am Soc Microbiol
Cited by 6 Related articles All 8 versions Cite Save

Tokyo University of Agriculture and Technology Tokyo, Japan

S Igarashi, K Sode - Enzyme Functionality: Design: Engineering, ..., 2003 - books.google.com
... 4.2 Application of PQQGDH for DNA Sensors DNA sensing has become very important since it is a powerful tool for detection of the **toxic** microorganisms in food (or the environment) and may also be used for fundamental studies in molecular biology (94). ...
Related articles Cite Save

Characterization and population dynamics of Toluene-degrading bacteria in a contaminated freshwater stream

STL Tay - 1998 - dspace.mit.edu
... Microorganisms may perceive the introduction of organic chemicals into the environment as either new nutritional opportunities or **toxic** threats, and it is expected that microbial communities ... 3. Dean, B. J. 1978. Genetic **toxicology** of benzene, toluene, xylenes and phenols. ...
Related articles All 3 versions Cite Save More

Genetic organization of the mau gene cluster in **Methylobacterium extorquens** AM1: complete nucleotide sequence and generation and characteristics of mau mutants ...

AY Chistoserdov, LV Chistoserdova... - Journal of ..., 1994 - Am Soc Microbiol
... Several genes responsible for the synthesis ofMADH in **Methylobacterium extorquens** AM1 (the mau genes) have been cloned recently (11); in addition, the MADH large and small subunit gene and the amicyanin gene from Paracoccus denitrificans (6, 64) and from Thiobacillus ...
Cited by 127 Related articles All 17 versions Cite Save

Parallelism and Epistasis in the de novo Evolution of Cooperation between Two Species

SM Douglas - 2014 - search.proquest.com
... to support growth of their auxotrophic E. coli partner (Figure 2.1a). A classic route to generating methionine overproduction in S. enterica has been the selection of resistance to ethionine, a **toxic** methionine analog ... throughput culturing methods for **Methylobacterium extorquens**. ...
Related articles All 5 versions Cite Save More

Prevention Strategy of Urogenital Infections by Using Lactobacilli with Probiotic Properties

L Pascual, L Barberis - Urinary Tract Infections, 2011 - intechopen.com
... not voiding after sexual intercourse and use of spermicides such as nonoxynol-9, which have been shown to be **toxic** to lactobacilli. ... of Lactobacillus or Bifidobacterium are normal residents of the gastrointestinal and/or vaginal microbiota and do not display infectivity or **toxicity**. ...
Cited by 1 Related articles All 6 versions Cite Save More

Protein and nucleic acid expression systems

HHT Nguyen, SI Chan - US Patent 7,799,552, 2010 - Google Patents
... For example, many proteins are **toxic** in cells that are commonly used for protein production, such as Escherichia coli and Bacillus subtilis, making cloning and expression difficult or impossible. ... 14821, **Methylobacterium** rhodinum (Heumann) Green and Bousfield. ...
Cited by 1 Related articles All 4 versions Cite Save

Nucleic acids and vectors for use with methanotrophic bacteria

RM Saville, J Silverman, J Minshull... - US Patent App. 15/ ..., 2015 - Google Patents
... Metabolic enzyme catalyzed the formation of a metabolite that is **toxic** to the cells. ... The pCAL-I2 expression system enables higher production of a **toxic** metabolite in the "induced" condition, likely due to reduced expression of metabolic enzyme prior to IPTG induction. ...
All 2 versions Cite Save

Paracoccus denitrificans CcmG is a periplasmic protein–disulphide oxidoreductase required for c-and aa3-type cytochrome biogenesis; evidence for a reductase role ...

MD Page, SJ Ferguson - Molecular microbiology, 1997 - Wiley Online Library
... DTT at these concentrations had no effect on the growth of PD1222 but 10mM DTT was **toxic** for both DP307 and PD1222 (Table 2). To show that the effect was not due to rever- sion, DP307 growing on nutrient agar containing DTT was picked and restreaked to nutrient agar ...
Cited by 62 Related articles All 6 versions Cite Save

Identification of Staphylococcus aureus proteins recognized by the antibody-mediated immune response to a biofilm infection

RA Brady, JG Leid, AK Camper... - Infection and ..., 2006 - Am Soc Microbiol
... S. aureus infection can lead to several diseases, ranging from minor skin infections (eg, furuncles and boils) and eye infections (eg, keratitis) to serious illnesses including bacteremia, endocarditis, septic arthritis, wound infections, pneumonia, **toxic** shock syndrome, and ...
Cited by 188 Related articles All 14 versions Cite Save

The Ribulose Monophosphate Pathway

H Atomi, T Imanaka, Y Sakai, I Orita, T Sato, H Yurimoto... - J. Bacteriol, 2006 - Citeseer

... The R1P can then be converted into R5P by phosphopento- mutase (13) and then ffow into the general pathway for nucle- otide synthesis. As HPS and PHI have been found to function in Ru5P syn- thesis, this also results in the generation of **toxic** formaldehyde. ...

Related articles Cite Save More

Biodegradation of low-molecular-weight halogenated hydrocarbons by methanotrophic bacteria

RS Hanson, HC Tsien, K Tsuji, GA Brusseau... - FEMS Microbiology ..., 1990 - Elsevier

... eubacteria [19], while the pink-pig- mented facultative methylotrophs "Methylo- bacterium **extorquens** strain AM1', "Methylo- bacterium strain DM4' and **Methylobacterium** organophilum strain ... Furthermore, they are non-**toxic**, unlike toluene that induces toluene oxygenases. ...

Cited by 26 Related articles All 7 versions Cite Save More

Microorganism modified for the production of 1, 3-propanediol

T Walther, JM Francois - US Patent 9,605,283, 2017 - Google Patents

... However, comparatively low product yields, harsh reaction conditions, and the production of **toxic** waste streams ... most preferentially Escherichia coli, Bacillus subtilis, Corynebacterium glutamicum, Clostridium acetobutylicum, **Methylobacterium extorquens**, or Lactococcus lactis ...

Cited by 1 Related articles All 4 versions Cite Save

Structure-function studies of the methanopterin biosynthesis enzymes MJ1099, DmrB, and DmrX

EJ Morales - 2015 - search.proquest.com

... that when M. **extorquens** lacks the means to synthesize H4MPT, the metabolicintermediate formaldehyde accumulates and is **toxic** to the cell ... In **Methylobacterium extorquens**, insertion or deletion mutagenesis studies ofgenes in an archaeal-like gene cluster found six genes (orfi ...

Related articles All 2 versions Cite Save More

Metabolic and stress responses of Acinetobacter oleivorans DR1 during long-chain alkane degradation

C Park, B Shin, J Jung, Y Lee... - Microbial ..., 2017 - Wiley Online Library

... Staphylococcus aureus (Toga- shi et al., 2007) and Mycobacteria (Mukherjee et al., 2013), although the **toxicity** mechanism remains ... pathways to the glyoxylate shunt during alkane metabolism as seen in Rhodobacter spaeroedes and **Methylobacterium extorquens** AM1 (Ensign ...

Cite Save

Production of carbon-13-labeled cadaverine by engineered Corynebacterium glutamicum using carbon-13-labeled methanol as co-substrate

L Leßmeier, J Pfeifenschneider, M Carnicer... - Applied microbiology ..., 2015 - Springer

... 2006) as in the Gram-negative methylotrophs like **Methylobacterium extorquens**. ... Formaldehyde produced in the oxidation of methanol may be dissimilated by oxidation to CO 2 , in order to regenerate reducing equivalents and to regulate **toxic** formaldehyde levels (Gutheil et al. ...

Cited by 17 Related articles All 12 versions Cite Save

Genetics in methylotrophic bacteria: Appendix. Final report

ME Lidstrom - 1998 - osti.gov

... We have concentrated our effort on studying promoters in M. **extorquens** AM1. ... Isolation of a RecA strain of **Methylobacterium** AM1 will be extremely useful for future genetic ... and industrial sectors, as TCE contamination of groundwater, terrestrial sites and **toxic** waste dumps is ...

Cite Save More

Processes and Rates of Bacterial Evolution

N Delaney - 2013 - search.proquest.com

... The MP medium, similar to other media used for **Methylobacterium** species [36,40,41], is unusually metal rich. ... The higher metal concentrations in MP medium are not **toxic** to M. **extorquens** however, as we found no advantage on either succinate or methylamine to increasing ...

Related articles All 4 versions Cite Save More

Cultivation optimization of Methylosinus trichosporium OB3b for methanobactin recovery: Structural effects of dissolved oxygen and cell density on the ...

I Chavarri - 2015 - search.proquest.com

... methanol oxidation to formaldehyde reactions, which may cause formaldehyde to accumulate **poisoning** the cells. ... or consumed by these organisms by binding to them and reducing their **toxicity**. ... Methylotrophy in **Methylobacterium extorquens** AM1 from a genomic point of view. ...

Related articles All 2 versions Cite Save More

Methods for rapid identification of bacillus cereus

CH Chen, TC Chang, HC Ding - US Patent 6,699,679, 2004 - Google Patents

... BACKGROUND OF THE INVENTION Bacillis cereus is gram-positive, spore-forming, motile, aerobic rod which inhibits in soil and has been recognized as an opportunistic food **poisoning** pathogen. ... cloacae. **Methylobacterium**, 11048, 12234, 2, 0, 2. **extorquens**. ...

Cited by 1 Related articles All 4 versions Cite Save

Structure, mechanism and physiological roles of bacterial cytochrome c peroxidases

JM Atack, DJ Kelly - Advances in microbial physiology, 2006 - Elsevier

... Oxidative stress results from the formation of **toxic** oxygen intermediates formed by incomplete reduction of oxygen. Reduction of oxygen ... Imlay, 1999). Superoxide and H 2 O 2 interact to form the highly **toxic** hydroxyl radical. Build ...

Cited by 52 Related articles All 11 versions Cite Save More

Experimental horizontal gene transfer of methylamine dehydrogenase mimics prevalent exchange in nature and overcomes the methylamine growth ...

DD Nayak, CJ Marx - Microorganisms, 2015 - mdpi.com

... In contrast, when three replicate populations of wild type M. **extorquens** PA1 were ... Keywords: Methylotrophy; Methylamine; Experimental Evolution; **Methylobacterium**; Horizontal Gene Transfer (HGT). ... amine, mono-methylamine (CH 3 NH 2 ; MA) is a **toxic**, inflammable organic ...

Cited by 2 Related articles All 10 versions Cite Save More

Assembly and catalysis of molybdenum or tungsten-containing formate dehydrogenases from bacteria

T Hartmann, N Schwanhold, S Leimkühler - Biochimica et Biophysica Acta (..., 2015 - Elsevier

... has the advantage of safe portability as compared to liquid fuels such as methanol, which is **toxic** and highly ... Table 1, Mo/W-containing FDHs were isolated and characterized from several prokaryotes, including methylotrophs (**Methylobacterium extorquens**, **Methylobacterium** sp ...

Cited by 17 Related articles All 7 versions Cite Save

Molecular Biology of Methanol-Utilizing Bacteria

ME LIDSTROM - Methane and Methanol Utilizers, 2013 - books.google.com

... The product of allyl alcohol oxidation, allyl aldehyde (acrolein), is **toxic** and kills the cells. ... organophilum XX: moxF Met Ser Arg Phe Val Thr Ser Val Ser Ala Leu Ala Met Leu Ala Leu Ala Pro Ala Ala Leu Ser Ser Val Ala Tyr Ala **Methylobacterium extorquens** AM1: moxF Met Ser ...

Related articles Cite Save

A New Approach to Controlling Epilepsy

VA Herrera - The McNair Scholars Journal of the University of ..., 2013 - depts.washington.edu

Page 122. 113 A New Approach to Controlling Epilepsy Vicky A. Herrera Abstract Epilepsy is a neurological disease characterized by recurring seizures, and it affects millions. We hypothesize that modulation of p38 mitogen ...

Related articles Cite Save More

Whole genome comparison of 1,803 bacteria: An analysis of genetic relatedness and species-specific antibiotic target identification.

A Bissell - 2013 - repository.library.northeastern.edu

... computational methods has been demonstrated (Kitchen, 2004; McInnes, 2007, Schneider, 2010), candidate drugs have failed to make it to market for lack of penetration and human cell **toxicity**, among other reasons. Combining the search for ...

Cite Save More

2| Optimality Review

FJ Bruggeman, B Teusink - pdfs.semanticscholar.org

... that increases CheB activity. Chemotaxis allows bacterial cells to swim in the direction of favoured chemical attractants (such as food) or away from repellents (such as **toxic** compounds) by changing the frequency of tumbling (Larsen et al, 1974; Berg and Tedesco, 1975). ...

Cite Save More

Oxidation Pathways in Methylotrophs

I Goldberg - Biology of Methylotrophs, 2013 - books.google.com

... can only autoreduce the homologous cytochrome cl, whereas the MDH of **Methylobacterium** extor- quens ... Mutants of M. **extorquens** AM1 and Hyphomicrobium X lacking MDH grow unimpaired on meth ... concentration must be kept very low since this compound is **toxic** to the cells. ...

Related articles Cite Save

Interactions of TolB with the Translocation

TB Box - Citeseer

... The vast majority of colicins exert their lethality by a C-terminal cyto- **toxic** domain that either causes membrane depolarization of the cytoplasmic membrane (the pore-forming colicins) or deg- radation of RNA or DNA (the enzymatic colicins). ...

Related articles Cite Save More

Methylotrophic producers of bioplastics

SA Zamakhaeva, DN Fedorov, YA Trotsenko - Applied Biochemistry and ..., 2017 - Springer

... The data from enzymological analysis and isotopic experiments were the foundation to propose a regula- tory model for the biosynthesis of PHB and its copo- lymer PHB/V in **Methylobacterium extorquens**, which is a typical representative of serine **methylobacteria** [17, 18]. ...

Cite Save

Chapter Eight-Non-targeted Tracer Fate Detection

D Weindl, A Wegner, K Hiller - Methods in enzymology, 2015 - Elsevier

Stable isotopes have been used to trace atoms through metabolism and quantify metabolic fluxes for several decades. Only recently non-targeted stable isotope la.

Cited by 6 Related articles All 10 versions Cite Save More

Microbially influenced corrosion communities associated with fuel-grade ethanol environments

CHD Williamson, LA Jain, B Mishra, DL Olson... - Applied microbiology ..., 2015 - Springer

... 2011; Pollock 2012). At high concentrations, ethanol is thought to be **toxic** to microbes due to negative impacts on cell membranes (Taylor et al. 2012). ... 2012). The Alphaproteobacteria in the pyrosequencing library from sample EXT.1 included **Methylobacterium** spp. ...

Cited by 2 Related articles All 15 versions Cite Save

Essential functions in bacteria

T Bergmiller - 2011 - e-collection.library.ethz.ch

... Katz C, Cohen-Or I, Gophna U, Ron EZ: The ubiquitous conserved glycopeptidase gcp prevents accumulation of **toxic** glycated proteins. ... Laukel M, Rossignol M, Borderies G, Volker U, Vorholt JA: Comparison of the proteome of **Methylobacterium extorquens** AM1 grown under ...

Related articles Cite Save More

Awakening sleeping beauty: production of propionic acid in Escherichia coli through the sbm operon requires the activity of a methylmalonyl-CoA epimerase

RA Gonzalez-Garcia... - Microbial cell ..., 2017 - microbialcellfactories.biomedcentral. ...

Skip to main content. Advertisement. Biomed Central ...

All 10 versions Cite Save More

Physiology and biochemistry of the methane-producing Archaea

R Hedderich, WB Whitman - The prokaryotes, 2006 - Springer

... Therefore, microorganisms that catalyze these reactions cannot grow, and **toxic** levels of the VFAs accumulate. However, if the methanoarchaea are present, H 2 is rapidly metabolized, and its partial pressure is maintained below 10 –3 – 10 –4 atmospheres. ...

Cited by 125 Related articles All 3 versions Cite Save More

Propionate metabolism in Mycobacterium tuberculosis: characterization of the vitamin B12-dependent methylmalonyl pathway

SA Savvi - 2009 - wiredspace.wits.ac.za

... source.....106 5.11 Propionyl-CoA incorporation into virulence lipids relieves **toxicity** on valerate .....110 5.11.1 Maintaining methylmalonyl-CoA homeostasis in MTB.....112 5.12 ...

Cited by 2 Related articles All 3 versions Cite Save

Genetically modified bacteria and methods for genetic modification of bacteria

T Hitchcock, MS Rhee - US Patent App. 14/742,492, 2015 - Google Patents

... In some embodiments a pathogenic molecule is a **toxic** molecule (eg, a toxin). In certain embodiments a gene encoding a pathogenic molecule and/or a **toxic** molecule is knocked out. In certain embodiments a bacteria is genetically ...

Cited by 1 Related articles All 2 versions Cite Save

Evolution after introduction of a novel metabolic pathway consistently leads to restoration of wild-type physiology

SM Carroll, CJ Marx - PLoS genetics, 2013 - journals.plos.org

... and evolutionary responses to a novel, sub-optimal central metabolism in **Methylobacterium extorquens** AM1 ... As a facultative methylotroph, M. **extorquens** AM1 is capable of utilizing one-carbon (C ... are oxidized first to formaldehyde, and in wild-type (WT), this **toxic** intermediate ...

Cited by 27 Related articles All 15 versions Cite Save More

Draft genomes of Nautella italica strains CECT 7645 T and CECT 7321: Two roseobacters with potential pathogenic and biotechnological traits

L Rodrigo-Torres, MJ Pujalte, DR Arahal - Marine genomics, 2016 - Elsevier

Nautella italica is a member of the family Rhodobacteraceae described in 2009. Strain LMG 24365T (= CECT 7645T, = DSM 26436T, = CCUG 55857T) was.

Cited by 1 Related articles All 6 versions Cite Save

The modifier protein of formaldehyde dehydrogenase from Methylococcus capsulatus (Bath)

SA Tate - 1996 - wrap.warwick.ac.uk

... From the data presented it is proposed that the function of mFDH may be to aid in reducing **toxic** formaldehyde concentrations in the organism and the role of the nFDH ... 1970). The MDH isolated from **Methylobacterium extorquens** AMI is composed of two ...

All 5 versions Cite Save More

Bacterial genome evolution within a clonal population: from in vitro investigations to in vivo observations

M Beaume, N Monina, J Schrenzel... - Future microbiology, 2013 - Future Medicine

... was notably highlighted in two other studies: one with long-term laboratory evolution of E. coli [10], and one with an engineered strain of **Methylobacterium extorquens** [11]. ... The species E. coli is partly defined by its inability to metabolize citrate (Cit -) under **toxic** conditions. ...

Related articles All 9 versions Cite Save

Life in extreme environments: approaches to study life-environment co-evolutionary strategies

X Xiao, Y Zhang - Science China Earth Sciences, 2014 - Springer
... oxygen species (ROS) increases significantly at low temperature, and ROS are **toxic** to the ... to this process is that O2, which may cause addi- tional **toxicity**, is not ... Towards kinetic modeling of global metabolic networks: **Methylobacterium extorquens** Am1 growth as Validation. ...
Cited by 6 Related articles All 9 versions Cite Save

Protein with recombinase activity for site-specific DNA-recombination

F Buchholz, M Karimova - US Patent 9,719,109, 2017 - Google Patents
... Another object of the invention is to provide a novel, highly specific, recombinase system for site-specific genetic recombination with preferably low **toxicity**. ... 21, SEQ ID No. 22. **Methylobacterium**. **extorquens** DM4. YP_003280920.1, SEQ ID No. 23, SEQ ID No. 24. ...
All 2 versions Cite Save

Protein with recombinase activity for site-specific DNA-recombination

F Buchholz, M Karimova - US Patent 9,428,754, 2016 - Google Patents
... Another object of the invention is to provide a novel, highly specific, recombinase system for site-specific genetic recombination with preferably low **toxicity**. ... 21, SEQ ID No. 22. **Methylobacterium**. **extorquens** DM4. YP_003280920.1, SEQ ID No. 23, SEQ ID No. 24. ...
Related articles All 4 versions Cite Save

Minimal effect of gene clustering on expression in Escherichia coli

LW Liang, R Hussein, DHS Block, HN Lim - Genetics, 2013 - Genetics Soc America
Skip to main content.
Cited by 10 Related articles All 8 versions Cite Save More

Performance, Microbial Ecology, and Life Cycle Assessment of an Activated Carbon Biofilter for Methanol Removal

CW Babbitt - 2007 - researchgate.net
... requirements of the PCO- biofilter system. However, the operating impacts to global warming and human **toxicity** for the PCO-biofilter system were higher than for the RTO, because of the replacement requirements of packing for the ...
Related articles All 5 versions Cite Save More

Quinoproteins as Biosensors

Y Kitagawa - Principles and Applications of Quinoproteins, 1992 - books.google.com
Page 445. 20 Quinoproteins as Biosensors Isao Karube and Kenji Yokoyama University of Tokyo, Tokyo, Japan Yasushi Kitagawa Asahi Breweries, Ltd., Tokyo, Japan I. INTRODUCTION Many biosensors using biocatalysts, such ...
Related articles Cite Save

Modularity of methylotrophy, revisited

L Chistoserdova - Environmental Microbiology, 2011 - Wiley Online Library
... A MDH first characterized in **Methylobacterium extorquens** (Anthony, 1982; 2004) and later detected in most of the model methylotrophs was a heterotetramer ... in terms of energy generation but also in terms of keeping the intracellular levels of formaldehyde at non-**toxic** levels. ...
Cited by 157 Related articles All 6 versions Cite Save More

Metabolic network analysis of the marine bacterium Dinoroseobacter shibae

AF Bartsch - 2016 - scidok.sulb.uni-saarland.de
... Roseobacter clade, a subgroup of the Alphaproteobacteria. The Gram-negative small oval rod bacterium has first been isolated from the **toxic** marine algae Prorocentrum lima occurring in sand and sediment (Pradella et al. 2004, Wagner-Döbler et al. 2010, Biebl et al. 2005). ...
Related articles All 2 versions Cite Save

Proteomics in India: the clinical aspect

S Mukherjee, A Bandyopadhyay - Clinical ..., 2016 - clinicalproteomicsjournal. ...
Skip to main content. Advertisement. Biomed Central ...
Cited by 1 Related articles All 11 versions Cite Save More

The effectors and sensory sites of formaldehyde-responsive regulator FrmR and metal-sensing variant

D Osman, C Piergentili, J Chen, LN Sayer... - Journal of Biological ..., 2016 - ASBMB

Advertisement. Advertisement: ASBMB Partnership with Overleaf. The Journal of Biological Chemistry Sign In » Search by Keyword Author Year Vol Page Advanced Search ». Skip to main page content. ...

Cited by 7 Related articles All 8 versions Cite Save

Promiscuous anaerobes

LL Grochowski, RH White - Annals of the New York Academy of ..., 2008 - Wiley Online Library

... Life arose and first evolved on earth under anaerobic conditions, 1 where the effect of **toxic** oxygen gas was not able to influence the nature of reactions leading to the first living system(s). It may be thus expected that the most likely place to gain insights into the earliest ...

Cited by 15 Related articles All 6 versions Cite Save More

Isotopomer analysis of cellular metabolism in tissue culture: A comparative study between the pathway and network-based methods

TD Vo, SK Lim, WNP Lee, BO Palsson - Metabolomics, 2006 - Springer

... The combination of higher lactate, proton, and urea secretions into media A creates a higher energy demand and is likely to be more **toxic** to the cells. Media B is thus more advantageous and can be further improved with an increased asparagine addition. ...

Cited by 12 Related articles All 5 versions Cite Save

Prospecção de genes codificadores de enzimas lipolíticas em biblioteca metagenômica de consórcio microbiano degradador de óleo diesel.

MR Pereira - 2011 - teses.usp.br

... Most lipolytic enzymes are derived from microbes, present low **toxicity**, are easily biodegraded and are notably selective of chemicals, a very positive trait which permits pharmaceutical products made with these enzymes to have few collateral effects. ...

Cited by 1 Related articles Cite Save More

Chapter Twenty-Four-De Novo Designed Imaging Agents Based on Lanthanide Peptides Complexes

AFA Peacock - Methods in enzymology, 2016 - Elsevier

Herein are discussed a selection of lanthanide peptide/protein complexes in view of their potential applications as imaging agents, both in terms of luminescenc.

Related articles All 3 versions Cite Save More

Parallel mutations result in a wide range of cooperation and community consequences in a two-species bacterial consortium

SM Douglas, LM Chubiz, WR Harcombe, FM Ytreberg... - PloS one, 2016 - journals.plos.org

... to support community growth failed. We thus turned to a classic route to generating methionine overproduction in S. enterica, selection of resistance to ethionine, a **toxic** methionine analog [19,20]. Methionine production in S ...

Cited by 1 Related articles All 14 versions Cite Save More

Constraint-based analysis of metabolic capacity of Salmonella typhimurium during host-pathogen interaction

A Raghunathan, J Reed, S Shin... - BMC systems ..., 2009 - bmcsystbiol.biomedcentral.com

Skip to main content. Advertisement. Biomed Central ...

Cited by 134 Related articles All 16 versions Cite Save More

Applications of cellular fatty acid analysis.

DF Welch - Clinical Microbiology Reviews, 1991 - Am Soc Microbiol

Page 1. CLINICAL MICROBIOLOGY REVIEWS, Oct. 1991, p. 422-438 Vol. 4, No. 4 0893-8512/91/040422-17$02.00/0 Copyright © 1991, American Society for Microbiology Applications of Cellular Fatty Acid Analysis DAVID ...

Cited by 250 Related articles All 15 versions Cite Save

Characterization of microbial populations in the subsurface

MP Buttner, P Cruz, KJ Stetzenbach, AJ Smiecinski - 2006 - digitalscholarship.unlv.edu

... Barton et al. (1992) compiled a list of bacteria from various sources capable of binding, precipitating, absorbing, depositing, reducing and transforming various **toxic** elements, including Aeromonas, Bacillus megaterium, Citrobacter, Desulfovibrio, Escherichia coli, Flavobacterium ...

All 2 versions Cite Save

Physiology and biochemistry of the methane-producing archaea

R Hedderich, WB Whitman - The Prokaryotes, 2013 - Springer

... Under standard conditions, when the H 2 partial pressure is 1 atm., the fermentations of VFAs and alcohols to acetate and H 2 are thermodynamically unfavorable. Therefore, microorganisms that catalyze these reactions cannot grow, and **toxic** levels of the VFAs accumulate. ...

Cited by 23 Related articles Cite Save More

Newly discovered bacterium in the family acetobacteraceae

SM Holland, DE Greenberg, A Zelazny... - US Patent ..., 2015 - Google Patents

... These costs hinder market expansion for these and other related businesses. It would be useful to manufacture and market a biomass degrading and treatment method capable of converting organic waste materials into non-**toxic** end-products. ...

Related articles All 4 versions Cite Save

A tricistronic heat shock operon is important for stress tolerance of Pseudomonas putida and conserved in many environmental bacteria

SS Krajewski, M Joswig, M Nagel... - Environmental ..., 2014 - Wiley Online Library
... procedures'. Since P. putida has the ability to inhabit environments contaminated with aromatic substances, we asked whether HspX, Y and Z are involved in tolerance against the **toxic** effects of aromatic compounds. All mutants ...
Cited by 12 Related articles All 10 versions Cite Save More

Multiple σEcfG and NepR Proteins Are Involved in the General Stress Response in **Methylobacterium extorquens**

A Francez-Charlot, J Frunzke, J Zingg, A Kaczmarczyk... - PloS one, 2016 - journals.plos.org
... However, only the deletion of rsiA1 is lethal (being **toxic** due to the overactivation of ... expansion of regulatory components of the GSR can be more pronounced: **Methylobacterium** strains genome ... since deletion of ecfG1, one of the six ecfG paralogues of M. **extorquens** AM1, does ...
Related articles All 11 versions Cite Save More

The pyrroloquinoline quinone (PQQ)-containing dehydrogenases

C Anthony - ADVANCES IN PHOTOSYNTHESIS AND ..., 2004 - books.google.com
... role in energy production and (in enteric bacteria) they may also function in the rapid removal of potentially **toxic** oxygen during ... The X-Ray Structure of Methanol Dehydrogenase The X-ray structure has been determined for the MDH from **Methylobacterium extorquens** (Blake et ...
Cited by 2 Related articles Cite Save

Interaction of the Escherichia coli transporter DctA with the sensor kinase DcuS: presence of functional DctA/DcuS sensor units

J Witan, J Bauer, I Wittig, PA Steinmetz... - Molecular ..., 2012 - Wiley Online Library
... The study was performed with DctA rather than DcuB as the co-sensor, since overexpression of dcuB and many of its variants is **toxic** to the cell (Kleefeld et al., 2009; Bauer et al., 2011). It was tested whether the DctA and DcuS proteins interact and form functional units. ...
Cited by 26 Related articles All 7 versions Cite Save

Method for measuring cells, and reagent for cell measurement

M Okanojo, H Noda, S Fukuzono - US Patent 9,290,789, 2016 - Google Patents
... 11. The method according to claim 1 , wherein at least one microbial species selected from the group consisting of Bacillus subtilis, Pseudomonas aeruginosa, Pseudomonas fluorescence, **Methylobacterium extorquens**, Escherichia coli, Staphylococcus aureus, Clostridium ...
Related articles All 4 versions Cite Save

Trace metal requirements for microbial enzymes involved in the production and consumption of methane and nitrous oxide

JB Glass, VJ Orphan - Frontiers in microbiology, 2012 - ncbi.nlm.nih.gov
Cited by 87 Related articles All 19 versions Cite Save

Pyridine nucleotide transhydrogenases enable redox balance of Pseudomonas putida during biodegradation of aromatic compounds

PI Nikel, D Pérez-Pantoja... - Environmental ..., 2016 - Wiley Online Library
... On the other hand, toluene and xylenes are quite **toxic** for bacteria above a certain threshold concentration, since they can partition into the bacterial cell membrane and disorganize its structure by removing lipids and proteins, which eventually leads to cell death, and also by ...
Cited by 4 Related articles All 5 versions Cite Save More

Development of a novel prokaryotic two-hybrid system for the detection and analysis of protein-protein interactions in vivo

PA Clarke - 2000 - doras.dcu.ie
Page 1. Development Of A Novel Prokaryotic Two-Hybrid System For The Detection And Analysis Of Protein-Protein Interactions In Vivo. Paul Clarke PhD. 2000 Page 2. Development Of A Novel Prokaryotic Two-Hybrid System For The Detection And ...
Related articles All 4 versions Cite Save More

Molecular basis for trimethoprim and sulphonamide resistance in Gram negative pathogens

M Grape - 2006 - openarchive.ki.se

... 1968 [15, 18, 19]. Since the drug has a wide antibacterial spectrum, low **toxicity** and few side effects, is easy to produce and thus relatively inexpensive, the drug has been widely used for many types of infections. It turned out ...

Cited by 4 Related articles All 2 versions Cite Save More

Proteomics of Fusobacterium nucleatum within a model developing oral microbial community

EL Hendrickson, T Wang, DAC Beck... - ..., 2014 - Wiley Online Library

By continuing to browse this site you agree to us using cookies as described in About Cookies. Remove maintenance message. ...

Cited by 15 Related articles All 11 versions Cite Save

Methylotrophs in natural habitats: current insights through metagenomics

L Chistoserdova - Applied microbiology and biotechnology, 2015 - Springer

... A major metabolic challenge for methylotrophs is dealing with formaldehyde, the extremely **toxic** intermediate of many of the C1 oxidative ... also of a variety of species without an obvious role in methane oxidation such as Methylophilaceae, **Methylobacterium**, Xanthobacter, and ...

Cited by 17 Related articles All 10 versions Cite Save

Biochemische und molekularbiologische Untersuchungen zu Lacton-Hydrolasen des bakteriellen Aromaten-und Halogenaromaten-Abbaus

IS Hinner - 1998 - books.google.com

Page 1. Biologie Isabelle-S. Hinner Biochemische und molekular- biologische Untersuchungen zu Lacton-Hydrolasen des bakteriellen Aromaten- und Halogenaromaten-Abbaus Herbert Utz Verlag Wissenschaft Page 2. Page 3. Page 4. Page 5. ...

Cited by 4 Related articles Cite Save More

18 Physiology and Biochemistry of the Methane-Producing Archaea

RHWB Whitman - 2013 - Springer

... Under standard conditions, when the H2 partial pressure is 1 atm., the fermentations of VFAs and alcohols to acetate and H2 are thermodynamically unfavorable. Therefore, microorgan- isms that catalyze these reactions cannot grow, and **toxic** levels of the VFAs accumulate. ...

Related articles Cite Save

The development of mechanistic enzymology in the 20th century

TDH Bugg - Natural product reports, 2001 - pubs.rsc.org

Cited by 35 Related articles All 7 versions Cite Save

Adaptive laboratory evolution of antibiotic resistance using different selection regimes lead to similar phenotypes and genotypes

LJ Jahn, C Munck, MMH Ellabaan... - Frontiers in ..., 2017 - ncbi.nlm.nih.gov

Related articles All 8 versions Cite Save

The biosynthesis of methanol dehydrogenase

IW Richardson - 1992 - eprints.soton.ac.uk

... This thesis reports studies on the periplasmic quinoprotein methanol dehydrogenase (MDH), principally from the facultative methylotroph **Methylobacterium extorquens**, to investigate which factors are necessary for the formation of active enzyme. ... **Methylobacterium extorquens** 9 ...

Related articles All 5 versions Cite Save More

Expression vectors based on RK2 and TOL plasmids

JM Blatny, P Karunakaran, S Valla - US Patent 6,258,565, 2001 - Google Patents

... This may be particularly useful if the gene product is **toxic** to the host cell. ... The effects of the cop254D mutation on expression was rather puzzling, but we believe that the results may at least partly be caused by a **poisoning** effect on the cells mediated by the high copy number of ...

Cited by 5 Related articles All 2 versions Cite Save

Дія протимікробних препаратів складного походження

ВС Мельник, ВВ Баті, ОБ Левчук, НВ Бойко - 2013 - dspace.uzhnu.edu.ua

Page 1. НАЦІОНАЛЬНА АКАДЕМІЯ НАУК УКРАЇНИ МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ ТОВАРИСТВО МІКРОБІОЛОГІВ УКРАЇНИ ІМ. С.М. ВИНОГРАДСЬКОГО ІНСТИТУТ МІКРОБІОЛОГІЇ І ВІРУСОЛОГІЇ ІМ. Д.К. ...

Related articles Cite Save

Global trends, seasonal cycles, and European emissions of dichloromethane, trichloroethene, and tetrachloroethene from the AGAGE observations at Mace ...

PG Simmonds, AJ Manning... - Journal of ..., 2006 - Wiley Online Library

... However, they are classed as hazardous air pollutants and **toxic** volatile organic compounds in regional air quality inventories. [3] About 70% of CH 2 Cl 2 emissions are anthropogenic in origin from foam plastic products, metal cleaning and other solvent uses [Cox et al., 2003]. ...

Cited by 48 Related articles All 5 versions Cite Save More

Bioreactor cultivation of Bacillus methanolicus expressing green fluorescent protein

B Wong - 2012 - search.proquest.com

... Previous feed strategies in B. methanolicus have been designed to minimize the **toxic** effects of formaldehyde and formate accumulation in culture [15] and also to utilize direct methods in measuring methanol concentration in bioreactors [5]. Although carbon-limited feeding ...

Related articles All 4 versions Cite Save More

Microorganism culture vessel, microorganism test kit, method for testing dialysate, method for culturing microorganism, method for testing microorganism and method ...

Y Onji, M Ushiyama, K Aoki - US Patent App. 14/433,035, 2013 - Google Patents

... enrichment culture, and then provided for testing. [0003]. For example, a sensitivity of 1 cfu/25 g is required for testing bacteria capable of causing food **poisoning**, such as Salmonella. Moreover, testing of not only a pyrogen but ...

Related articles All 2 versions Cite Save

Protein

P Lind, C Soderberg - US Patent App. 10/187,171, 2002 - Google Patents

... Furthermore, Bott (Arch Microbiol (1997) 167:78-88) discloses anaerobic citrate metabolism and its regulation in enterobacteria, and Arps et al. (J Bacteriol, June 1993; 175(2): 3776-83) discloses the genetics of malyl coenzyme A lyase in **Methylobacterium extorquens** AM1. ...

All 5 versions Cite Save

Der mikrobielle Abbau von Etherverbindungen unter besonderer Berücksichtigung von Aralkyl-und Alkylethern

YH Kim - 1999 - elib.uni-stuttgart.de

Page 1. - 1 - Der mikrobielle Abbau von Etherverbindungen unter besonderer Berücksichtigung von Aralkyl- und Alkylethern Anreicherung, Isolierung, Charakterisierung und Klassifizierung der abbauenden Bakterien und vergleichende ...

Cited by 3 Related articles All 3 versions Cite Save

Introducing a new bioengineered bug: **Methylobacterium extorquens** tuned as a microbial bioplastic factory

P Höfer, P Vermette, D Groleau - Bioengineered bugs, 2011 - Taylor & Francis

... A recent example of micro- organism and product development is the use of recombinant **Methylobacterium extorquens** ATCC 55366 strains in the production of second generation bio-polyesters. ... **Methylobacterium extorquens** tuned as a microbial bioplastic factory ...

Cited by 6 Related articles All 6 versions Cite Save

Biocatalysis: biochemical fundamentals and applications

P Grunwald - 2009 - books.google.com

... and thus low energy consumption Amount of byproducts is low They are biodegradable Preparation on large scale is possible through fermentation (microbial enzymes) Reuse is possible (immobilization) They can be designed to a certain extent They are non-**toxic** if correctly ...

Cited by 59 Related articles All 5 versions Cite Save More

A theoretical study of methanol oxidation mechanisms by methanol dehydrogenase enzymes for fuel cell applications

NB Idupulapati - 2009 - search.proquest.com

... Amino acids labels denote their location in the sequence obtained from the entry 1W6S (**Methylobacterium Extorquens** W3A1[32]) of the Protein ... For catalyst materials, tertiary platinum/ruthenium-based alloys seem to offer the best performance when CO **poisoning** is of ...

Related articles All 3 versions Cite Save More

Current approaches to the prevention of catheter-related infections

B Jansen - INFECTIOUS DISEASE AND THERAPY SERIES, 1997 - books.google.com

... bacteria and C. albicans (96). Among metals with antimicrobial activity, silver has raised the interest of many investigators because of its good antimicrobial action and low **toxicity**. Sioshansi et al. used ion implantation to deposite ...

Cited by 17 Related articles Cite Save

Engineered botulinum neurotoxin

M Dong, L Peng, PEG Stenmark... - US Patent ..., 2017 - Google Patents

... the receptor binding domain of BoNT/A and BoNT/B, as indicated in the table, can significantly change the potency and **toxicity** of these ... toxin protease domain" means a C. botulinum toxin domain that can execute the enzymatic target modification step of the **intoxication** process. ...

Related articles All 4 versions Cite Save

Compounds and methods of treating infections

S Page, S Garg, M Keenan, A McCluskey... - US Patent App. 14/ ..., 2014 - Google Patents

... There are few currently registered alternatives for multidrug resistant (MDR) bacterial infections, forcing clinicians to consider older generation drugs such as colistin with narrow spectrum and considerable potential for **toxic** side-effects. ...

Cited by 1 Related articles All 2 versions Cite Save

Engineering primary metabolic pathways of industrial micro-organisms

A Kern, E Tilley, IS Hunter, M Legiša, A Glieder - Journal of biotechnology, 2007 - Elsevier

Metabolic engineering is a powerful tool for the optimisation and the introduction of new cellular processes. This is mostly done by genetic engineering. Since.

Cited by 102 Related articles All 11 versions Cite Save

ПОВЕРХНОСТНЫЕ СЛОИ МЕТАНОТРОФНЫХ БАКТЕРИЙ

ВН Хмеленина, НЕ Сузина, ЮА Троценко - Микробиология, 2013 - elibrary.ru

Page 1. МИКРОБИОЛОГИЯ, 2013, том 82, № 5, с. 515–527 515 1 Общим свойством многих прокариот является присутствие на внешней поверхности клеточной стенки (КС) регулярных гликопротеиновых обра зований ...

Related articles Cite Save More

Method to increase the number of detectable photons during the imaging of a biological marker

K Rogers, S Shorte, J Dragavon, S Blazquez - US Patent 9,329,132, 2016 - Google Patents
The present invention relates a method to determine the presence of a photon producing biological marker in a cell, tissue or organism of interest. The method is based on Fluorescence by Unbound Excitation from Luminescence (FUEL) and comprises the steps of a) providing conditions ...
Related articles All 4 versions Cite Save

Use of nuclear magnetic resonance to design ligands to target biomolecules

SW Fesik, PJ Hajduk, ET Olejniczak - US Patent 5,989,827, 1999 - Google Patents
... target. False negatives typically occur in assays that use concentrations of test compounds that are either too high (resulting in **toxicity**) or too low relative to the binding or dissociation constant of the compound to the target. Another ...
Cited by 30 Related articles All 2 versions Cite Save

Microbiology and Biodegradation: Deep Ultraviolet Microscopy for the Detection, Quantification, and Characterization of Microbes

KH Nealson, R Bhartia, W Hug - 2015 - dtic.mil
Page 1. Standard Form 298 (Rev 8/98) Prescribed by ANSI Std. Z39.18
213-821-2271 W911NF-11-1-0288 58297-LS.1 Final Report a. REPORT 14.
ABSTRACT 16. SECURITY CLASSIFICATION OF: This proposal was funded ...
Cite Save

N-Heterocyclic quinones

RH Thomson - Naturally Occurring Quinones IV, 1997 - Springer
Page 1. 5 N-Heterocyclic qui nones In a different context the quinones in this chapter would be regarded as alkaloids. It is a miscellaneous group with no large families of closely related compounds. The pyrrole ring occurs in ...
Related articles Cite Save More

Biofiltración de altas concentraciónes de formaldehido bajo la adición continua de ozono.

MG Maldonado Díaz - 2013 - repositorio.ipicyt.edu.mx
... M3 Módulo 3 Page 12. xi NIOSH National Institute of Occupational Safety and Health (Instituto Nacional de Seguridad Ocupacional y Salud) NTP National **Toxicology** Program (Programa de Toxicología Nacional, Estados Unidos de América) O2 Oxígeno molecular O3 Ozono ...
Related articles Cite Save

Examination of metabolic and regulatory networks of Desulfovibrio species

CL Hemme - 2004 - mospace.umsystem.edu
... The sulfate-reducing bacteria are also among a select group of organisms that may be used as tools for the bioremediation of **toxic** heavy metal contaminants from the ... bioremediation efforts (15-18). Several Desulfovibrio species have been shown to reduce **toxic** heavy ...
Cited by 1 Related articles All 2 versions Cite Save More

Methods of intracellular conversion of single-chain proteins into their di-chain form

S Ghanshani, LQ Le, Y Liu, LE Steward - US Patent 8,546,108, 2013 - Google Patents
... The binding, translocation, and enzymatic activity of these three functional domains are all necessary for **toxicity**. While all details of this process are not yet precisely known, the overall cellular **intoxication** mechanism whereby Clostridial toxins enter a neuron and inhibit ...
Cited by 2 Related articles All 4 versions Cite Save

Foam adsorption

L Blank, B Kuepper, EMDA Villa... - US Patent App. 14/ ..., 2012 - Google Patents
... petrochemical feedstock. Biosurfactants are amphiphilic surface-active substances of microbial origin, ie, synthesized by living cells. They are generally non-**toxic**, biodegradable and thus environmental friendly. Interest in microbial ...
Cited by 1 Related articles All 2 versions Cite Save

Modified Clostridial Toxins Comprising an Integrated Protease Cleavage Site-Binding Domain

S Ghanshani, LQ Le, Y Liu... - US Patent App. 12/970,239, 2010 - Google Patents
... BuNT, 143, M1-R422, K423-I847, K848-K1251. [0019]. The binding, translocation and enzymatic activity of these three functional domains are all necessary for **toxicity**. While all details of this process are not yet precisely known, the overall cellular **intoxication** mechanism whereby ...
Cited by 2 Related articles All 4 versions Cite Save

cd1 nitrite reductase from Pseudomonas aeruginosa: reactivity with oxygen and conformational control

F Centola - 2006 - padis.uniroma1.it

... it is **toxic** for denitrifiers too. In fact, a knockout mutation for NO reductase is lethal, but the effect can be suppressed inactivating the NO generator (ie nitrite reductase). During denitrification, the steady state NO concentration is around 0.5-30 nM, while the **toxicity** of NO is shown ...

Related articles All 2 versions Cite Save More

An investigation into carbon flow through the metabolic networks ofRhodobacter sphaeroides

MS Carter - 2014 - search.proquest.com

... CcrR Transcriptional activator of ccr in **Methylobacterium extorquens**. ... Conversely, a transcriptional activator has been identified in **Methylobacterium extorquens**, but it is reported to be responsible only for the regulation of ccr expression and is not present in R. sphaeroides (54). ...

Related articles All 4 versions Cite Save More

Purification, Characterization and Site-directed Mutagenesis of a Methanogen Ribofuranosylaminobenzene 5'-phosphate Synthase

ME Bechard - 2003 - etd.fcla.edu

... 2003). Methylotrophic growth of M. **extorquens** on one-carbon compounds such as methanol, and methylamines results in the production of the **toxic** compound formaldehyde. ... 2003. Methylotrophy in **Methylobacterium extorquens** AM1 from a genomic point of view. J. Bacteriol. ...

Related articles All 2 versions Cite Save More

Expresión de las proteínas recombinantes cry2aa y cry2ab de Bacillus thuringiensis var. kurstaki y su evaluación biológica sobre larvas de primer instar de Tecia …

G Arias, L Yhiset - 2011 - repository.javeriana.edu.co

... negative control, but no with the positive control, showing that the Cry2Aa protein has a **toxic** activity against this pest. On the other hand, E. coli BL21 pET151-Cry2Ab had not significant differences with the negative control, which in this case, demonstrates the low **toxicity** of this ...

Related articles All 3 versions Cite Save

The genomic prediction and characterization of transmembrane β-barrels in Gram-negative bacteria

TC Freeman Jr - 2009 - search.proquest.com

The genomic prediction and characterization of transmembrane β-barrels in Gram-negative bacteria. Abstract. Transmembrane β-barrels (TMBB) are a special structural class of proteins predominately found in the outer membranes ...

Related articles All 4 versions Cite Save

Methanocaldococcus jannaschii and the Recycling of S-adenosyl-L-methionine

DV Miller - 2017 - vtechworks.lib.vt.edu

... 630 0.82% Bacteroides fragilis YCH46 0.73% **Methylobacterium extorquens** AM1 0.41% Escherichia coli K12 0.44% Saccharomyces cerevisiae (Baker's yeast) 0.05% Table 2. Kinetic parameters of DadD with 5'-dA, MTA, SAH, and Ad Substrate KM (mM) kcat (s-1) kcat/KM (M ...

Related articles Cite Save

Glyoxylate Metabolism in Mycobacterium smegmatis

LN Merkov - 2006 - digitalcommons.rockefeller.edu

Page 1. Rockefeller University Digital Commons @ RU Student Theses and Dissertations 2006 Glyoxylate Metabolism in Mycobacterium smegmatis Lubomir Nikolaev Merkov Follow this and additional works at: http://digitalcommons ...

Cited by 4 Related articles Cite Save

Polyhydroxyalkanoates in Gram-positive bacteria: insights from the genera Bacillus and Streptomyces

SP Valappil, AR Boccaccini, C Bucke, I Roy - Antonie Van Leeuwenhoek, 2007 - Springer

... They are biodegradable, insoluble in water, non-**toxic**, biocompatible, piezoelectric, thermoplastic and/or elastomeric. ... are produced on the industrial scale using Gram-negative bacteria exclusively (such as Wautersia eutropha, **Methylobacterium** organophillum, Pseudomonas ...

Cited by 159 Related articles All 14 versions Cite Save

Genetically engineered bacterium comprising energy-generating fermentation pathway

M Koepke, RO Jensen, JBYH Behrendorff... - US Patent ..., 2017 - Google Patents

... lactis, Bacillus subtilis, Bacillus licheniformis, Zymomonas mobilis, Klebsiella oxytoca, Klebsiella pneumonia, Corynebacterium glutamicum, Trichoderma reesei, Cupriavidus necator, Pseudomonas putida, Lactobacillus plantarum, and **Methylobacterium extorquens**. 10. ...

All 2 versions Cite Save

Synthetic methylotrophy to liquid fuels and chemicals

ET Papoutsakis, S Nicolaou, A Fast... - US Patent App. 15/ ..., 2015 - Google Patents

A non-naturally occurring microbe capable of growing in a medium comprising methanol is provided. The methanol contributes to a significant percentage (eg, at least 40%) of the carbon source for the non-naturally occurring microbe, which expresses heterologous methanol ...

All 2 versions Cite Save

Formate metabolism in sulfate reducing bacteria

SIM Silva - 2011 - search.proquest.com

... human larg intestine, has also been implicated in inflammatory bowel. diseases because of its **toxic** effects to epithelial colonic cells [19]. Nevertheless, SRO are drawing increased attention because of their. ... enzymes to cope with oxygen **toxicity**. It was recently shown that a. ...

Related articles All 2 versions Cite Save

Multiple ligand binding and kinetic isotope effects in methanol dehydrogenase

P Hothi - 2004 - lra.le.ac.uk

... 2.4.2 Purification of Mutant MDH from **Methylobacterium extorquens** AM 1.... 55 2.4.3 Partial Purification of Anaerobic MDH from M. methylotrophus W 3 A 1 .... 56 2.5 KINETIC STUDIES..... 57 ...

All 2 versions Cite Save More

Infections associated with urinary catheters

CE Chenoweth, S Saint - Catheter-Related Infections, 2005 - researchgate.net

... Because this practice allows for flow of organisms colonizing the catheter into the bladder, and in view of the potential for local **toxicity** and the complexity of this method, antibacterial irrigation cannot currently be recommended. ...

Cited by 2 Related articles All 4 versions Cite Save More

Destoxificação biológica do hidrolisado hemicelulósico de bagaço de cana-de-açúcar para utilização em processos fermentatativos

LCSR Soares - 2012 - teses.usp.br

... Paulo, 2012. During the acid pretreatment step, required for the disruption of the lignocelluloses matrix and sugars release, several **toxic** compounds are produced and released in the hemicellulosic hydrolyzates. These compounds ...

Cited by 3 Related articles All 2 versions Cite Save More

Methods of activating clostridial toxins

MF Verhagen, DG Stathakis, LE Steward - US Patent 8,486,422, 2013 - Google Patents

... The binding, translocation and enzymatic activity of these three functional domains are all necessary for **toxicity**. While all details of this process are not yet precisely known, the overall cellular **intoxication** mechanism whereby Clostridial toxins enter a neuron and inhibit ...

Cited by 1 Related articles All 5 versions Cite Save

Genetics and physiology of ammonia catabolism by the methane-oxidizing bacterium, Methylococcus capsulatus Bath

A Poret-Peterson - 2009 - search.proquest.com

... Whether genes involved in both processes are co-regulated remains to be answered, but their NH3-responsiveness has physiological implications and suggests that M. capsulatus Bath has a tiered strategy to cope with potential **toxicity** from NH3 exposure. ...

Cited by 1 Related articles All 3 versions Cite Save More

Genomic patterns and phenotypic plasticity in prokaryotes analyzed within an ecological framework

JA García López, J Mas Gordi - 2011 - ddd.uab.cat

... Bioremediation refers to the use of microorganisms to return **toxic** chemical elements to their natural cycles in nature. It may provide an effective method of environmental cleanup, which is one of the major challenges facing human society today. ...

Related articles All 3 versions Cite Save More

Degradable clostridial toxins

LE Steward, EG Fernandez-Salas, MA Gilmore... - US Patent ..., 2011 - Google Patents

... The binding, translocation and enzymatic activity of these three functional domains are all necessary for **toxicity**. While all details of this process are not yet precisely known, the overall cellular **intoxication** mechanism whereby Clostridial toxins enter a neuron and inhibit ...

Cited by 5 Related articles All 6 versions Cite Save

Staphylococcus aureus osteomyelitis: Characterization of bacterial antigens and utilization as vaccine candidates and imaging targets

R Brady - 2007 - search.proquest.com

... dorsal pedis and posterior tibia pulses, poor capillary refill, and decreased sensation, but fever and systemic **toxicity** are often absent. ... Several of these are enterotoxins, which cause food **poisoning**. Another toxin, **toxic** shock syndrome toxin (TSST), causes **toxic** shock syndrome. ...

Related articles All 4 versions Cite Save

Conformational Analysis

C Jones - NUCLEAR MAGNETIC RESONANCE-LONDON-, 1993 - books.google.com

Page 395. 10 Conformational Analysis BY C. JONES 1 INTRODUCTION The format of this review is similar to that in the previous volume. There have been an increasing number of studies of biopolymers, particularly oligonucleotides, large peptides and proteins. ...

Related articles All 4 versions Cite Save

Produkcja polihydroksykwasów z osadu czynnego

E Klimiuk, T Pokój - Biotechnologia, 2008 - pfb.info.pl

... They are marked by high degree of polimerization, non-**toxicity**, wide range of applica- tion ... **Methylobacterium** organophilum lub Protomonas extroquens syntezują kwas poli-3-hydroksymasłowy w obecnoœci metano- lu ... Do tej grupy należą również P. **extorquens** i P. ...

Cited by 1 Related articles All 7 versions Cite Save More

Characterization of mechanisms involved in rickettsia pathogenicity

M Vellaiswamy - 2011 - hal.archives-ouvertes.fr

... recognize one epitope and have markedly higher specific activity than polyclonal serum. Advantages of mAbs formulations are superior in homogeneity, constancy, pathogen specificity, low **toxicity**, enhancement of immune function. Advances in biotechnology have enabled the ...

Related articles All 6 versions Cite Save

Improving biotechnological processes through automated flow cytometry

AB Gilbert - 2008 - search.proquest.com

Improving biotechnological processes through automated flow cytometry. Abstract. In the cytostat, an automated flow cytometry system is used to monitor and control a continuous culture. Cytostat technology was applied to measure ...

Related articles All 2 versions Cite Save More

Zum Mechanismus der 2-Hydroxyglutaryl-CoA Dehydratase aus Clostridium symbiosum

M Hetzel - 2004 - archiv.ub.uni-marburg.de

Page 1. Zum Mechanismus der 2-Hydroxyglutaryl-CoA-Dehydratase aus Clostridium symbiosum zur Erlangung des Doktorgrades der Naturwissenschaften (Dr. rer. nat.) dem Fachbereich Biologie der Philipps-Universität Marburg vorgelegt von Marc Hetzel aus Dernbach/Ww ...

Cited by 3 Related articles All 3 versions Cite Save More

Probiotic potential of lactic acid bacteria isolated from rainbow trout (Oncorhynchus mykiss, Walbaum) and rearing environment. Importance in the prevention of fish …

CAD Araújo - 2016 - search.proquest.com

... the ban of antibiotics as prophylactic treatment, the reduction of authorized antibiotics, the control of the veterinary prescription, the establishment and surveillance of maximum residue limits and the prohibition of the use of certain antibiotics for their high **toxicity** or importance in ...

Related articles All 2 versions Cite Save

Inverse metabolic engineering: a rational approach for efficient and robust microorganism development

CT Trinh - 2008 - search.proquest.com

... et al. 2005 ; Lee, et al. 2003). Efficient and robust microorganisms can also be used for bioremediation to detoxify **toxic** chemicals such as pesticides and industrial wastes (Wackett and Hershberger 2001). An application that ...

Cited by 2 Related articles All 2 versions Cite Save More

In silico analysis of microbial biosynthetic capabilities at the genome-scale

M Imielinski - 2007 - search.proquest.com

... 5.3.3DHA or DHAP **toxicity** may underly the lethality of 3 glycolytic mutants ... disables the production of a pathogenic factor or induces the accumulation of a **toxic** metabolic intermediate ... flexibility in in the C3-C4 interconversion pathways of the organism M. **extorquens** and validate ...

Related articles All 3 versions Cite Save More

Evaluación y diseño de bacterias lácticas (BAL) de origen alimentario y de otros hospedadores como factorías celulares de producción de bacteriocinas

JJJ Martínez - 2015 - eprints.ucm.es

Page 1. UNIVERSIDAD COMPLUTENSE DE MADRID FACULTAD DE VETERINARIA Departamento de Nutrición, Bromatología y Tecnología de los Alimentos TESIS DOCTORAL Evaluación y diseño de bacterias lácticas (BAL ...

Related articles All 2 versions Cite Save More

Modeling molecular mechanisms of mammalian mineralization

JA Horst - 2010 - search.proquest.com

... personal communication, Sam Stupp). Self assembly has been extended to design peptides comprised by only natural amino acids, thus lowering the chance for adverse immune responses and **toxicity**. Beta sheet conformations ...

Related articles All 2 versions Cite Save More

Les modules de" détection/résistance" aux antibiotiques peptidiques chez les firmicutes

S Coumes - 2011 - theses.fr

Page 1. Université de la Méditerranée, Aix-Marseille II Faculté des Sciences de Luminy 163, Avenue de Luminy 13288 Marseille Cedex 09 THESE DE DOCTORAT Spécialité : Microbiologie présentée et soutenue publiquement par Stéphanie Coumes Florens ...

Cite Save

Les modules de" détéction/résistance" aux antibiotiques peptidiques chez les Firmicutes

SC Florens - 2011 - tel.archives-ouvertes.fr

Page 1. Les modules de " détéction/résistance " aux antibiotiques peptidiques chez les Firmicutes Stéphanie Coumes Florens To cite this version: Stéphanie Coumes Florens. Les modules de " détéction/résistance " aux antibiotiques pep- tidiques chez les Firmicutes. ...

All 4 versions Cite Save

Appendix 6-3

cholar "pseudomonas extorquens" pathogenicity

About 43 results (0.05 sec) My prof

[PDF] Studies on a new oxalate-decomposing bacterium, Pseudomonas oxalaticus
SR Khambata, JV Bhat - Journal of bacteriology, 1953 - repository.ias.ac.in
... Furthermore, the loss of viru- lence of strain Ox4 indicates that **pathogenicity** is an unstable characteristic. ... What is even more significant, two of the strains were observed to be **pathogenic** to white ... JANOTA, L. 1950 Utilization of oxalic acid by **Pseudomonas extorquens**, Bassalik. ...
☆ Cited by 66 Related articles All 8 versions »

[PDF] ias.ac.in
Full-Text @ UML Library

Methylobacterium species: an increasingly important opportunistic **pathogen**
AL Truant, R Gulati, O Giger... - Laboratory ..., 2015 - academic.oup.com
... classification and to develop an algorithm for the proper identification and treatment of infection with this opportunistic **pathogen**. ... **Pseudomonas extorquens**, V extorquens, and Flavobacterium extorquens are now synonymous with M extorquens.u'2x The genus Protomonas has ...
☆ Cited by 14 Related articles All 3 versions

[PDF] oup.com
Full-Text @ UML Library

Isolation of Protomonas extorquens (the 'Red Phantom') from a patient with AIDS
J Holton, R Miller, V Furst, H Malnick - Journal of Infection, 1990 - Elsevier
... Materials and methods Strains examined **Pseudomonas extorquens** (NCIB9399), Ps. ... Identification of unusual **pathogenic** Gram-negative aerobic and facultatively anaerobic bacteria. ... mesophilicum infection: Case report and literature review of an unusual opportunistic **pathogen**. ...
☆ Cited by 10 Related articles All 6 versions »

The role of oxalic acid and bicarbonate in calcium cycling by fungi and bacteria: some possible implications for soil animals
K Cromack Jr, P Sollins, RL Todd, R Fogel, AW Todd... - Ecological Bulletins, 1977 - JSTOR
... The plant **pathogen** Sclerotium rolfsii Sacc, by excreting oxalic acid, chelates Ca from Ca pectate in ... **Pseudomonas extorquens** Pseudomonas oxalaticus Streptomyces sp. ... production and synergistic action of oxalic acid and polygalacturonase during **pathogenesis** by Sclerotium ...

[PDF] uga.edu

Studies on a new oxalate-decomposing bacterium, Pseudomonas oxalaticus

SR Khambata, JV Bhat - Journal of bacteriology, 1953 - repository.ias.ac.in

... Furthermore, the loss of viru- lence of strain Ox4 indicates that pathogenicity is an unstable characteristic. ... What is even more significant, two of the strains were observed to be pathogenic to white ... JANOTA, L. 1950 Utilization of oxalic acid by Pseudomonas extorquens, Bassalik. ...

☆ 99 Cited by 66 Related articles All 8 versions »

Methylobacterium species: an increasingly important opportunistic pathogen

AL Truant, R Gulati, O Giger… - Laboratory …, 2015 - academic.oup.com

... classification and to develop an algorithm for the proper identification and treatment of infection with this opportunistic pathogen. ... Pseudomonas extorquens, V extorquens, and Flavobacterium extorquens are now synonymous with M extorquens.u'2x The genus Protomonas has ... ☆ 99 Cited by 14 Related articles All 3 versions

Isolation of Protomonas extorquens (the 'Red Phantom') from a patient with AIDS

J Holton, R Miller, V Furst, H Malnick - Journal of Infection, 1990 - Elsevier

... Materials and methods Strains examined Pseudomonas extorquens (NCIB9399), Ps. ... Identification of unusual pathogenic Gram-negative aerobic and facultatively anaerobic bacteria. ... mesophilicum infection: Case report and literature review of an unusual opportunistic pathogen. ... ☆ 99 Cited by 10 Related articles All 6 versions »

The role of oxalic acid and bicarbonate in calcium cycling by fungi and bacteria: some possible implications for soil animals

K Cromack Jr, P Sollins, RL Todd, R Fogel, AW Todd… - Ecological Bulletins, 1977 - JSTOR ... The plant pathogen Sclerotium rolfsii Sacc, by excreting oxalic acid, chelates Ca from Ca pectate in ... Pseudomonas extorquens Pseudomonas oxalaticus Streptomyces sp. ... production and synergistic action of oxalic acid and polygalacturonase during pathogenesis by Sclerotium ... ☆ 99 Cited by 88 Related articles All 9 versions

A contribution to the study of the intestinal microflora of Indian earthworms

SR Khambata, JV Bhat - Archives of Microbiology, 1957 - Springer

... a red, non watel~-soluble pigment resembled BASSALIK'S (1913 b) Bacillus extorquens--now reisolated and reclassified as Pseudomonas extorquens by LUD ... and perhaps the oxalates present therein, are the factors preventing the growth and survival of pathogenic bacteria. ... ☆ 99 Cited by 29 Related articles All 6 versions »

Pseudomonas mesophilica and an unnamed taxon, clinical isolates of pink-pigmented oxidative bacteria.

GL Gilardi, YC Faur - Journal of clinical microbiology, 1984 - Am Soc Microbiol

... 1974. Studies on the produc- tion of pink pigment in Pseudomonas extorquens NCIB 9399 growing in continuous culture. J. Appl. Bacteriol. ... 1983. Revised tables from the identification of unusual pathogenic gram negative bacteria. Centersfor Disease Control, Atlanta, Ga. VOL. ... ☆ 99 Cited by 69 Related articles All 10 versions

Ecology of the methylotrophic bacteria on living leaf surfaces

WA Corpe, S Rheem - FEMS Microbiology Letters, 1989 - Elsevier

... The predominant type of methylotroph encountered on the surfaces of more than 50 species of plants, were the pink-pigmented, facultatively methylotrophic bacteria (PPFMs) of the Pseudomonas extorquens type [1 ... [20] Leben, C. (1974) Survival of plant pathogenic bacteria. ...

☆ 99 Cited by 192 Related articles All 5 versions »

Antimicrobial Activities of Different Organic Extracts of Nut Shells of Juglans Regia (walnut)

N Raaman, K Mathiyazhagan, R Jegadeesh, S Divakar… - researchgate.net

... S. aureus and S.mutans), gram negative (E. coli and P.aeruginosa) and pathogenic yeast (C ... cereus, Micrococcus luteus, Salmonella typhimirium, Streptococcus pneumonia, Enterococcus faecalis, Bacillus thrungiensis, Serratiamarcescens, Pseudomonas extorquens, Proteus sp ... ☆ 99 Related articles All 2 versions »

Antimicrobial susceptibility of glucose-nonfermenting gram-negative bacilli (NFGNB)

GL Gilardi - Clinical Microbiology Newsletter, 1984 - Elsevier

... The pathogenic anaerobic bacteria, 2nd ed. Charles C. Thomas Co., Springfield. 13. ... mendocina (6) Pseudomonas putrefaciens (72) Pseudomonas maltophilia (527) Pseudomonas diminuta (42) Pseudomonas vesicularis (32) Pseudomonas extorquens (6) Pseudomonas ...

☆ 99 Cited by 12 Related articles All 2 versions »

Phylogenetic affiliation of the pseudomonads based on 16S rRNA sequence.

Y Anzai, H Kim, JY Park… - … of systematic and …, 2000 - ijs.microbiologyresearch.org

... (1996) IAM 12691T AB021415‡ Pseudomonas echinoides Sphingomonas rRNA lineage Kersters et al. (1996) ATCC 14820T AB021370† 'Pseudomonas extorquens' and 'Pseudomonas rosea' Methylobacterium extorquens Kersters et al. (1996) JCM2802T D32224 ...

☆ 99 Cited by 787 Related articles All 17 versions

Microbial dynamics during shelf-life of industrial Ricotta cheese and identification of a Bacillus strain as a cause of a pink discolouration

E Sattin, NA Andreani, L Carraro, L Fasolato, S Balzan… - Food …, 2016 - Elsevier

... The chance of spoilage and pathogenic microorganism growth and survival depends on extrinsic factors associated with production and storage conditions, but also on intrinsic factors such as the composition of the microbial community (Ledenbach and Marshall, 2009). ... ☆ 99 Cited by 5 Related articles All 7 versions

Antimicrobial activity of the ethanol extracts of some plants natural growing in Aydin, Turkey

H Biyik - African Journal of Microbiology Research, 2010 - academicjournals.org

... susceptibility of the probiotic strains to those of clinical isolates, and their antimicrobial activity against food-borne pathogenic and spoilage ... study examines the antimicrobial efficacy of a phytochemical and a metallic nanoparticle against the top Gram positive resistant pathogen. ...

☆ 99 Cited by 17 Related articles All 3 versions

Aerobic methylotrophic bacteria as phytosymbionts

YA Trotsenko, EG Ivanova, NV Doronina - Microbiology, 2001 - Springer

... more than 50 plant species, is a typ- ical pink-pigmented facultative methylobacterium (PPFM), Pseudomonas extorquens [8]. This ... bacteria of the genera Azospirillum, Rhizobium, and Pseudomonas) or adverse effects (these are phyto- pathogenic Pseudomonas, Agrobacterium ...

☆ 99 Cited by 55 Related articles All 7 versions

Microbiodeterioration of library materials part 1, chapters 1—3

R Kowalik - Restaurator, 1980 - degruyter.com

... Some yeast cells have a volume hundreds of times that of Staphylococcus aurcus, bacteria pathogenic to man. ... Silicates are dissolved by the activity of microorganisms and the highest degradation is caused by Pseudomonas extorquens.1 It evidently can destroy marble, the ...

☆ 99 Cited by 40 Related articles All 2 versions »

Protomonas extorquens を分離した呼吸器感染症の 4 例と検出菌の細菌学的性状

林敏明， 河野茂， 山口恵三， 廣田正毅， 原耕平… - 感染症学雑誌, 1990 - jstage.jst.go.jp

... 私達の症例では 4 例 中 3 例 が最終的に原疾患の ため に死亡 してい るが,そ の経過 中,本 菌が opportunistic pathogen と して感染症を惹起して いることが推測 された.症 例 2 に おけるごとく臨 床経過 ...

3) Janota, L.: Utilization of oxalic acid by Pseudomonas extorquens. Bassalik. Med. ...

☆ 99 Cited by 2 Related articles All 5 versions

The characteristics and questionable taxonomic position of the oxalate-decomposing bacterium, Vibrio extorquens

VN Iyer, SR Khambata, JV Bhat - Proceedings: Plant Sciences, 1960 - Springer

... "Przebieg zuzywania kwasu s zczawowego przez Pseudomonas extorquens Bassalik, w zalezonosci od poczatkoweg licsby komorek," Med. ... "A method for the rapid differentiation of certain non- pathogenic, asporogenous bacilli," Nature, 1954, 173, 208-09. ... ☆ 99

Cited by 3 Related articles All 7 versions »

The family Methylobacteriaceae

DP Kelly, IR McDonald, AP Wood - The Prokaryotes, 2014 - Springer

... This organism was variously named Bacillus extorquens, Vibrio extorquens, Pseudomonas extorquens, Pseudomonas methylica, Mycoplana rubra, Flavobacterium extorquens, Protaminobacter ruber, Protomonas extorquens, and finally its current definition as ...

☆ 99 Cited by 9 Related articles All 2 versions »

Taxonomy of methylotrophic bacteria

PN Green - Methane and methanol utilizers, 1992 - Springer

... in bacterial taxonomy: evaluation, application, prospects, in: Proceedings of the 4th International Conference on Plant Pathogenic Bacteria (INRA ... Downs, J., and Harrison, DEF, 1974, Studies

on the production of pink pigment in Pseudomonas extorquens NCIMB 9399 growing ... ☆ 99

Cited by 49 Related articles All 3 versions »

Aspects of Single-Cell Protein Processes

JH LITCHFIELD - Advances in Applied Microbiology, 1978 - books.google.com

... through residues in the substrate such as polyaromatic hydrocarbons and from contamination by pathogenic microor- ganisms or ... Examples of these organisms include Pseudomonas extorquens (Harrison, 1973; Downs and Harrison, 1974), Hyphomicrobium sp.(Wilkinson and ...

☆ 99 Cited by 1 Related articles

Methylobacterium

PN Green - The prokaryotes, 2006 - Springer

☆ 99 Cited by 96 Related articles All 3 versions »

Bioprocess technology

YK Lee - Microbial Biotechnology: Principles and Applications, 2013 - World Scientific

☆ 99 Cited by 5 Related articles All 2 versions »»Class I.

Alphaproteobacteria class. nov.

GM Garrity, JA Bell, T Lilburn - Bergey's Manual® of Systematic …, 2005 - Springer

... Philadelphia. pp. 297–300. Further Reading. Bandi, C., AJ Trees and NW Brattig. 2001. Wolbachia in filarial nematodes: evolutionary aspects and implications for the pathogenesis and treatment of filarial diseases. Vet. Parasitol. 98 ... ☆ 99 Cited by 1451 Related articles All 11 versions »»

Grouping of Pseudomonas species on the basis of cellular fatty acid composition and the quinone system with special reference to the existence of 3-hydroxy fatty …

H OYAIZU, K KOMAGATA - The Journal of General and Applied …, 1983 - jstage.jst.go.jp

... Pseudomonas pallero- nii KS 0230 had 3-OH C$;o. "Pseudomonas extorquens" KS 0111, "P. rosea" KS 0312, and Pseudomonas sp. BP-22 had 3-OH C14;o• ... Page 16. 1983 Grouping of Pseudojnonas Species 31 pathogenic species, P. syringae (30)). ... ☆ 99 Cited by 179 Related articles All 5 versions

Mikrobielle Protein-Gewinnung auf Methanol-Basis

M Reuß, H Sahm, F Wagner - Chemie Ingenieur Technik, 1974 - Wiley Online Library

... 1.) Der Organismus darf nicht pathogen sein und darf keine Toxine produzieren. ... Johnson und Quayle [32] konnten ein ahnliches oder gleiches Enzym in Pseudomonas AM 1, Pseudomonas methanica, Pseudomonas extorquens und Protaminobacter ruber nachweisen. ... ☆ 99 Cited by 26 Related articles »»

Microbial biotechnology: principles and applications

LY Kun - 2003 - books.google.com

... Secondary metabolites, particularly from microbial sources, are selective in their actions on pathogenic bacteria and fungi. ... Lactic cultures are also believed to neutralize the effect of enterotoxin from E. coli, which are pathogenic for pigs. ...

☆ 99 Cited by 57 Related articles All 4 versions »»

Isolation and Characterization of Pink Pigmented Facul Tative Methylotrophs From Coleus forskohlii and Their Influence on Growth and Tuber Yield

SR Pattanashetti - 2012 - krishikosh.egranth.ac.in

... Figure No. Title 1 Antagonistic activity of the PPFM isolates against different plant pathogenic fungi ... They sequester ferric iron, whose concentration is very low in well aerated soils, in a form that cannot be utilized by the pathogen, thereby reducing its number and/or activity. ... ☆ 99 Related articles All 2 versions

Physiology and biochemistry of amidase production by Methylophilus methylotrophus.

NJ Silman - 1990 - lra.le.ac.uk

... Methylocystis spp. Type II facultative methanotrophs Pink-pigmented facultative methylotrophs Methylobacterium organophium Pseudomonas AMI Pseudomonas extorquens Pseudomonas TP I Pseudomonas At2 9 10 The Hyphomlcrobla ...

☆ 99 Related articles All 4 versions »»

Myco-protein: A twenty-year overnight success story

APJ Trinci - Mycological Research, 1992 - Elsevier

... subjects (see below) showed the strain to Growth of Fusarium graminearum in continuous flow be non-toxic to animals, non-pathogenic to wheat ... 1983), Harrison (1976) described an improvement in yield factor from 0'40 to 0'47 for a strain of Pseudomonas extorquens grown in ... ☆ 99 Cited by 66 Related articles All 6 versions »»

A taxonomic study of some Gram-negative facultatively methylotrophic bacteria

PN Green, IJ Bousfield - Microbiology, 1982 - mic.microbiologyresearch.org

... 623 One hundred and fifty pink-pigmented facultatively methylotrophic bacteria (PPFMs) of the 'Pseudomonas extorquens' type, 28 other facultative methylotrophs and 16 non-methylo- trophic marker strains of the genera Pseudomonas, A lcaligenes, Mycoplana and Microcyclus ... ☆ ❞

Cited by 111 Related articles All 3 versions »

Numbers of bacteria and their distribution on cotton plants during development

MI Cartagenova - 1987 - ttu-ir.tdl.org

... consisted of three gram negative endotoxin producing species: Ent e robacte r agglome rans, P s eudomona s syringae and Pseudomonas extorquens. Fischer examined cotton from various parts of the world including Lubbock, Texas and found that ... ☆ ❞ Related articles All 2 versions »

Heterologous gene expression in methylotrophic yeast

JF Tschopp, JM Cregg - Biology of Methylotrophs, 1991 - books.google.com

... 305 Page 329. 306 Heterologous Gene Expression in Methylotrophic Yeast timum of most microorganisms, P. pastoris cultures are less susceptible than most to contamination. Studies to date suggest that P. pastoris SCP is non- pathogenic and devoid of toxins and pyrogens. ...

☆ 99 Cited by 18 Related articles All 4 versions

Taxonomic studies on some Gram-negative methylotrophic bacteria

O Jenkins, D Jones - Microbiology, 1987 - mic.microbiologyresearch.org

... Vibrio anguillarum Area I11 Cluster IIIA Subcluster IIIA 1 'Methylobacterium organophilum' ' Pseudomonas extorquens' ... NCTC, National Collection of Type Cultures; ATCC, American Type Culture Collection; NCPPB, National Collection of Plant Pathogenic Bacteria; NRRL ...

☆ 99 Cited by 21 Related articles All 5 versions »

Expression of antibody or a fragment thereof in lactobacillus

L Hammarström, H Marcotte, MA Alvarez… - US Patent …, 2014 - Google Patents ...

In one embodiment the microorganism expresses one or more exogenous proteins. In one embodiment the one or more exogenous proteins treats or prevents a pathogenic infection. In one embodiment the pathogen is a virus. ... ☆ 99 Related articles All 4 versions

Evoluzione della comunitÃ microbica durante la shelf-life della Ricotta Industriale

A Tiengo - 2015 - tesi.cab.unipd.it

Page 1. UNIVERSITÀ DEGLI STUDI DI PADOVA Dipartimento di Biomedicina Comparata ed Alimentazione Corso di Laurea Magistrale in Biotecnologie per l'Alimentazione Evoluzione della comunità microbica durante la shelf-life della Ricotta Industriale ...

☆ 99 »

Ülkemizde doğal yayılışa sahip karayosunlarından Sphagnum centrale CEO Jensen ve S. Capillifolium (Ehrh.) Hedw'un (Bryophyta) anti-mikrobiyal aktivitesinin …

F Başer - 2016 - adudspace.adu.edu.tr

... Salmonella thyphimurium CCM 5445, Klebsiella pneumoniae UC57, Micrococcus roseus, Micrococcus flavus ATCC 14452, Citrobacter freundii ATCC 8090, Bordatella bronchiseptica ATCC 4617, Erwinia amylovora, Pseudomonas extorquens, Pseudomonas fluorescens ...

☆ 99

16S amplicon Next Generation Sequencing approach evaluation and its application to food microbial communities characterization

E Sattin - 2016 - paduaresearch.cab.unipd.it

... Nucleic Acids Res.; 24(17):3381-91. Cerca con Google. 38. Soumitesh Chakravorty et al. (2007).A detailed analysis of 16S ribosomal RNA gene segments for the diagnosis of pathogenic bacteria. J Microbiol Methods.; 69(2): 330–339. Cerca con Google. 39. ... ☆ 99

Related articles »

Process for the production of fine chemicals

G Plesch, P Puzio, A Blau, R Looser, B Wendel… - US Patent …, 2013 - Google Patents

... The term “analogous conditions” means that all conditions such as, for example, culture or growing conditions, assay conditions (such as buffer composition, temperature, substrates, pathogen strain, concentrations and the like) are kept identical between the experiments to be ... ☆ 99 Cited by 5 Related articles All 2 versions

Process for the production of fine chemicals

G Plesch, P Puzio, A Blau, R Looser… - US Patent App. 13 …, 2011 - Google Patents

The present invention relates to a process for the production of fine chemicals in a microorganism, a plant cell, a plant, a plant tissue or in one or more parts thereof. The present invention relates further to a process for the control of the production of fine chemicals in a microorganism ...

☆ 99 Related articles All 2 versions

Process for the production of fine chemicals

G Plesch, P Puzio, A Blau, R Looser, B Wendel… - US Patent …, 2011 - Google Patents

... The term “analogous conditions” means that all conditions such as, for example, culture or growing conditions, assay conditions (such as buffer composition, temperature, substrates, pathogen strain, concentrations and the like) are kept identical between the experiments to be ... ☆ 99 Cited by 1

Related articles All 5 versions

Adapting microorganisms for agricultural products

E De Crecy - US Patent App. 12/770,656, 2010 - Google Patents

Disclosed herein are methods and compositions to convert a carbonaceous material to produce a fatty acid, biofuel, biodiesel, or other useful end-product. Organisms are evolutionarily modified to utilize carbon and/or nitrogen sources available in a carbonaceous material. Culture ...

☆ 99 Cited by 1 Related articles All 2 versions

Adapting Microorganisms for Agricultural Products

US Patent 20,150,004,672, 2015 - freepatentsonline.com

Disclosed herein are methods and compositions to convert a carbonaceous material to produce a fatty acid, biofuel, biodiesel, or other useful end-product. Organisms are evolutionarily modified to util.

☆ 99 Related articles »

Adapting Microorganisms for Agricultural Products

JR Eudes de Crecy - US Patent App. 14/184,069, 2014 - Google Patents

Disclosed herein are methods and compositions to convert a carbonaceous material to produce a fatty acid, biofuel, biodiesel, or other useful end-product. Organisms are evolutionarily modified to utilize carbon and/or nitrogen sources available in a carbonaceous material. Culture ...

☆ 99 Related articles

Process for the production of fine chemicals

M Ebneth, P Puzio, A Blau, TB Walk, V Haake… - US Patent …, 2011 - Google Patents

... The term “analogous conditions” means that all conditions such as, for example, culture or growing conditions, assay conditions (such as buffer composition, temperature, substrates, pathogen strain, concentrations and the like) are kept identical between the experiments to be ... ☆ 99 Cited by 1

Related articles All 5 versions

KnipBio

August 9, 2018

Louis Carlacci, Ph.D.
Chemist, Ingredient Safety Team
Division of Animal Feeds
Center for Veterinary Medicine
U.S. Food and Drug Administration
7519 Standish Place
Rockville, MD 20855

RE: GRAS Notice No. AGRN 26

Dear Dr. Carlacci:

KnipBio, Inc., would like to thank you and your colleagues at CVM for the very productive conference call on July 12, 2018 regarding the above-referenced GRAS Notice, and for sending us the meeting minutes for that call. The following are KnipBio's responses to the questions and other issues raised during that call. In the remainder of this letter, CVM's comments and questions are shown in italics, followed by KnipBio's response to each. We have marked certain information that we consider a part of the pre-fermentation manufacture information as confidential. Confidential information in the text, figures and tables is enclosed within black boxes or borders. We believe this is consistent with the agency's policy that manufacturing-related information is considered confidential business information and not released under the freedom of information procedures (21 CFR 20.61(a)). We understand the final determination will be made by the FOI officers of the Center for Veterinary Medicine.

Background

The substance is Methylobacterium extorquens protein (or KBM) derived from genetically engineered Methylobacterium extorquens strain KB203 through fermentation and spray drying the biomass. This notice filed February 7, 2018, informs the FDA of KnipBio's view that Methylobacterium extorquens protein is GRAS through scientific procedures when used as a protein source in food for aquaculture species and when used at an intended use rate of up to 10% of the diet. The substance is intended to replace soybean or fish meal in the aquaculture diet.

Chemistry, Manufacturing and Controls:

1. *CVM recommended that the notifier explain where the signals for spirilloxanthin would be located in the tunable UV spectra and total ion current MS spectra as this relates to the conclusion that the parent strain does not produce spirilloxanthin, given that M. extorquens strain KB203 is genetically engineered to remove the spirilloxanthin production pathway and the physical data on strain KB203 and the parent strain KB200 are the same.*

(b) (4)

This finding is supported in the literature. It has been broadly published that certain bacteria, including spirilloxanthin-producing *R. rubrum,* use bacteriochlorophyll systems to utilize light energy for reducing equivalents to improve growth. Such systems use a variety of carotenoids including spirilloxanthin to efficiently transfer energy to bacteriochlorophyll molecules, and many strains have been reported to exhibit different color phenotypes under light and dark conditions ((Yurkov and Beatty, 1998); (Papagiannakis *et al.*, 2002);(Niedzwiedzki *et al.*, 2015) ; (Siddaramappa *et al.*, 2018)). Indeed, Steifel *et al.* (2013) identified several species of *Methylobacterium* that express bacteriochlorophyll (as determined by fluorescent phenotype) in light conditions found on the leaves of plants. These strains exhibited varying phenotypes when cultivated on various media with a day/night cycle. Specifically, in data reported in Steifel *et al*., the reference strain *M. extorquens* PA1 did not exhibit fluorescence when grown on methanol or succinate, suggesting a downregulation of these genes under methanol fermentation (i.e. the conditions of KnipBio's fermentation).

(b) (4)

(b) (4)

(b) (4)

(b) (4)

(b) (4)

(b) (4)

(b) (4)

(b) (4)

(b) (4)

2. *CVM recommended that for all the components in the defoamer (b) (4), the notifier provide the chemical name, CAS number and either the AAFCO ingredient definition number, the CFR citation or other information (such as citing the FDA letter that contains a list of allowed technical additives, that was sent to the Enzyme Technical Association) justifying its acceptability for use in the manufacture of animal food.*

Please refer to the two letters dated July 13, 2018, from (b) (4) in **Appendix 2**, stating that the composition of (b) (4) Foam Control (b) (6) is "polyglycol", i.e. [alpha]-Hydro-omega-hydroxy-poly (oxyethylene)/poly(oxypropylene)/ poly(oxyethylene) block copolymer (CAS Reg. No. (b) (4)), and that the use of this product complies with 21 CFR Part 173.340, Secondary Direct Food Additives Permitted in Food for Human Consumption, when used as a defoaming agent, and which notes that its ingredients are listed under §173.340(a)(3). The letter further states that "The Center for Veterinary Medicine has used regulatory discretion and not taken action against the use of substances approved for use in human food as antifoaming or defoaming agents in animal feeds (21 CFR Part 173.340) when used according to the existing regulations."

Please also refer to the letter of September 11, 2003 from FDA CFSAN to Gary Yingling on behalf of the Enzyme Technical Association, shown in **Appendix 3**, discussing the use of several antifoaming agents, and stating the conclusion that these agents can be used by enzyme manufacturers in accordance with good manufacturing practice. Note that the chemical compound making up (b) (4), with the CAS number cited above, is the third compound listed in Table 1 of the September 11, 2003 letter.

CVM recommended that the notifier provide a replacement for boric acid that is appropriate for use in animal food production as boric acid is not approved for this use. The notifier stated on the call that a replacement for boric acid would not be used. This should be confirmed in the amendment.

KnipBio confirms that boric acid will not be used in the manufacture of the notified substance.

CVM recommended that the notifier provide an animal food grade specification for methanol, as the specification in the notice does not include tests for the heavy metal lead, and acetone and aldehyde impurities, which are tests listed in the Food Chemicals Codex monograph for methanol.

The specification of the methanol used for manufacture of the notified substances will follow the specification in the Food Chemicals Codex monograph (Food Chemicals Codex, 4th Edition (1996) page 251).

Table 1. Food Chemicals Codex specification for methanol.

Methanol specification	Min. 99.85%
Acetone + aldehydes	Not more than 0.003%
Acidity (as formic acid)	Not more than 0.0015%
Alkalinity (as NH_3)	Not more than 3 ppm
Heavy metals (as Pb)	Not more than 1 ppm
Non volatiles residues	Not more than 10 ppm
Water	Not more than 0.1%

As an example of the sourced methanol to be used in commercial manufacture, Table 2 below is a comparison of the Certificate of Analysis of 3 batches of methanol that have been used for large scale fermentation by KnipBio.

Table 2: Example of source of methanol to be used in the KnipBio fermentation.

Supplier	(b) (4)	
Product #	(b)	
	Spec	Results
Methanol spec	Min. 99.85%	99.96%
Acetone + aldehydes	Max. 0.003%	0.001%
Acidity (as formic acid)	Max. 0.0015%	0.001%
Titrable Acid (meq/g)		

Alkalinity (as NH_3)	3.0 ppm max.	2.000 ppm
Titrable Base (meq/g)		
Heavy metals (as Pb)	Max. 1.0 ppm	0.200 ppm
Non volatiles residues	Max. 10 ppm	10.000 ppm
Solubility in Water		Passes test
Water	Max. 0.1%	0.04%

KnipBio will ensure that the manufacturing of the notified substance will be performed under GMP conditions.

3. *CVM recommended that the notifier provide a specification that includes an analytical test for PHB content, as this is an important identity and safety marker. CVM recommended that the notifier provide a specification that includes tests for impurities including, methanol and heavy metals, such as lead, cadmium, mercury and arsenic or explain why they are not needed. For each test in the specification, CVM recommended that the notifier provide the analytical method citation and acceptance criteria. The acceptance criteria should be supported by batch analysis. Analytical methods should be citations of compendia analytical methods or, in lieu of citations of compendia methods, copies of the validated analytical methods supported with validation summaries.*

Then notified substance is a safe and efficacious protein that can be used at a 10% inclusion in aquafeed. The specification of the notified substance is shown in the following Table 3, which also indicates citations for the analytical methods to be used.

Table 3. Specification of the notified substance.

	Method	Value
Moisture %	AOAC 930.15	<7
Protein (crude) %	AOAC 990.03	>50
PHB %	Adapted from Karr et al. (1983) (see **Appendix 4**)	< 25
Methanol % (w/v)	Adapted from Anthon et al. (2004) (see **Appendix 5**)	<0.004
Total coliform (cfu/g)	MFHPB-34	<5
Appearance (color)		Light pink to reddish color
Appearance (form)		Fine powder

KnipBio suggests that a specification for heavy metals such is not needed based on the fact that there is no source of these heavy metals in the growth media. We verified the absence of heavy metals in 3 fermentation batches (table below).

The following Table 4 shows the analysis of heavy metals and other constituents in 3 batches of the notified substance, as performed by (b) (4) . The column in the Table entitled "Methods" indicates the methods used by (b) (4), identified by their AOAC reference numbers (http://www.aoac.org/).

Table 4. Heavy metal analysis in three batches of the notified substance.

	Method	Batch KB203-0616-2/8/17	Batch KB203-1016-2/8/17	Batch KB203-10615-5/16/17
Moisture %	AOAC 930.15	(b) (4)		
Protein (crude) %	AOAC 990.03			
Fat (crude) %	AOAC 920.39			
Fiber (crude) %	AOAC 978.10			
Ash %	AOAC 942.05			
Calcium %	AOAC 985.01/984.27			
Phosphorus %	AOAC 985.01/984.27			
Sodium %	AOAC 985.01/984.27			
Chloride %	AOAC 937.09			
Magnesium %	AOAC 985.01/984.27			
Manganese ppm	AOAC 985.01/984.27			
Iron ppm	AOAC 985.01/984.27			
Zinc ppm	AOAC 985.01/984.27			
Copper ppm	AOAC 985.01/984.27			
Potassium %	AOAC 985.01/984.27			
Selenium ppm	AOAC 986.15			

Sulfur %	AOAC 923.01	(b) (4)
Arsenic ppm	AOAC 990.08	
Lead ppm	AOAC 990.08	
Mercury ppm	NJFL MERC.001	
Boron ppm	AOAC 990.08	
Cobalt ppm	AOAC 990.08	
Cadmium	AOAC 967.61	
Molybdenum ppm	AOAC 990.08	
Vitamin C %	AOAC 967.21	

4. *CVM recommended that the notifier provide test results and analytical methods for the contents of methanol, in three to five batches, as a significant amount of methanol is used in the manufacture. CVM recommended that the notifier provide information on the analytical methods used for the analysis of heavy metals. Analytical methods should be citations for the compendia analytical methods or, in lieu of citations of compendia methods, copies of the validated analytical methods supported with validation summaries.*

Although very little to no methanol is expected in the final product, KnipBio tested the amount of methanol in 3 spray dried batches of biomass by adapting a colorimetric method published by Anthon and Barret (2004). The method used and the processing of samples is described in **Appendix 5**. The summary in Table 5 below indicates the maximum level of methanol that could be detected in 20mg of dried biomass resuspended in 1 ml of solvent, as measured in **Appendix 5**.

Table 5. Methanol analysis in three batches of the notified substance.

Sample	**% Methanol (w/v)**
Batch from June 2015	(b) (4)
Batch from May 2016	
Batch from October 2016	

LOD: 0.002475 % (w/v)

AOAC methods for measurement of heavy metals are cited above.

5. *For the room temperature stability results in Table 2-5, CVM recommended that the notifier provide the acceptance criteria and analytical methods. Analytical methods in the notice should include citations for the compendia analytical methods or, in lieu of citations of compendia methods, copies of the validated analytical methods supported with validation summaries.*

The notified substance is a nutritious and efficacious protein flour. Measurement of the protein content as well as PHB over time show that the substance is stable under standard storage conditions (room temperature and ambient humidity): the protein content is very consistent (50-52%) and does not

change within a 15% range (acceptance criteria). These results, along with the citations for the analytical methods used, are shown in Table 6.

Table 6. Analytical results of 3 batches of the notified substance.

	Analysis date	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	PHB (%)
Method		AOAC 930.15	AOAC 990.03	AOAC 920.39	AOAC 978.10	AOAC 942.05	Adapted from Karr *et al.* (1983)
Batch June 2015	8/8/2018	(b) (4)					
	7/24/2017						
	5/17/2017						
	10/31/2016						
	8/17/2016						
	9/14/2015						
	Avg						
	std						
Batch June 2016	8/8/2018						
	7/24/2017						
	5/17/2017						
	2/10/2017						
	10/31/2016						
	9/9/2016						
	6/15/2016						
	Avg						
	std						
Batch Oct 2016	8/8/2018						
	7/24/2017						
	5/17/2017						
	2/10/2017						
	11/9/2016						
	10/31/2016						
	Avg						
	std						

CVM noted that the stability information obtained for one batch stored at a higher temperature, 45°C, for period of 3 months, is an appropriate combination of temperature and duration to support stability for up to one year. However, for accelerated stability testing, we typically expect stability for three batches, and for each batch, 3 temperatures and appropriate duration. We allow a stability claim of up to 1 year with a successful accelerated stability study. CVM

> *recommended that the notifier explain the increase in standard plate count in the stability study at a higher temperature (see Table 2-6 of the notice) and rule out the possibility of pathogenic organisms.*

KnipBio will rely on the room temperature stability study, which demonstrates the stability in excess of one year on multiple batches. However, we are answering the questions raised on the standard plate count assessment related to the accelerated storage conditions (see table 2-6), to be thorough.

KnipBio has solicited the comments of (b) (4) the lab supervisor at (b) (4) who said: "Modern microbiological theory for standard plate count is based on the possibility of counting bacterial colonies in plates. Under this theory, 87,000 to 180,000, 57,000 and 120,000 are considered to be very similar numbers as they are in the same magnitude." This statement strongly suggests that there is no significant difference between the different measurements at week 3 and week 12. Because there were no pathogens such as *Staphylococcus aureus, Salmonella* or *E. coli* detected at time zero of this study, KnipBio did not anticipate that any of these bacteria would appear during the accelerated shelf life study. Moreover, none of these microorganisms could be detected in the notified substance after 1 year of storage at room temperature, which is another reason KnipBio did not anticipate the presence of pathogens. As mentioned in the Narrative of the GRAS Notice, containers with samples stored at room temperature were often opened to withdraw samples for protein and PHB QC analysis, and that might explain the increase in standard plate count. Upon manufacturing, such processes are not anticipated as the notified substance is destined to be processed in a timely manner and not subject to long period of storage.

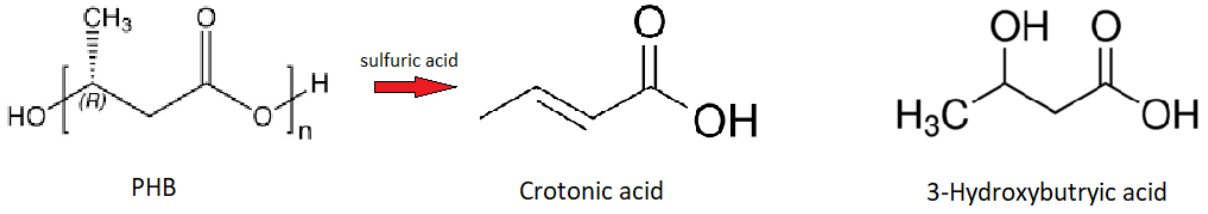
The numerical, but non-statistically relevant increase in CFUs noted suggests a possibility of human handling error. In addition to the single cell protein samples tested in the accelerated stability test described above, the company also tested various batches, from its inventory. In approximately four tests, where samples were stored in a way consistent with product specifications (i.e. stored at room temperature, inside a propylene bag), CFU derived from the product was observed to be very low. Two samples from 2015 and two samples from 2016 yielded 1800, 38000, 2800 and 8600 CFUs respectively at initial testing, suggesting that the residual biological potential remains quite low under proper storage conditions.

6. *CVM recommended that the notifier provide information on the verification of the in-house method for the analysis of PHB content in the notified substance, which is based on a comparison with the results of a validated method. This information consists of the standard calibration procedure, the equations used to compute the PHB content, method verification summary, a summary of standard calibration results and the validation summary for the method used for comparison.*

KnipBio has developed an in-house method for the analysis of PHB content, that has been adapted from the published method of Karr *et al*. (Karr, Waters and Emerich, 1983). As shown in **Appendix 4**, this method has been verified against the Karr method, using the criteria of "Guidelines for the Validation of Chemical Methods for the FDA FVM Program." 2nD edition. April 2015. US Food & Drug Administration, Office of Foods and Veterinary Medicine. The following is a summary of the experiments that have been carried out: please see **Appendix 4** for more detail.

Summary:

KnipBio adapted and verified a method based on a HPLC assay published by Karr *et al.* 1983 (Karr, Waters and Emerich, 1983) to measure Polyhydroxybutyrate (PHB). PHB is converted by sulfuric acid into crotonic acid. Crotonic acid can be measured in crude reactions by absorbance at 210 nm or more precisely by separation and measurement on an HPLC or UPLC. Following conversion, there are no major peaks other than crotonic acid when measured by absorbance at 210nm.



PHB Crotonic acid 3-Hydroxybutryic acid

Appendix 4 describes two methods KnipBio evaluated for assaying PHB content. The chosen method, referred to as "Method 1" in the Appendix, showed excellent repeatability, linearity, low limits of detection and quantitation, and acceptable specificity. Our adaptation to using a UPLC reduced per sample times from 30 minutes in Karr *et al.* to 3 minutes per sample. The data presented herein supports the use of Method 1 for the analysis of PHB content in KnipBio produced single cell protein (SCP) containing 0.05 to 30% PHB (w/w). Collectively, the results presented here suggest that the largest contributions to error are in measuring dry cell weights and standard preparation.

Table 7: Summary of acceptance criteria and results of PHB assay.

Verification	**Acceptance Criteria**
Repeatability Precision	$RSD_r < 4$ %.
Linearity*	$r > 0.995$
LOD†	S/N > 5

LOQ‡	S/N > 10
Specificity	Signal in matrix blank < twice the LOQ
Accuracy	4 Spike samples with 1mg PHB have <10% Dev on average

*Linearity is tested using standards of amount 50, 100, 250, 500, 1000, 2000, 3000 ug.
†Limit Of Detection is (b) (4) ug/mL or an equivalent amount of (b) PHB in Method 1.
‡Limit Of Quantification is (b) (4) ug/mL or an equivalent amount of (b) ug PHB in Method 1.

The repeatability/ precision of the method was tested by comparing (1) the same sample injected three times, and (2) ten separate dilutions of the same analyte. By using a 500μg PHB standard diluted 50 times, we determined that the Quantitative Method Acceptability Criteria RSD (Guidelines for the Validation of Chemical Methods for the FDA FVM Program) was below the 4-6% values for 100 to 10mg/kg method levels. These results are shown in Section 3 of **Appendix 4**.

The linearity of the method was determined based on the correlation coefficient for at least six standards generated from purified PHB in amounts between 50 and 3000 μg. The results for four separately prepared standards from three users showed a r2>0.99 fitting a quadratic equation, thus demonstrating the linearity of the method. These results are shown in Section 4 of **Appendix 4**.

The limits of detection (LOD) and limits of quantitation (LOQ) for the method were determined by (1) quantifying the minimum amount of PHB possible, and (2) the range over which the method can be accurately used. By using standards of 50, 25, 25, 12.5, 5, 2.5 μg PHB injected multiple times, we obtained an acceptable linearity (r > 0.99295, r2 > 0.998590) of the method. The LOD is 0.0067 mg/mL or an equivalent amount of 1ug PHB. The LOQ is 0.0167 μg/mL or an equivalent amount of 1.25 ug PHB. The low concentration samples were also compared to their theoretical value. For samples with greater than a 5 ug PHB equivalence (0.0333 μg/mL concentration), the % deviation was less than 10%. Linearity between the theoretical and measured values was acceptable (r2 > 0.9992). These results are shown in Section 5 of **Appendix 4**.

The specificity and accuracy of the method was determined by (1) investigating whether there are other substances in matrix blanks or media lacking PHB that could interfere with determining the PHB content and (2) measuring the accuracy or closeness of the results to a theoretical value of PHB. To determine if other substances in the matrix or media could interfere with PHB measurement, KnipBio analyzed several strains grown in minimal media supplemented with either methanol or succinate as the sole carbon source. We used strains unable to produce PHB (as described in **Appendix 4**) and also spiked known amounts of PHB in cell extracts prior to analysis by UPLC. Based on specificity and accuracy acceptance criteria, no signal in the matrix blanks should be greater than 2 times the LOQ (<2 .5ug) and spiked samples of 2 matrix blanks with 1mg PHB should be within 10% of their theoretical values. No PHB could be detected in the samples from cells unable to produce this compound, demonstrating that no other substance in the matrix could interfere with the signal. Moreover, all the theoretical PHB added to the sample was measured within a 10 % error, demonstrating the accuracy of the method. These results are shown in Section 6 of **Appendix 4**.

In summary, through the experiments and data summarized above and presented in **Appendix 4**, KnipBio has verified that the analytical method developed and used in-house accurately measures PHB in the notified substance.

7. *The notice Part 3 section "Concentration of methanol in the notified substance" argues that there is less than 0.00125% MeOH (0.01mg/mL) in the notified substance given that "samples were run [sic] at a 4X concentration compared to the standards, and no signal was found to be more fluorescent than the blank control." CVM recommended that the notifier explain how the methanol content in the notified substance can be reduced by a factor of 4, as the method determines the methanol content in culture supernatant, and the sample is derived by re-suspending the notified substance in phosphate buffer solution.*

We describe with more detail in **Appendix 5** how we determined the LOD of methanol with the verified method and how we measured the amount of methanol in the notified substance.

For the validation of the in-house method used to determine the contents of methanol and formaldehyde, CVM recommended that the notifier provide the equations used to compute the results, a method validation summary, and a summary of standard calibration results. The validation summary should demonstrate performance characteristics such as precision, accuracy, sensitivity, selectivity, limit of detection, limit of quantitation, linearity, range, and ruggedness to ensure that results are meaningful and appropriate to make a decision. The method validation should address the completeness of the extraction of methanol from the notified substance.

KnipBio has developed an in-house method for the analysis of methanol and formaldehyde content, that has been adapted from the published method of Anthon and Barrett (2004) (Anthon, Barrett and Arrett, 2004). As shown in **Appendix 5**, this method has been verified against the published method, using the criteria of "Guidelines for the Validation of Chemical Methods for the FDA FVM Program." 2^{nD} edition. April 2015. US Food & Drug Administration, Office of Foods and Veterinary Medicine. The following is a summary of the experiments that have been carried out: please see **Appendix 5** for more detail.

We sought to test the amounts of formaldehyde and methanol in spray dried batches of biomass by using a colorimetric method commonly used for quantifying methanol in aqueous solutions (Anthon, Barrett and Arrett, 2004). The same method is used for both analytes, with one added step used in the methanol assay. To test for methanol, an alcohol oxidase from *Pichia pastoris* is first used to convert methanol to formaldehyde prior to adding the Nash reagent. The Nash reagent is a mixture of acetylacetone and ammonia which reacts specifically with formaldehyde to produce a chromophore that can be detected with absorbance or fluorescence. To test for formaldehyde, samples are simply mixed with the Nash reagent without the enzymatic pretreatment.

Formaldehyde and methanol are not expected to be in high concentrations at the end of methanol fermentation of *Methylobacterium extorquens* due to the residual enzyme activities from multiple methanol oxidases and formate activating enzyme ((Marx *et al.*, 2003);(Chistoserdova *et al.*, 2003);(Ochsner *et al.*, 2014)). Furthermore, any residual formaldehyde is expected to react with proteins, lipids, and other compounds in the biomass. Methanol which is much more volatile than water (vapor pressure 13.02 kPA vs 2.34 kPa at 20 °C), would be expected to evaporate during spray drying, drum drying, or lyophilization.

In **Appendix 5**, we describe several experiments in which we adapt and verify the Anthon and Barrett method to measure methanol and formaldehyde in dried cellular biomass.

(1) To extract any cellular methanol or formaldehyde in the dried biomass, we resuspend the biomass in dilute phosphate buffered saline (PBS) and subject the cellular material to freeze thaw cycles that is frequently used to lyse bacterial cells.
(2) To ensure that all methanol or formaldehyde could be detected, we spiked samples with known amounts of methanol or formaldehyde.
(3) To test for specificity of the methanol signal, we extracted methanol from cells grown in absence or presence of methanol.
(4) To test for lower amounts of methanol or formaldehyde, we include higher amounts of the sample in the reaction relative to the standards.

Summary of the verification of the method used to detect methanol

(1) We established the linearity of a standard methanol curve with concentration of methanol between (b) (4) (v/v) (r^2>0.99). (Experiment 1 in Section 3 of **Appendix 5**).
(2) Specificity was validated with cell samples grown in absence of methanol (no detectable methanol in the cell pellet or supernatant of the cultures). Taking into account the dilution factors, we show that the methanol detected is specific in spray dried samples when spiked in at 0.05 and 0.005%. Experiment 2 in Section 4 of **Appendix 5**).
(3) Method accuracy within 10% was established by spiking known amounts of methanol into the measured samples. Experiment 2 in Section 4 of **Appendix 5**).
(4) Full extraction of the methanol was verified by recovering and measuring known spiked amounts of methanol. The spiked samples, which confirmed that all methanol has been properly extracted and accounted for, had measured values that were on average 5.6% of the expected values. Experiment 3 in Section 5 of **Appendix 5**).
(5) We determined the limit of methanol detection by increasing sample volumes relative to standards: it is possible to detect methanol as low as 0.002475 % (w/v)). Experiment 1 in Section 3 of **Appendix 5**).
(6) Based on the data in **Appendix 5**, the levels of methanol measured in 3 different batches of fermentation) are summarized in the table below.

Table 8. Assayed levels of methanol in 3 batches of the notified substance.

Sample	mg/mL cell susp.	% MeOH (w/v)
P1 (June 2015 sample)	(b) (4)	
P2 (May 2016 sample)		
P3 (October 2016 sample)		

Summary of verification of the formaldehyde detection method

As described in more detail in Experiment 4 in Section 6 of **Appendix 5**, the method used has acceptable linearity when using formaldehyde standards of 0.001 to 0.05% (w/v). When linearity is below our acceptance criteria of $r^2 < 0.99$, it is usually due to a pipetting error. Samples outside the acceptable linear range, such as those giving values above 0.05% (w/v) or below 0.001% (w/v) are discarded.

As in the Methanol assay, the amount of formaldehyde measured can be lowered by using more sample than standard. When tested between 0.00004% (w/v) and 0.0001% (w/v) linearity was an acceptable $\mathbf{r^2}$>0.9918.

None of the extractions from the powders had any response even when sample were 25 times greater than the formaldehyde standard (50µL sample volume).

Target Animal Safety:

1. *CVM noted that for certain contaminants/fermentation end products, the notifier cites regulations in the Code of Federal Regulations as demonstrating that the amounts in the biomass do not raise safety concerns. However, these regulations are for specific uses of these substances and/or their contaminants and thus, a simple citation of the regulation is not sufficient; there should be consideration of target species. CVM suggested use of exposure calculations with reference to species and the appropriate scientific literature to support the lack of safety concerns. In addition, when addressing target animal safety, stating and relying on actual animal exposure is preferable to reliance on percent replacement of another dietary ingredient.*

The maximum level of methanol in the notified substance is 0.004% (w/v). In 20mg/mL dried biomass no formaldehyde above the LOD could be detected. At a 10% maximum inclusion volume in the final animal feed, the levels would be as indicated in Table 9 below:

Table 9. Maximum levels of methanol and formaldehyde in the notified substance.

	Maximum amount in KBM (% w/v)	Maximum amount in feed using 10% KBM (Calculated level: % w/v)
Methanol	0.004	0.0004
Formaldehyde	<0.00004	<0.000004

LOD methanol: (b) (4) (w/v)

LOD formaldehyde: (b) (4) (w/v)

The levels of Methanol and Formaldehyde present in the notified substance are insignificant and not a safety concern.

With regard to formaldehyde, as an example, the product Formalin (a 37% solution of formaldehyde containing up to 15% methanol) has been approved by the FDA to control parasites in fin fish and shrimp hatcheries at levels up to 250ppm (0.0005% w/v) in the water (21 CFR 529.1030). As such, a safety assessment has been completed to permit these levels in the water for a short time.

In addition, a paper from 1997 (Tisler and ZagorcKoncan, 1997) found the 48h LC90 to be 87.0 mg/L (87 ppm) in water for juvenile rainbow trout (*Oncorhynchus mykiss*) which is ~87.0 ppm (0.015% w/v).

As described in the Narrative in KnipBio's original submission, formaldehyde levels were determined in three 1500L batches of the dried notified substance. Although the sample was concentrated 20X, formaldehyde could not be detected, based on the extrapolation of a standard curve established with known amounts of formaldehyde.

FDA has reviewed the safety of the use of a formaldehyde solution as a *Salmonella* control agent in animal feeds (all animal feeds) at a level of 5.4 pounds/ton of feed (0.27%) (see 21 CFR 573.460(b)(1)). Based on the fact that this formaldehyde solution contains only 37% formaldehyde, this is an effective level of 0.1% formaldehyde compound in feed (or 1000 ppm in feed).

In the finished commercial product KnipBio will specify on the label of the notified substance either that the levels of formaldehyde in the product are guaranteed to be below 0.00004% w/v (as currently measured) or that the levels of formaldehyde are in compliance with 21 CFR 573.460.

With regard to methanol, a literature search suggests that methanol has low toxicity to aquatic organisms as indicated on the Safety Data Sheet (SDS) below.

12. ECOLOGICAL MEASURES

Ecotoxicity:

Data for 100% Methyl Alcohol: Acute Toxicity to Fish - LC50 Fish (96 hours)

Minimum: 15000 mg/l

Maximum: 29400 mg/l

Median: 24000 mg/l

Study number: 8

Reference: Poirier, S.H., M.L. Knuth, C.D. Anderson-Buchou, L.T. Brooke, A.R. Lima, and P.J. Shubat 1986. Comparative Toxicity of Methanol and N,N-Dimethylformamide to Freshwater Fish and Invertebrates. Bull.Environ.Contam.Toxicol. 37(4):615-621; Bengtsson, B.E., L. Renberg, and M. Tarkpea 1984. Molecular Structure and Aquatic Toxicity – an Example with C1-C13 Aliphatic Alcohols. Chemosphere 13(5/6):613-622

A recent research article from Kaviraj *et al.* (Kaviraj, Bhunia and Saha, 2004) studied the toxicity of methanol in Tilapia and no significant difference in growth parameters could be observed in their 90-day chronic toxicity bioassay for a methanol concentration < 23.75 ppm (0.0000475 % w/v).

One can also note that the notified substance does not contain toxic heavy metals. As a comparison, the table below compares the notified substance with fish meal, one of the most important source of protein in aquaculture feed.

Table 10. Comparison of heavy metal levels in fishmeal and notified substance.

	Fishmeal*	Notified substance
Selenium ppm	2-5	< 0.1
Arsenic ppm	10	<0.05
Lead ppm	10	<0.05
Mercury ppm	0.5	<0.05

*(Adamse, Van der Fels-Klerx and de Jong, 2017)

2. *CVM indicated that the notifier did not address the potential for spillover effects resulting from the genetic engineering of the microbial strain in the notice. Data, such as the spectral analyses, fermentation end product analyses, and other information, may be able to address this point, i.e., that the deleted genetic material was not expressed in the parent strain and thus, there are no metabolic differences between the parent and engineered strains.*

There is no reason to believe that the limited genetic modifications KnipBio made to the parental strain had any spillover effects. As reported in the original GRAS Notice, KnipBio performed whole-genome sequencing of the production strain, and a comparison to the parental strain showed that there was no unexpected genetic rearrangement after the genetic manipulations performed (b) (4) (b) (4) In addition, as described above, KnipBio demonstrated that (b) (4) (b) (4) therefore suggesting that (b) (4) (b) did not result in spillover effect. Finally, KnipBio has been using and growing strain KB203 in its laboratories and in fermentors for more than 4 years and has never identified or noticed any adverse traits, certainly none that would affect the safety of the notified substance.

3. *CVM noted that the bioengineered organism may be viable when present in animal feed products. The notifier should clarify why the presence of these viable bioengineered cells is not a concern. Potential avenues would be to indicate that labeling will include processing instructions to address viability or again, to compare the engineered strain to its parent and explain how viability is not a concern.*

Although there is a possibility that there may be some viable cells in the KBM product, the downstream processing and pelletization will include high-temperature extrusion (process in which the mixed feed ingredients are cooked under high temperature (usually >100°C), moisture and high pressure within a short time) which will further decrease the number of these viable cells to approximately zero. Extrusion is a process in which the mixed feed ingredients are cooked under high temperature (usually >100°C), moisture and high pressure within a short time. In every test we have conducted to measure CFU formation using standard plate assays, we have found this process to be highly effective in eliminating viability. We have tested feed manufactured for shrimp and trout feeding trials and have not been able to recover any *Methylobacterium* microorganisms from these feeds, therefore KnipBio strongly believes that the notified substance will be depleted of live *Methylobacterium*.

We do not believe the engineered version of the strain has a competitive advantage as compared to the wild type in any way. Specifically, by eliminating the microbe's ability to produce bacterial cellulose, fermentations benefit from more thorough mixing and significantly less clumping. However, in nature, bacteria prefer to attach themselves to a surface in many cases. The engineered strain has a significantly lower ability to attach because of this modification and therefore would be expected to be outcompeted in a theoretical head-head match-up.

Additionally, we accept CVM's recommendation to include a requirement for pelleting the final feed in the directions for use of the final commercial product.

4. *CVM reported that the Hardy et al. reference became publicly available in April 2018. The final, published paper should be included in any amendment.*

A PDF copy of the published Hardy *et al.* paper (*Aquaculture Research* 2018 49:2218–2224), is attached as **Appendix 6**.

5. *The published article authored by Tlusty et al. is considered pivotal for target animal safety. The Tlusty article has inconsistencies/omissions within the section reporting the salmon study, such as actual biomass inclusion rate, test diet composition, references to tables, etc. Given this, the notifier should explain how it can be concluded that the studies in grunt and shrimp were adequate, well-controlled, and thus, suitable to support its conclusion.*

The studies discussed in the Tlusty article were independently conducted. The salmon study was restricted to a digestibility study and did not include a growth study. Diets and techniques used in the salmon digestibility study were described in Table 2 of the Tlusty paper and are based on the standard method described (Gaylord *et al.*, 2009). The experimental design of the salmon digestibility study included a 70%-30% diet with chromic oxide used as an inert marker. Experimental diet formulations were consistent with the experimental design in which two experimental diets were used: 1) the control diet and 2) the diets containing 70% control feed and 30% KBM. This is discussed on page 8 of the Tlusty paper (Digestibility of KBM using Atlantic salmon). Table 5 of the Tlusty paper provides the protein digestibility measurements as assessed by the formulas provided on page 9 of the paper. The study demonstrated that there was no significant difference between diet digestibility, protein digestibility or individual amino acid digestibility between the control diet and the diet containing 30% KBM. KnipBio has not discerned the concerns CVM has expressed regarding the quality of the reporting of the salmon study in the Tlusty paper, and wish to discuss this further if CVM continues to have concerns.

The shrimp diets in the growth studies sought to replace 50% and 100% of fishmeal (FM) of a diet considered to be commercially relevant and are described as % FM. These percentages correlate to an inclusion rate of 6.3% and 12.6% respectively. The diet formulation description is found in Table 1 of the Tlusty paper, which describes the inclusion rate as (g kg^{-1}).

Grunt diets are described similarly to the shrimp diets (g kg^{-1}) and are found in Table 3 of the Tlusty paper. The two experimental diets were 5% and 25% respectively and while there was a numeric increase in growth for grunts fed KBM at the higher inclusion rate, it is not considered statistically significant.

It may be that the difference in the way the Tlusty paper reported the inclusion rate is confusing, but we have full confidence that the studies were well-controlled and suitably designed and conducted in the aquaculture studies. All these trials were conducted by aquaculturists skilled in the science of animal husbandry, aquatic biology and mechanisms were in place to comply with IACUC standards. State of the art facilities at Roger Williams University and USDA-ARS were employed to conduct these trials. Tanks

were randomized appropriately, and diets were fed strictly according to protocol. The studies meet the requirement of an adequate and well-controlled experiment.

6. *The proposed NOEL for shrimp, based on the pivotal Tlusty article, is contradicted by the data/information present in the article. Data within the Tlusty article may support a use rate for KBM of 6%. It was discussed that shrimp growth was consistently decreased at higher inclusion rates for the biomass. The notifier stated that the shrimp diet used in the Tlusty study may have encountered a formulation error. CVM commented that if the diet was not formulated correctly, it may call into question the suitability of the study to support safety in shrimp. The notifier will consider how the proposed use rate could be supported with other data and information, potentially corroborative unpublished information.*

We note that the thrust of our safety and utility argument is based on the comparison of the composition of *Methylobacterium extorquens* biomass with conventional feed ingredients and feeds and is based on the compositional analysis. This is a typical approach for major ingredients in the diet. We are corroborating this assessment with live animal studies. Some of this corroborating data is found in the published paper (Tlusty *et al.*, 2017). However, in Appendix 2-11 and Table 2-8 of the original GRAS Notice, KnipBio provided a number of additional studies that can be used to corroborate the safety and utility of the biomass as a protein source.

CVM has specially questioned the support of the Tlusty article for the use of use of up to 10% of the diet with the *M. extorquens* biomass in shrimp diets. As you note, this paper reported that the shrimp on the high KBM diet (12.6% KBM) had a decreased growth rate; but an increase in feed conversion ratio, indicating that there was not an issue with availability of the nutrition of the *M. extorquens* biomass diet was observed. The Tlusty paper reported that air bubbles were seen in the pellets prepared for the shrimp diet SHR-KH (100% KBM replacement, which corresponds to a 12.6% inclusion for the total diet) and therefore the pellets likely did not properly sink in the water column while the other two diets (control and 6.3% inclusion) did. Shrimp are bottom feeders and it is very likely that the shrimp that were fed the high inclusion biomass received fewer available pellets in the water column, which may account for the reduced weight gain and SGR.

However, other adequate and well-controlled studies have corroborated the safety and availability of the notified substance for Pacific White Shrimp. In another recently completed study (**Appendix 7**) the notified substance KBM was fed at 0, 6, 13.3 and 26.6 % of the feed. The study included a growth trial (using the four identified diets) and demonstrated no difference in growth between the 13.3% inclusion and the control group when expressed as biomass, mean weight, weight gain or feed conversion ratio.

Table 2-8 in the submitted GRAS Notice and the companion Appendix 2-11, as well as the published Tlusty study clearly demonstrated that the notified substance is an available and safe protein source when fed at levels up to 10% of the feed. The safety is corroborated by the University of Auburn growth study (2016—see GRAS Notice appendix 2-11) as well as another digestibility study from University of Auburn (2016—see appendix 2-11) at levels up to 12% of the diet.

Based on the totality of the data, the composition of the biomass, the published study, and the corroborative studies there is ample evidence to demonstrate that use of the notified substance at levels up to 10% in shrimp diets is safe.

7. *CVM also noted that the European Food Safety Authority's (EFSA) Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) published two scientific opinions in July, 2017; the publications were subsequently revised to include another author. In their publications, the FEEDAP expressed concerns about the safety of Escherichia coli and other gram negative bacterial biomasses intended to be fed to food producing animals. The notifier should explain how the information and conclusions within the FEEDAP documents impact their determination that the proposed use of the notified substance is GRAS. The publications are:*
    - *EFSA FEEDAP Panel. 2017. Scientific Opinion on the safety and nutritional value of a dried killed bacterial biomass from Escherichia coli (FERM BP-10941) (PL73 (LM)) as a feed material for pigs, ruminants and salmonids. EFSA Journal. 15:4935. https://doi.org/10.2903/j.efsa.2017.4935.*
    - *EFSA FEEDAP Panel. 2017. Scientific Opinion on the safety and nutritional value of a dried killed bacterial biomass from Escherichia coli (FERM BP-10942) (PT73 (TM)) as a feed material for pigs, ruminants and salmonids. EFSA Journal.15:4936. https://doi.org/10.2903/j.efsa.2017.4936.*

KnipBio thanks FDA for bringing these publications to our attention. We first note that these two publications ("the FEEDAP documents") are largely positive statements that certain strains of modified *E. coli* can be safely used in the European Union to produce a substance for use in animal feed. Although these documents expressed some uncertainties, there were few or no assertions that the *E. coli* biomass would have adverse effects on animals, or on humans ingesting products derived from such animals. Indeed, the panel's conclusions in both the FEEDAP documents included the statement "***The recipient strain E. coli K-12S B-7 is considered to be safe***." (*emphasis added*)

We further note that the FEEDAP documents produce absolutely no evidence to implicate gram-negative organisms other *E. coli* as having any adverse effects – the documents merely assert that products derived from other gram-negative microorganisms may pose similar issues as those considered in the FEEDAP documents, without providing any specifics or rationale in support of such assertions, much less the citation of any literature supporting the assertions.

Although KnipBio respectively contends that the FEEDAP documents do not add any tangible evidence or scientific arguments that are relevant to the safety assessment of the notified substance, we offer the following additional comments to distinguish any plausible concerns raised in the FEEDAP documents from the present safety assessment.

There are biological, physiological and taxonomic differences between *E. coli* and the species used to produce the notified substance, *M. extorquens.* There is no evidence that *M. extorquens* produces harmful endotoxins, lipopolysaccharides (LPS), or any other substance identical or similar to such

substances that are produced by some strains of *E. coli* or other Gram-negative microorganisms that are known to be pathogens. In fact, as KnipBio exhaustively set forth in the Narrative section of the original GRAS Notice, there is no evidence in the literature which implicates *M. extorquens* as having any pathogenic, toxic or other negative characteristics.

Gram-negative microorganisms are used as fish feed or to produce fish feed substances. For example, a species of *Methylococcus capsulatus* has been approved as a fish feed for use in the EU (product name: FeedKind). Although this species does not use methanol as a carbon source, it uses methane (which is converted to methanol by a methane monooxygenase enzyme with high requirement in copper). Another Gram negative alphaproteobacterium species used for aquaculture is *Rhodopseudomonas palustris* (Kim and Lee, 2000). Please also refer to a recently-published review article (Gamboa-Delgado and Márquez-Reyes, 2018) that summarizes the safe use of a variety of microbial species for aquaculture feed.

KnipBio believes that the conclusions of this literature review in the original GRAS Notice are more than sufficient to rebut the unspecific, hypothetical concerns expressed in the FEEDAP documents regarding hypothetical risks of unspecified Gram-negative species.

KnipBio would like to briefly address several specific comments in the FEEDAP documents pertaining to these hypothetical concerns. On page 9 of Document 2017.4935[1], EFSA says:

> The traits introduced [into the strain of *E. coli*] are well known and do not raise safety concern.

KnipBio's production organism has no added traits – only gene deletions.

Also on page 9 of Document 2017.4935, EFSA says:

> Southern or PCR analysis confirmed the absence of all full-length antibiotic resistance genes used during the entire genetic modification.

KnipBio has confirmed through whole-genome sequencing of the production organism that there is no antibiotic resistance gene present in the production organism. Similarly, this whole-genome sequencing showed that there was no unexpected genetic rearrangement after the genetic manipulations performed. Sequences of the regions of interest (*celA* and *crtCDF*) were included in Appendix 2-2 of the original GRAS Notice. KnipBio performed a BLAST search of the *M. extorquens* genome sequence against the Comprehensive Antibiotic Resistance Database (https://card.mcmaster.ca/) and did not find any hits (data can be provided on request).

On page 9 of Document 2017.4935, EFSA says:

[1] Although we reference only the 2017.4935 document, there are similar or identical statements in the 2017.4936 document as well.

> Bioinformatic analysis did not show any biologically relevant similarity to known allergens or toxins for any of the putative peptides that might be produced from the open reading frames …….

KnipBio performed a BLAST analysis of the entire *M. extorquens* genome against the database of toxins, and the results of that analysis were included in Appendix 2-2 of the original GRAS Notice. The *M. extorquens* genome has no homology to any known toxins. The question of similarity to allergens is of lower importance when fish are the target species. In addition, KnipBio has not introduced any heterologous open reading frames into the production organism, so there would not be expected to be any impact of the genetic engineering that might have introduced sequences coding allergens or toxins.

Finally, we note that also on page 9 of Document 2017.4935, EFSA makes the following comment which, contrary to the implication of the passages cited by CVM in the Meeting Minutes, is a confirmation that in spite of the hypothetical concerns, EFSA concluded that the *E. coli* strain in question could be used to produce an animal feed ingredient:

> Therefore, the product PL73 (TM), obtained from E. coli BP-10942, does not give rise to any safety concern with regard to the genetically modified strain from which it is made.

In conclusion, KnipBio maintains that there is nothing in the FEEDAP documents that implicates *M. extorquens* or any other specific gram-negative organism as being inherently hazardous or unsuited for use in production of animal feed ingredients, other than mere speculation. The FEEDAP documents make no assertions of lack of safety, nor do they remotely point to any specific features of any microorganism that might raise concerns. The documents merely call for such feed materials to be "assessed for safety", and that is exactly the process which FDA is currently undertaking, using the data and literature evidence presented by KnipBio.

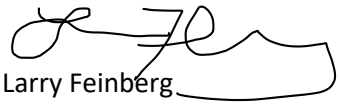
Molecular biology:

CVM indicated the notice states on page 8 that the spirilloxanthin pathway was deleted as described in published U.S. patent application US 14/454,816 (Feinberg and Marx, 2015), whereas on page 40 the patent is described as U.S. patent application 20150044327A1. The notifier should provide a copy of the patent.

A copy of this patent application is attached as **Appendix 8.** By way of clarification, 20150044327A1 is the Publication Number of this pending patent application, and USSN 14/454,816 is the Serial Number of this application. Thus, both numbers describe the same patent application. KnipBio regrets any confusion this differing nomenclature may have caused.

Thank you very much for the opportunity to address these questions. Please contact the under-signed if there are any additional questions we can address.

Sincerely,



Larry Feinberg
CEO

List of Appendices

Appendix 1. Spirilloxanthin methods and analysis (Confidential).

Appendix 2. Information about anti-foaming agent.

Appendix 3. ETA Letter re anti-foaming agent.

Appendix 4. Verification of PHB Assay (Confidential).

Appendix 5. Verification of Methanol and Formaldehyde Assay (Confidential).

Appendix 6. Copy of Hardy *et al*. paper.

Appendix 7. Corroborative shrimp data-FDA.

Appendix 8. U.S. Patent Application Publication Number 20150044327A1 (Serial Number USSN 14/454,816).

References:

Adamse, P., Van der Fels-Klerx, H. J. (Ine) and de Jong, J. (2017) 'Cadmium, lead, mercury and arsenic in animal feed and feed materials - trend analysis of monitoring results', *Food Additives & Contaminants: Part A*, 49, p. 19440049.2017.1300686. doi: 10.1080/19440049.2017.1300686.

Anthon, G. E., Barrett, D. M. and Arrett, D. I. M. B. (2004) 'Comparison of Three Colorimetric Reagents in the Determination of Methanol with Alcohol Oxidase . Application to the Assay of Pectin Methylesterase', *Society*, 52(12), pp. 3749–3753. doi: 10.1021/jf035284w.

Britton, G. and Pfander, H. (no date) 'Carotenoids', 1.

Chistoserdova, L. *et al.* (2003) 'MINIREVIEW Methylotrophy in *Methylobacterium extorquens* AM1 from a Genomic Point of View', *Journal of Bacteriology*, 185(10), pp. 2980–2987. doi: 10.1128/JB.185.10.2980.

Gamboa-Delgado, J. and Márquez-Reyes, J. M. (2018) 'Potential of microbial-derived nutrients for aquaculture development', *Reviews in Aquaculture*, 10(1), pp. 224–246. doi: 10.1111/raq.12157.

Gaylord, T. G. *et al.* (2009) 'Apparent digestibility of nutrients and energy in extruded diets from cultivars of barley and wheat selected for nutritional quality in rainbow trout Oncorhynchus mykiss', *Aquaculture Nutrition*, 15(3), pp. 306–312. doi: 10.1111/j.1365-2095.2008.00595.x.

Karr, D. B., Waters, J. K. and Emerich, D. W. (1983) 'Analysis of Poly-beta-Hydroxybutyrate in Rhizobium japonicum Bacteroids by Ion-Exclusion High-Pressure Liquid Chromatography and UV Detection.', *Applied and environmental microbiology*, 46(6), pp. 1339–1344.

Kaviraj, A., Bhunia, F. and Saha, N. C. (2004) 'Toxicity of Methanol to Fish, Crustacean, Oligochaete Worm, and Aquatic Ecosystem', *International Journal of Toxicology*, 23(1), pp. 55–63. doi: 10.1080/10915810490265469.

Kim, J. K. and Lee, B. K. (2000) 'Mass production of Rhodopseudomonas palustris as diet for aquaculture', *Aquacultural Engineering*, 23(4), pp. 281–293. doi: 10.1016/S0144-8609(00)00057-1.

Marx, C. J. *et al.* (2003) 'Novel methylotrophy genes of Methylobacterium extorquens AM1 identified by using transposon mutagenesis including a putative dihydromethanopterin reductase', *Journal of Bacteriology*, 185(2), pp. 669–673. doi: 10.1128/JB.185.2.669-673.2003.

Niedzwiedzki, D. M. *et al.* (2015) 'Functional characteristics of spirilloxanthin and keto-bearing Analogues in light-harvesting LH2 complexes from Rhodobacter sphaeroides with a genetically modified carotenoid synthesis pathway', *Biochimica et Biophysica Acta (BBA) - Bioenergetics*. Elsevier B.V., 1847(6–7), pp. 640–655. doi: 10.1016/j.bbabio.2015.04.001.

Ochsner, A. M. *et al.* (2014) 'Methylobacterium extorquens: methylotrophy and biotechnological applications', *Applied Microbiology and Biotechnology*, 99(2), pp. 517–534. doi: 10.1007/s00253-014-6240-3.

Papagiannakis, E. *et al.* (2002) 'An alternative carotenoid-to-bacteriochlorophyll energy transfer pathway in photosynthetic light harvesting.', *Proceedings of the National Academy of Sciences of the United States of America*, 99(9), pp. 6017–22. doi: 10.1073/pnas.092626599.

Siddaramappa, S. *et al.* (2018) 'Genomewide characterisation of the genetic diversity of carotenogenesis in bacteria of the order Sphingomonadales', *Microbial Genomics*, 4(4). doi: 10.1099/mgen.0.000172.

Stiefel, P., Zambelli, T. and Vorholt, J. a. (2013) 'Isolation of Optically Targeted Single Bacteria by Application of Fluidic Force Microscopy to Aerobic Anoxygenic Phototrophs from the Phyllosphere', *Applied and Environmental Microbiology*, 79(16), pp. 4895–4905. doi: 10.1128/AEM.01087-13.

Tisler, T. and ZagorcKoncan, J. (1997) 'Comparative assessment of toxicity of phenol, formaldehyde, and industrial wastewater to aquatic organisms', *Water Air and Soil Pollution*, 97(3–4), pp. 315–322. doi: Doi 10.1023/A:1026472313561.

Tlusty, M. *et al.* (2017) 'A transdisciplinary approach to the initial validation of a single cell protein as an alternative protein source for use in aquafeeds', *PeerJ*, 5, p. e3170. doi: 10.7717/peerj.3170.

Yurkov, V. V and Beatty, J. T. (1998) 'Aerobic anoxygenic phototrophic bacteria.', *Microbiology and molecular biology reviews : MMBR*, 62(3), pp. 695–724.

KnipBio

T-5

ATTN: Dr Carlacci

Center for Veterinary Medicine

Division of Animal Feeds

7519 Standish Place HFV220

Rockville MD 20855

8/9/18

Dear Dr Carlacci and team,

Please find enclosed KnipBio's Amendment to the GRAS notification AGRN26 including a copy of the appendices & references on this enclosed CD.

Thank you,

Larry Feinberg

CEO

KnipBio INC

110 Canal Street

Lowell MA 01852

Trull, Chelsea T-8

From: Carlacci, Louis
Sent: Friday, September 28, 2018 8:52 AM
To: Trull, Chelsea
Cc: Wong, Geoffrey K
Subject: FW: response to Amendment AGRN 26. (GRAS Submission # M-000059-Z-0006)
Attachments: USP Monographs_ Formaldehyde Solution.pdf; 180927 FDA Amendment FINAL.pdf; Appendix 5. CONFIDENTIAL.Revised Verification of Methanol and Formaldehyde Assay-Amendment2 -CPB DS 180925.pdf; CAS No 67-56-1.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Chelsea please file this amendment for submission M000059
Thank you.
Lou

Louis Carlacci, Ph.D.
Chemist
Ingredient Safety Team (HFV-224)
Division of Animal Feeds
Center for Veterinary Medicine
Ph 240-402-2921

From: Catherine Pujol-Baxley <cpb@knipbio.com>
Sent: Thursday, September 27, 2018 2:56 PM
To: Wong, Geoffrey K <Geoffrey.Wong@fda.hhs.gov>; Carlacci, Louis <Louis.Carlacci@fda.hhs.gov>
Cc: Kristi Smedley <smedley@cfr-services.com>; Larry Feinberg <lfeinberg@knipbio.com>
Subject: response to Amendment AGRN 26. (GRAS Submission # M-000059-Z-0006)

Dear Dr Wong and Carlacci,

please find enclosed KnipBio's response to the question raised about the amendment to GRAS notice AGRN 26.
We are also attaching a revised Appendix 5 as well as a copy of 2 new references that were used in our response.
We would like to thank the committee for their thorough review of our submission.

Please let us know should you have any question.

Sincerely,

KnipBio

--
Catherine J. Pujol-Baxley, PhD
VP of R&D

M2D2-4th floor
110 Canal Street- Lowell MA 01854
Email: cpb@knipbio.com | Office: +1 978-934-6339 | www.knipbio.com

Trull, Chelsea

From: Carlacci, Louis
Sent: Tuesday, October 02, 2018 2:50 PM
To: Trull, Chelsea
Subject: FW: KnipBio Amendment AGRN 26

Louis Carlacci, Ph.D.
Chemist
Ingredient Safety Team (HFV-224)
Division of Animal Feeds
Center for Veterinary Medicine
Ph 240-402-2921

From: Kristi Smedley <smedley@cfr-services.com>
Sent: Tuesday, October 02, 2018 1:29 PM
To: Carlacci, Louis <Louis.Carlacci@fda.hhs.gov>; 'Catherine Pujol-Baxley' <cpb@knipbio.com>
Cc: Wong, Geoffrey K <Geoffrey.Wong@fda.hhs.gov>; 'Larry Feinberg' <lfeinberg@knipbio.com>
Subject: RE: KnipBio Amendment AGRN 26

Lou:

Thank you for your call. You requested clarification on page 4, second paragraph (last sentence). That sentence you cited included two typos, and was intended to state "We have corrected the specification in Table 3 above to say that there is less than 0.3 mg methanol per gram of biomass. "

The changes are in red (above)

We apologize for the oversight on our part. We have supported the safety specification specific to 0.3 mg methanol /gram of biomass (as provided in table 3 on page 3).

Kristi O. Smedley, Ph.D.

Center for Regulatory Services, Inc.
5200 Wolf Run Shoals Rd.
Woodbridge, VA 22192

Ph. 703-590-7337
Cell (b) (6)
Fax 703-580-8637

From: Carlacci, Louis [mailto:Louis.Carlacci@fda.hhs.gov]
Sent: Tuesday, October 02, 2018 11:59 AM
To: Kristi Smedley; 'Catherine Pujol-Baxley'

Cc: Wong, Geoffrey K; 'Larry Feinberg'
Subject: KnipBio Amendment AGRN 26

Hi Kristi.
Based on our phone conversation this morning, would you respond to this email with the notifier's clarification. In the amendment dated September 27, 2018, the pdf file named 180927 FDA Amendment Final on page 4 of 9 states that the notifier has "corrected the specification in Table 9 above to say that there is less than 0.2 mg methanol per gram of biomass." However, this pdf file does not contain a Table 9 and the acceptance criterion established for methanol content in the provided specification (Table 3 page 3) is 0.300mg/gm.

Please do not send an updated file. Just provide the clarification in an email. I will delete the emails you sent this morning to clarify the issue.

Thank you.

Lou

Louis Carlacci, Ph.D.
Chemist
Ingredient Safety Team (HFV-224)
Division of Animal Feeds
Center for Veterinary Medicine
Ph 240-402-2921

KnipBio

September 27, 2018

Louis Carlacci, Ph.D.
Chemist, Ingredient Safety Team
Division of Animal Feeds
Center for Veterinary Medicine
U.S. Food and Drug Administration
7519 Standish Place
Rockville, MD 20855

RE: GRAS Notice No. AGRN 26

Dear Dr. Carlacci:

KnipBio, Inc., would like to thank you and your colleagues at CVM for the efficient conference call on September 18, 2018 regarding the amendment to GRAS Notice AGRN 26 and your request for response. We have received the meeting minutes for the call and have written our response to the issues raised below. In the remainder of this letter, CVM's comments and questions are shown in bold italics, followed by KnipBio's response. In some cases, revisions or differences from previously-submitted information are highlighted in yellow.

Background

The substance is Methylobacterium extorquens protein (or KBM) derived from genetically engineered Methylobacterium extorquens strain KB203 through fermentation and spray drying the biomass. This notice was filed February 7, 2018. FDA received an amendment dated August 9, 2018. The notice informs the FDA of KnipBio's view that Methylobacterium extorquens protein is GRAS through scientific procedures when used as a protein source in food for aquaculture species and when used at an intended use rate of up to 10% of the diet. The substance is intended to replace soybean or fish meal in the aquaculture diet. Minutes CVM indicated that we are interested in clarification on the data and information contained in the amendment dated August 9, 2018. We indicated that we believe that these can be addressed by the notifier in an additional amendment to the notice. The chemistry, manufacturing, and controls and target animal safety sections of the notice will need to be addressed in the amendment.

Chemistry, Manufacturing and Controls:

1. *We note that the notice currently states that the lead content is "<0.05[ppm]" but that a release specification does not include a test for lead. We recommend that a test for lead be included in the specification. If your firm concludes that a specification test for lead is appropriate, please provide a complete specification for the notified substance that includes the test for lead, acceptance criteria, and the AOAC method used for testing. Given the current finding of <0.05ppm lead, we recommend less than 0.05ppm lead. Given that a) methanol is the carbon source used for growth of*

Methylobacterium extorquens strain KB203, b) the specification for methanol (contained in Table 1 in the amendment dated August 9, 2018) has the lead content at no more than 1ppm, c) in the description of the source methanol contained in Table 2, the actual content of heavy metals as lead is 0.200ppm, and d) the measured lead content in the notified substance is less than 0.05ppm (which is the method detection limit), it is not clear from the description of the manufacture where the accumulated lead is separated from the manufactured substance and how this is controlled. Thus, we recommend a specification for the notified substance that includes a specification test for lead.

KnipBio provides the following response, to replace or supplement the response to FDA's question #3 in the August 9, 2018 Amendment.

The following Table shows the analysis of heavy metals in 3 batches of the notified substance, as performed by (b) (4) The column in the Table entitled "Methods" indicates the methods used by NJFL, identified by their AOAC reference numbers (http://www.aoac.org/).

Table 4 from the August 9, 2018 amendment. Heavy metal analysis in three batches of the notified substance.

	Method	Batch KB203-0616-2/8/17	Batch KB203-1016-2/8/17	Batch KB203-10615-5/16/17
Arsenic ppm	AOAC 990.08	(b) (4)		
Lead ppm	AOAC 990.08			
Mercury ppm	NJFL MERC.001			
Cadmium	AOAC 967.61			

As a quality control (QC) measure, KnipBio will determine at regular intervals (as determined necessary for assuring safety) that the amount of heavy metals (as lead) in each manufactured batch is below 0.05 ppm, using the AOAC method above.

Expressing the amount of methanol in mg/g of biomass, a revised Specification of the notified substance is shown in Edited Table 3 of the August 9, 2018 AGRN amendment.

Edited Table 3: Specification of the notified substance

	Method	Value
Moisture %	AOAC 930.15	<7
Protein (crude) %	AOAC 990.03	>50
PHB %	Adapted from Karr *et al.* (1983)	< 25
Methanol (mg/g)	Adapted from Anthon *et al.* (2004)	<0. 3
Lead ppm	AOAC 990.08	<0.05
Total coliform (cfu/g)	MFHPB-34	<5
Appearance (color)		Light pink to reddish color
Appearance (form)		Fine powder

2. Please clarify the interpretation of the methanol testing data in the amendment dated August 9, 2018. In Tables 3 and 7 on pages 4 and 8 (and other locations) in pdf file Appendix 5, the units for methanol content is reported as "% (w/v)." However, the content units are actually mg/ml, which is verified by multiplying the methanol content as % v/v by 792mg/ml (density of methanol) and dividing by 100%. As a result, the maximum methanol content in the notified substance as reported in Table 7 (and in the specification) is 0.00396mg/ml and not 0.00396% (w/v). In addition, the linearity higher limit in Table 3 is incorrectly stated. It should be 0.025%v/v. Please verify the following calculation to determine the methanol content in units of milligrams methanol per milligrams of the notified substance (which is the form requested in the specification). The sample solutions used in testing were derived from sonication of a solution containing 20mg dry cell biomass per milliliter of solution and separation of the supernatant. The sample solution is diluted to give the test solution. According to Table 7 on page 8, the maximum possible methanol content in the sample solution is 0.0005%v/v or 0.00396mg methanol per milliliter sample solution. The amount of methanol in the dried biomass is 0.020% (w/w) (or (100% × 0.00396mg/ml) / (20mg biomass/ml)). Note, the notice states that there is less than 0.00125% MeOH (0.01mg/mL) in the notified substance. We recommend the specification acceptance criterion for methanol content in terms of mg methanol per mg dried biomass (or corresponding percentage or ppm).

The following is KnipBio's response:

KnipBio would like to thank Dr Carlacci and the committee for detecting the unit inconsistencies and the edits to capture these changes are highlighted below as well as in the Revised Appendix 5 attached with this letter.

KnipBio has developed a method to test the amounts of methanol in spray dried batches of biomass by adapting a colorimetric method commonly used for quantifying methanol in aqueous solutions (Anthon GE and DM Barrett (2004) J. Agricultural & Food Chemistry 52(12):3749-53).

Methanol is not expected to be in high concentrations at the end of methanol fermentation of *Methylobacterium extorquens* due to the residual enzyme activities from multiple methanol oxidases and formate activating enzyme. Moreover, methanol which is much more volatile than water (vapor pressure 13.02 kPA vs 2.34 kPa at 20 °C), would be expected to evaporate during spray drying, drum drying, or lyophilization.

The extracted methanol was detected in volume percent (% v/v). Using the density of methanol (0.792 g/mL), volume percent was converted to mg per mL methanol. To determine the mg methanol per gram biomass, the mg/mL methanol value was divided by the mg/mL of the suspended biomass that was extracted and the number was multiplied by 1000.

Based on these calculations, we edited the tables from Appendix 5 of Amendment AGRN 26 (A revised version of Appendix 5 is attached at the end of this letter). Edits are highlighted below. More specifically, we have corrected the issues of units in Tables 3, 5, and 7, and also added the calculated mg methanol per gram of biomass. We have also clarified the units in the text and the table columns throughout Appendix 5. We have corrected the specification in Table 9 above to say that there is less than 0.2 mg methanol per gram of biomass.

The "linearity higher limit" in Table 3 is 0.25% v/v as was described in the text. Table 1 in Appendix 5 had an error and has been corrected to reflect that the standard range used in experiments was 0.005% to 0.25% (v/v) methanol.

The edited Table 3 from Appendix 5 of the August 9, 2018 amendment below summarizes the Linearity and LOD of the methanol measurement in the standard assay.

Edited Table 3. Linearity and LOD summary.

MW Methanol: 32.04 g/mol

	% (v/v)	mM	% (w/v)	mg/mL
Linearity lower limit	0.005	1.23	0.00396	0.0396
Linearity higher limit	0.25	61.74	0. 198	1.98
Limit of detection	0.0003125	0.077	0.0002475	0.002475

Edited Table 5. Maximum possible methanol possible in cell biomass from Experiment 2.

Sample	Feed	OD	DCW (mg)	(mg/mL) cell susp.	MeOH measured (% v/v)	MeOH measured (mg/mL)	mg MeOH / g biomass
1	Before	2.16	2.59	13.0	< 0.00125	< 0.0099	< 0.76
1	After	3.96	4.75	23.8	< 0.00125	< 0.0099	< 0.42
2	Before	3.18	3.82	19.1	< 0.00125	< 0.0099	< 0.52
2	After	4.33	5.20	26.0	< 0.00125	< 0.0099	< 0.38

The amount of methanol in 3 batches of spray dried biomass were measured

1. Sample 1 – June 2015 run
2. Sample 2 – May 2016 run
3. Sample 3 – October 2016 run

All the samples had very low, but linear increases (r^2 >0.8 to 0.98) in absorbance with increasing sample volume consistent with them having low amounts of methanol

The amount of Methanol in spray dried powder samples is presented in Table 7. Conversion in mg methanol/g of biomass was done by using the standard methanol density of 0.792 g/mL.

Edited Table 7: Maximum possible methanol possible in cell biomass.

Sample	mg/mL cell resuspension	MeOH measured (% v/v)	MeOH measured (mg/mL)	mg MeOH / g biomass
P1 (June 2015 run)	20.0	0.00038	0.00301	0.15
P2 (May 2016 run)	20.0	< 0.0003125	< 0.002475	<0.12
P3 (Oct. 2016 run)	20.0	0.00050	0.00396	0.20

Target Animal Safety:

1. *Within the amendment to your GRAS Notice, please clarify the target animal safety section (TAS) item 7 on pages 24 to 26 to better connect the different aspects of your safety argument. CVM notes, in specific, that the firm should delete any statements indicating that the agency is conducting a safety assessment of their notified substance. The TAS narrative should be revised to make the firm's argument clear and comprehensive.*

KnipBio provides the following revised version of the section of the TAS found on pages 24-26 of the August 9, 2018 amendment:

KnipBio thanks FDA for previously bringing the following publications to our attention. A) *EFSA FEEDAP Panel. 2017. Scientific Opinion on the safety and nutritional value of a dried killed bacterial biomass from Escherichia coli (FERM BP-10941) (PL73 (LM)) as a feed material for pigs, ruminants and salmonids. EFSA Journal. 15:4935. https://doi.org/10.2903/j.efsa.2017.4935. B) EFSA FEEDAP Panel. 2017. Scientific Opinion on the safety and nutritional value of a dried killed bacterial biomass from Escherichia coli (FERM BP-10942) (PT73 (TM)) as a feed material for pigs, ruminants and salmonids. EFSA Journal.15:4936. https://doi.org/10.2903/j.efsa.2017.4936.*

We note that these two publications ("the FEEDAP documents") are largely positive statements about the safe use in the European Union of certain strains of modified *E. coli* to produce a substance for use in animal feed. Although these documents expressed some uncertainties, there were few or no assertions that the *E. coli* biomass would have adverse effects on animals, or on humans ingesting products derived from such animals. Indeed, the panel's conclusions in both the FEEDAP documents included the statement "***The recipient strain E. coli K-12S B-7 is considered to be safe***." (*emphasis added*). The documents suggested that other Gram-negative bacterial biomass could not rely on the safety assessment for the *E. coli* K-12S B-7 and should undergo a safety assessment.

KnipBio has completed a safety assessment for the use of *M. extorquens*, a Gram-negative organism. We note that it does not share any of the potentially problematic traits of certain other gram-negative microorganisms.

In particular, there are biological, physiological and taxonomic differences between *E. coli* and *M. extorquens*. There is no evidence that *M. extorquens* produces harmful endotoxins, lipopolysaccharides (LPS), or any other substance identical or similar to such substances that are produced by some strains of *E. coli* or other Gram-negative microorganisms that are known to be pathogens. This assertion is based on the literature search as described in Part 6 of the original GRAS notification and details provided in the appendices to support section 6. This review covered several hundred of peer-reviewed literature characterizing the fundamental biology of this organism. It is KnipBio's position that we thoroughly established in the Narrative section of the original GRAS Notice that there is no evidence in the scientific literature implicating *M. extorquens* as having any pathogenic, toxic or other negative characteristics.

We would also like to highlight several features of *M. extorquens* that address certain comments in the FEEDAP documents. KnipBio has confirmed through whole-genome sequencing of the production organism that there is no antibiotic resistance gene present in the production organism. Similarly, this whole-genome sequencing showed that there was no unexpected genetic rearrangement after the genetic manipulations performed. Sequences of the regions of interest (*celA* and *crtCDF*) were included in Appendix 2-2 of the original GRAS Notice. KnipBio performed a BLAST search of the *M. extorquens* genome sequence against the Comprehensive Antibiotic Resistance Database (https://card.mcmaster.ca/) and did not find any hits (data can be provided on request).

Also, on page 9 of Document 2017.4935, the FEEDAP document expressed the importance of ascertaining that there were no putative peptides encoded by the microorganism that have similarity to allergens or toxins. KnipBio performed a BLAST analysis of the entire *M. extorquens* genome against the database of toxins, and the results of that analysis were included in Appendix 2-2 of the original GRAS Notice. The *M. extorquens* genome has no homology to any known toxins. The question of similarity to allergens is of lower importance when fish are the target species. In addition, KnipBio has not introduced any heterologous open reading frames into the production organism, so there would not be expected to be any impact of the genetic engineering that might have introduced sequences coding allergens or toxins.

Finally, we note that also on page 9 of Document 2017.4935, the FEEDAP document makes the following comment which we believe is a confirmation that in spite of the hypothetical concerns, EFSA concluded that the *E. coli* strain in question could be used to produce an animal feed ingredient:

> Therefore, the product PL73 (TM), obtained from E. coli BP-10942, does not give rise to any safety concern with regard to the genetically modified strain from which it is made.

Some Gram-negative microorganisms are used as fish feed or to produce fish feed substances. For example, a species of *Methylococcus capsulatus* has been approved as a fish feed for use in the EU (product name: FeedKind). Although this species does not use methanol as a carbon source, it uses methane (which is converted to methanol by a methane monooxygenase enzyme with high requirement in copper). A recently-published review article (Gamboa-Delgado, J. and Márquez-Reyes, J. M. (2018) 'Potential of microbial-derived nutrients for aquaculture development', *Reviews in Aquaculture*, 10(1), pp. 224–246) summarizes the safe use of a variety of microbial species for aquaculture feed.

In conclusion, KnipBio maintains that they have assessed the safety of *M. extorquens,* a Gram-negative microorganism, as suggested by the FEEDAP document. Our review confirms the safety of *M. extorquens* for use in production of aquaculture feed ingredients. The documents merely call for such feed materials to be "assessed for safety", an assessment that has been conducted by KnipBio, and is a part of the notice being provided to FDA.

We recommend that you consider the safety of methanol as a contaminant based on the manufacturing chemistry question raised on the expected higher maximum methanol content. You should present a clear discussion with data to support that higher maximum methanol content does not present a safety concern for your notified substance.

The following are KnipBio's responses:

The maximum level of methanol in the notified substance is 0.3 mg/g.

(It is important to note that although the specifications for methanol have been changed to be expressed as mg/gram of biomass, the overall level of methanol has not changed)

The following are revisions to those portions of the Target Animal Safety sections of the original GRAS Notice specific for methanol, as indicated.

Revision to PART 3 "Target Animal Exposure" of the original GRAS Notice, beginning on page 28.

Concentration of methanol in the notified substance. Although methanol is used as a feedstock in the fermentation of the microorganism comprising the notified substance, concentrations of methanol in the notified substance are expected to be extremely low, if detectable at all. As fermentation progresses, methanol in the growth media is converted to microbial biomass or otherwise metabolized and is therefore expected to be depleted in the natural course of the fermentation. Further, when collecting cells by centrifugation at the end of the run, it would be expected that any remaining methanol would primarily be retained in the supernatant rather than the cell pellet.

Methanol levels have been tested in preparations of the notified substance. Dried KBM from the three 1500L batches run was resuspended in a 20mg/mL 0.05X PBS and assayed for methanol according to the Nash Reagent Absorbance and Alcohol oxidase method (See Appendix 3-4). Based on the extrapolation of a standard curve established with known amounts of methanol, this assay potentially allows the detection of methanol in the samples at concentrations as low as 0.005% (v/v) or 0.04mg/ml. Since the samples were run at a 16X concentration compared to the standards, where the highest signal seen was equivalent to 0.0005% (v/v) or 0.004mg/mL, the highest amount of methanol detected in the samples was 0.2mg per gram biomass. KnipBio is confident there is less than 0.3 mg methanol/gram biomass or 300 ppm in the notified substance. Since KBM will constitute no more than 10% of the total feed, the total potential methanol concentration will be less than 0.03 mg methanol/ gram feed (30 ppm) of the diet.

Methanol is a normal part of the diet as it is a component of fruits, vegetables and grains (EPA, 2013), and it is also a normal metabolite from food digestion. Based on various oral administration studies, EPA (EPA, 2013) determined that the NOAEL level was 500 mg/Kg bodyweight, based on subchronic studies

reviewed. Chronic studies exposing rats to methanol in drinking water (0-20,000 ppm) throughout their lifetime had no impact of viability. ("Overall, there was no pattern of compound-related clinical signs of toxicity, and the available data did not provide any indication that the control group was not concurrent with the treated group."). The review of these safety studies demonstrates that methanol is not toxic at levels found in potential methanol contaminated feed ingredients.

FDA's past regulatory actions appear to agree with EPA's overall safety assessment, that low levels of methanol in diet are not hazardous. Methanol contamination has been assessed in a number of products intended for animals. The most significant level of "contamination" is the use of methanol as a stabilizer in formalin (formaldehyde solution of 37%), in which methanol (USP, 2006) is generally added as a stabilizer at levels of 10-12%.

FDA has determined the safety of formalin as an animal drug for aquatic species and as a feed preservative in all feeds. 21 CFR 529.1030 permits the bathing of animals in concentrations of formalin at levels up to 2000 ul/l (which is equivalent to 200 ul methanol/liter) for brief periods of time. This level of methanol exposure is difficult to compare to feed specific methanol but suffice it to say the aquatic exposure for aquaculture species is magnitudes higher than a maximum level of 50 ppm in the complete feed.

21 CFR 573.460 covers the assessed level of formaldehyde in animal feed for various uses. The use as described in 21 CFR 573.460 (b)(1) is for maintaining feed Salmonella-negative. The permitted uses are for 2.5 Kg/ton of feed. Assuming that the formaldehyde product is stabilized by 10% methanol, this would be exposure of 0.25 Kg methanol/ton of feed or 0.025% methanol (250 ppm). This level of methanol contamination was permitted for all complete feeds for all animals.

Furthermore, according to a 2011 Position Paper from the UK Advisory Committee on Animal Feedingstuffs (UK Advisory Committee on Animal Feedingstuffs, 2011), citing (EFSA Panel on Contaminants in the Food Chain (CONTAM), 2010):

> In December 2010, EFSA published an Opinion on the use of glycerine as a co-product from biodiesel production from Category 1 animal by-products (ABP) and vegetable oils. EFSA stated that inclusion rates of glycerol are usually up to 15% of the diet of ruminants and up to 10% in non-ruminant diets, with no adverse effects on animal health. It also found that residual amounts of methanol (up to 0.5%) and sodium (up to 1%) had no adverse effects on animal health. However, a maximum level of 0.2% methanol is proposed for the EU Catalogue of Feed Materials required under Regulation 767/2009, but we envisage that any MPLS should only apply to category 3 tallow.

KnipBio therefore expects that methanol levels in the notified substance, which each batch below the limit of detection in the assay described above, will be below the maximum allowed concentration of 0.3 mg methanol/gram of biomass. This level of contamination will not provide a hazard.

Revision to PART 6, Narrative, Section 5(c)(ii), second paragraph, of the original GRAS Notice, beginning on page 50.

ii) Other Potential Contaminants

* * * * *

As discussed above, the concentrations of methanol and formaldehyde, which might arise in the notified substance due to its method of manufacture, are expected to be no more than 0.03% (300 ppm) and 0.0025% (25 ppm) respectively. Both substances are therefore expected to be present at levels below the maximum allowed under applicable regulations: for example 21 CFR 573.460(b)(1) for formaldehyde and methanol, as discussed in Section 3(a)(3) above.

2. *Intended Use: The firm should clarify the intended target animal species. CVM notes that in Part 1, the firm indicates the notified substance will be used in fish diets, but use in other animal species is discussed elsewhere in the notice including the target animal safety section. The firm should address these inconsistencies and revise the notice*

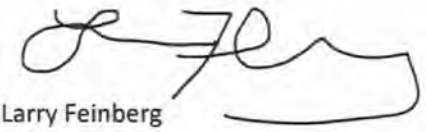
KnipBio appreciates the committee's keen eye: in the review of Part 1 section 4, the intended use is in aquaculture feed.

Revision to Part 1(4) "Intended conditions of use of the notified substance" of the Original GRAS Notice

The substance will be used as a replacement or soybean or fish meal, to constitute up to 10% of the diet in aquaculture feed.

Thank you very much for the opportunity to address these questions. Please contact the under-signed if there are any additional questions we can address.

Sincerely,



Larry Feinberg
CEO

References:
EPA, 2013. TOXICOLOGICAL REVIEW OF METHANOL (NONCANCER) (CAS No. 67-56-1) In Support of Summary Information on the Integrated Risk Information System (IRIS). September 2013

USP, 2006. Formaldehyde Solution. Page 967

Formaldehyde Solution
CH_2O 30.03

Formaldehyde.
Formaldehyde [*50-00-0*].

» Formaldehyde Solution in bulk containers contains not less than 37.0 percent, by weight, of formaldehyde (CH_2O), with methanol added to prevent polymerization. Formaldehyde Solution in small containers (4 liters or less) contains not less than 36.5 percent, by weight, of formaldehyde (CH_2O), with methanol present to prevent polymerization.

Packaging and storage— Preserve in tight containers, and preferably store at a temperature not below 15°.

Labeling— The label of bulk containers of the Solution directs the drug repackager to demonstrate compliance with the USP *Assay* limit for formaldehyde of not less than 37.0%, by weight, immediately prior to repackaging.

Identification—

A: Dilute 2 mL with 10 mL of water in a test tube, and add 1 mL of silver-ammonia-nitrate TS: metallic silver is produced either in the form of a finely divided, gray precipitate, or as a bright, metallic mirror on the sides of the test tube.

B: Add 2 drops to 5 mL of sulfuric acid in which about 20 mg of salicylic acid has been dissolved, and warm the liquid very gently: a permanent, deep-red color appears.

Acidity— Measure 20.0 mL into a flask containing 20 mL of water, add 2 drops of bromothymol blue TS, and titrate with 0.1 N sodium hydroxide VS: not more than 10.0 mL of 0.1 N sodium hydroxide is consumed.

Assay— Transfer about 3 mL of Solution to a tared flask containing 10 mL of water, insert the stopper in the flask tightly, and accurately determine the weight of the Solution taken. Slowly and quantitatively add a mixture of 50.0 mL of 1 N sodium hydroxide VS and 50 mL of hydrogen peroxide TS that has been previously neutralized to bromothymol blue TS with 1 N sodium hydroxide. Heat the contents of the flask cautiously on a steam bath for 15 minutes, shaking it occasionally with a rotary motion. Allow the mixture to cool, rinse the funnel and the inner wall of the flask with water, and after allowing it to stand for 30 minutes, add 2 to 5 drops of bromothymol blue TS, and titrate the excess alkali with 1 N sulfuric acid VS.

Perform a blank determination (see *Residual Titrations* under *Titrimetry* ⟨ 541 ⟩). Also make a correction based upon the acidity found in the test for *Acidity*. Each mL of 1 N sodium hydroxide is equivalent to 30.03 mg of CH_2O.

Auxiliary Information— *Staff Liaison* : Tina S. Morris, Ph.D., Senior Scientist
Expert Committee : (BBVV05) Biologics and Biotechnology - Vaccines and Virology
USP29–NF24 Page 967
Phone Number : 1-301-816-8397

Appendix 5

Amendment to AGRN 26 Revision

1. Background and Overall Summary

The purpose of the method is to test the amounts of methanol and formaldehyde in spray dried batches of biomass by adapting a colorimetric method commonly used for quantifying methanol in aqueous solutions that was published by Anthon and Barret (1). To test for methanol, an alcohol oxidase from *Pichia pastoris* is first used to convert methanol to formaldehyde prior to adding the Nash reagent (2). The Nash reagent is a mixture of acetylacetone and ammonia which reacts specifically with formaldehyde to produce a chromophore that can be detected with absorbance or fluorescence. To test for formaldehyde, samples are simply mixed with the Nash reagent.

Formaldehyde and methanol are not expected to be in high concentrations at the end of methanol fermentation of *Methylobacterium extorquens* due to the residual enzyme activities from multiple methanol oxidases and formate activating enzyme (3-5). Furthermore, any residual formaldehyde is expected to react with proteins, lipids, and other compounds in the biomass. Methanol which is much more volatile than water (vapor pressure 13.02 kPA vs 2.34 kPa at 20 °C), would be expected to evaporate during spray drying, drum drying, or lyophilization.

Summary:
Below are several experiments in which we adapt and verify a published method (1) to measure methanol and formaldehyde in dried cellular biomass. Our modifications are:

(1) To extract any cellular methanol or formaldehyde, we resuspend the dried biomass in dilute phosphate buffered saline (PBS) and subject the cellular material to freeze thaw cycles that is frequently used to lyse bacterial cells. The mixture is pelleted, and the resulting supernatant is tested for methanol or formaldehyde as described above.
(2) To test for lower amounts of methanol or formaldehyde, we include higher amounts of the sample in the reaction relative to the standards. If we add 2ul of a standard and 16uL of a sample and correct for volume changes, we should be able to measure formaldehyde or methanol 8 folds lower.

However, based on the data herein, we can state that the levels of methanol and formaldehyde detected from extractions of resuspended biomass samples (20 mg/mL) are less than 0.0004% (w/v) and below the limit of detection (0.00004 % w/v), respectively. These equate to less than 0.2 mg methanol or 0.02 mg formaldehyde per gram biomass.

2. Methanol Summary

In Experiments 1-3 below, we show our modification and verification of the method of Anthon and Barret (1) to attempt to measure methanol in spray dried biomass.

We established the linearity of the detection between (b) (4) and (b) (4) (w/v) and demonstrate that by increasing sample volumes relative to standards, it is possible to detect methanol as low as 0.002475% (w/v). We show that the methanol detected is specific in spray dried samples when spiked in at 0.05 and 0.005% (v/v).

Three powder biomass samples were resuspended to 20mg/mL and subjected to freeze thaw lysis to ensure the methanol present is in solution and tested exhaustively to try and determine the amount of methanol present. Based on the data in this experiment, the safest estimate of methanol present is less than 0.004% (mg/mL) or 0.0004% (w/v) per 20 mg biomass. These equate to less than 0.2 mg methanol per gram biomass (200ppm).

3. *Experiment 1: Determining linearity and LOD*

Rationale:

(1) Determine the linearity of methanol method using standards of (b) (4) to (b) MeOH (v/v) ((b) (4) mM).
(2) Determine the effects on linearity of increasing sample volume relative to standard volume to detect lower amounts of methanol.

Acceptance criteria:

Linearity is achieved if the standards from 0.005 to 0.25% (v/v) methanol have a $r^2 > 0.99$. For testing if increased samples give responses that are linear with their expected concentration a $r^2 > 0.95$ is considered acceptable.

Results:

Table 1 below shows at least three assays for three different users where linearity was achieved. When linearity is below our acceptance criteria of $r^2 < 0.99$ (**bold**ed values), it is usually due to the highest standard of 0.25% MeOH. When this standard is removed r^2 increases to over 0.99. Typically, samples measuring outside the acceptable linear range, such as those giving values above 0.25% or below 0.005%, are discarded. They are retested following dilution, or a larger amount of the sample is compared to the standard (see below). As in (1), 0.25% ethanol, acetone, or 2-propanol did not have any signal above the alcohol free blank (data not shown).

Table 1: Linearity results from three users of methanol method standards

User	r^2	% y intercept of 0.1% MeOH response	Standard range used in experiments (% v/v)	r^2 without 0.25% standard	Date
User 1	(b) (4)				170627
User 1					170628
User 1					170711
User 1					170712
User 2					180305
User 2					180419
User 2					180501
User 2					180523
User 3					180726

User 3	(b) (4)	180726
User 3		180727

The standard reaction uses 2uL of the standard solution in a total volume of 202 ul, making the effective concentration of the standards between 0.0122 to 0.611mM. To measure lower concentrations, 4, 8, 16, or 32ul of sample can be used. After taking into account the increased volume, the percent methanol can be measured below 0.005% (v/v).

Table 2 below lists three experiments where the volume of the lower concentration standards was increased to 4, 8, 16, or 32uL. A linear fit between the expected value and the corrected response was generally good with $r^2 > 0.975$. Thus, increasing the sample amount relative to the standard allows measuring methanol in the ug/mL range.

Table 2. Linearity results of samples at different volumes and lowest possible detectable limits

Experiment	% (v/v) Standard diluted	vol standards within range	r^2	Lowest Detectable % (v/v)	Lowest Detectable (mM)	Lowest detectable (mg/mL)
1A	(b) (4)					
1A						
1A						
1A						
1B						
1B						
1B						
1B						
1C						
1C						

Table 3. Linearity and LOD summary

	% (v/v)	mM	% (w/v)	mg/mL
Linearity lower limit	0.005	1.23	0.00396	0.0396
Linearity higher limit	0.25	61.74	0.198	1.98
Limit of detection	0.0003125	0.077	0.0002475	0.002475

MW Methanol:32.04 g/mol
Density: 0.792 g/mL

4. *Experiment 2: Determination of the specificity and accuracy measurement.*

Rationale:
Test for specificity, accuracy, linearity, and limit of detection of methanol from cells grown in flask in absence of presence of methanol. Determine specificity using methanol spiked samples

Experimental Design:
We utilized the following samples:

1. KB203 grown with methanol as the sole carbon source.

- Culture used for inoculation was grown in minimal medium with 0.5% methanol.
- Culture used for assay was inoculated with preculture of OD_{600} 0.05 into minimal media amended with 0.5% methanol.
- Cultures were fed an additional 0.5% methanol after 23 hours growth.
- Cell pellets from 4mL culture and culture supernatants were collected before feeding, where most of the initial methanol was depleted, and 3.5 hours after feeding.

2. KB203 grown with succinate as the sole carbon source.
   - Culture used for inoculation was grown in minimal medium with 30mM succinate.
   - Culture used for assay was inoculated with preculture of OD_{600} 0.05 into minimal media amended with 30mM succinate.
   - Cultures were fed an additional 30mM succinate after 23 hours growth.
   - Cell pellets from 4 mL culture and culture supernatants were collected before feeding, where most of the initial succinate was depleted, and 3.5 hours after feeding.

Sample processing:
All cell pellets were washed with 1mL 0.05X PBS. Following re-pelleting and removing the wash, the pellets were saved at -20°C until analysis. For analysis, cell pellets were resuspended by adding 200uL 0.05X PBS and mixing by pipetting.

To one tube of each cell pellet and culture supernatant, 1uL of 10% Methanol was added to spike in ~0.05% methanol. To one tube of each cell pellet after feeding, 10ul of 1mg/mL formaldehyde was added to spike in approximately 1.6mM formaldehyde (~0.048%) (see experiment 5). All cell pellet resuspensions were subjected to three freeze thaw cycles of at least ten minutes in a dry ice ethanol slurry and three minutes of bath sonication at room temperature. Following centrifugation at 15,000xG for 2 minutes, approximately 150uL of supernatant was transferred to a second tube and tested or methanol or formaldehyde levels. Samples were tested at 2, 4, 8, volumes relative to the 2uL standard volume.

Acceptance criteria:
Specificity is met if samples grown without methanol (succinate) have no detectable methanol in their supernatant and no detectable methanol in their cells. Spiked samples of methanol in succinate supernatants should be within 10% of the theoretical value. Accuracy is met if spiking of methanol results in methanol response that is within 10% of the theoretical value. Linearity is met if $r^2 > 0.95$ when comparing the measured methanol concentration of samples with increased volume relative to standards to their expected concentration.

Results:
None of the cells grown in methanol or succinate showed any detectable methanol (See Table 4). As expected the supernatant of the succinate grown cultures did not have detectable levels of methanol.

In the MeOH spiked samples, less MeOH than expected was seen for all cells, including succinate, suggesting possible residual methanol oxidase activity. Evidence that this activity is ablated in the spray drying process is given in Experiment 3 below. The succinate sample 2, did

have the expected amount of methanol in the spiked supernatant samples from before and after feeding, suggesting it did not have extracellular methanol oxidase activity.

In most cases, the linearity was acceptable when comparing the theoretical and measured amounts when samples were measure at 2, 4, and 8ul. Exceptions (**bold** in Table 4) were found in samples where the higher volume gave responses that were outside the linear range. Sample can thus be measured to at least 0.00125% (%v/v) methanol.

Table 4. Specificity and accuracy or addition of samples spiked with Methanol

sample	Feed	sample	Spike	% (v/v) MeOH	Linearity check r^2	Linearity check over .25%	Expected (% v/v)	Result (% v/v)	%Diff.
1	(b) (4)								
1									
1									
1									
1									
1									
1									
1									
2									
2									
2									
2									
2									
2									
2									
2									

Using the data above and the limit of detections tested, none of the cells from samples grown in flask had methanol greater than 0.76 mg per gram biomass (see Table 5 below). In subsequent experiments 3 and 4 below, we were able to determine methanol is even lower in dried powder because we use higher volumes of sample relative to the standards.

Table 5. Maximum possible methanol possible in cell biomass from Experiment 2

Sample	Feed	OD	DCW (mg)	(mg/mL) cell susp.	MeOH measured (% v/v)	MeOH measured (mg/mL)	mg MeOH / g biomass
1	(b) (4)						
1							
2							
2							

5. *Experiment 3: Testing for methanol and formaldehyde in spray dried biomass*

Rationale:

(1) Measure methanol and formaldehyde in spray dried biomass using the following samples:
   1. Powder 1 – June 2015 run
   2. Powder 2 – May 2016 run
   3. Powder 3 – October 2016 run

(2) Determine the minimum amount of methanol detectable by testing linearity of increasing sample volumes relative to standard volumes.

Sample Processing:

Powder was weighed and resuspended with 0.05X PBS to reach a concentration of 20mg/mL. The resuspension was aliquoted into two tubes of 200uL. To one tube of each powder, 1uL of 10% Methanol was added to spike in 0.05% methanol. All six tubes were subjected to three freeze thaw cycles of at least ten minutes in a dry ice ethanol slurry and three minutes of bath sonication at room temperature. Following centrifugation at 15,000xG for 2 minutes, approximately 150uL of supernatant was transferred to a second tube and tested or methanol. Samples were tested at 2, 4, 8, 16, 32uL volumes relative to the 2uL standard volume.

Acceptance criteria:

Linearity is met if $r^2 > 0.95$ when comparing the measured methanol concentration of samples with increased volume relative to standards to their expected concentration. Accuracy is met if spiking of methanol results in methanol response that is within 10% of the theoretical value.

Results:

All of the powders had very low, but linear increases (r^2 >0.8 to 0.98) in absorbance with increasing sample volume consistent with them having low amounts of methanol (Table 6). However, this increase in absorbance may also be due to proteins and other components.

The spiked samples had measured values that were on average 5.6% of the expected values (Table 6). Unlike the cells in Experiment 2 above, the spray dried powder has very little or no residual methanol oxidase activity. This is likely due to denaturation caused by heating during the spray dried process. The spiked samples also had acceptable linearity with increasing sample volumes (r^2 >0.995).

Table 6: Specificity and accuracy of samples of resuspended dried powder (20mg/mL) spiked with methanol at 0.05% (v/v)

	% (v/v) MeOH	Sample vol. used	Total vol.	Adjusted % (v/v) MeOH	Spike	r^2	sample volumes in range	Expected from spike (%v/v)	Measured from spike (%v/v)	%Diff
P1	(b) (4)									
P1										
P2										
P2										
P3										
P3										

The amount of Methanol in spray dried powders is presented in Table 7.

Table 7: Maximum possible methanol possible in cell biomass from Experiment 3

Sample	mg/mL cell resuspension	MeOH measured (% v/v)	MeOH measured (mg/mL)	mg MeOH / g biomass
P1 (June 2015 run)	(b) (4)			
P2 (May 2016 run)				
P3 (Oct. 2016 run)				

6. *Experiment 4: Formaldehyde*

Rationale:

(1) Determine the linearity of formaldehyde method using standards.
(2) Determine the effects on linearity of increasing sample volume.
(3) Determine the lowest amount of formaldehyde possible.

Acceptance criteria:

Linearity is achieved if the standards from 0.01 mg/mL (0.33mM) to 0.5 mg/mL (16.7mM) have a $r^2 > 0.99$. For testing if increased samples give responses that are linear with their expected concentration a $r^2 > 0.95$ is considered acceptable.

Results:

We generally have acceptable linearity when using formaldehyde standards of 0.01 mg/mL (0.001% w/v) to 0.5 mg/mL (0.05% w/v). Table 8 below shows several assays from different users. When linearity is below our acceptance criteria of $r^2 < 0.99$, it is usually due to a pipetting error. Samples outside the acceptable linear range, such as those giving values above 0.5 mg/mL or below 0.01 mg/mL are discarded. They are retested following dilution, or a larger amount of the sample is compared to the standard (see below). As expected (1), acetaldehyde did not increase response above background (not shown).

As in the Methanol assay, the amount of formaldehyde measured can be lowered by using more sample than standard. When tested between 0.00004% and 0.001% (w/v) linearity was an acceptable $r^2>0.9918$. Linearity of the samples describe in experiment 2 using 2, 10, 20uL sample

that were not outside the linear range were consistent with being able to measure lower concentrations by increasing sample volume (r^2 >.9551, 0.9532).

None of the extractions from the powders had any response above the LOD (0.00004% w/v) even when sample were 25 times greater than the formaldehyde standard (50uL sample volume).

Table 8: Linearity results from two users of formaldehyde method standards

	r^2	Background Corrected Response of 10mM	b	Percent y intercept of response	Standard range used (w/v)	Date
User 1	(b) (4)					
User 1						
User 1						
User 1						
User 2						
User 3						

References

1. Anthon GE and DM Barrett (2004) J. Agricultural & Food Chemistry 52(12):3749-53
2. Nash T (1953) Biochem. J. 55: 416 - 421.
3. Marx et al (2003) J. Bacteriology 185(24):7160-68
4. Chistoserdova et al (2003) J. Bacteriology 185(10):2980-2987
5. Oshser et al (2014) Appl Microbiology & Biotechnology 99(2):517-34

EPA/635/R-11/001Fa
www.epa.gov/iris

United States Environmental Protection Agency

TOXICOLOGICAL REVIEW

OF

METHANOL (NONCANCER)

(CAS No. 67-56-1)

In Support of Summary Information on the

Integrated Risk Information System (IRIS)

September 2013

U.S. Environmental Protection Agency
Washington, DC

DISCLAIMER

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

CONTENTS TOXICOLOGICAL REVIEW OF METHANOL (Noncancer)(CAS NO. 67-56-1)

CONTENTS TOXICOLOGICAL REVIEW OF METHANOL (Noncancer)(CAS NO. 67-56-1) iii

LIST OF TABLES v

LIST OF FIGURES vii

LIST OF ABBREVIATIONS AND ACRONYMS viii

AUTHORS, CONTRIBUTORS, AND REVIEWERS xvii

EXECUTIVE SUMMARY xxi
INTRODUCTION xxi
CHEMICAL AND PHYSICAL INFORMATION xxii
TOXICOKINETICS xxii
HAZARD IDENTIFICATION xxiv
DOSE-RESPONSE ASSESSMENT AND CHARACTERIZATION xxvi
RELATIONSHIP OF THE RFC AND RFD TO BACKGROUND METHANOL BLOOD LEVELS AND MONKEY BLOOD LEVELS ASSOCIATED WITH EFFECTS OF UNCERTAIN ADVERSITY xxviii

1...INTRODUCTION 1-1

2...CHEMICAL AND PHYSICAL INFORMATION 2-1

3...TOXICOKINETICS 3-1
3.1. OVERVIEW 3-1
3.2. KEY STUDIES 3-11
3.3. HUMAN VARIABILITY IN METHANOL METABOLISM 3-18
3.4. PHYSIOLOGICALLY BASED PHARMACOKINETIC MODELS 3-20
3.4.1. Model Requirements for EPA Purposes 3-20
3.4.2. Methanol PBPK Models 3-26
3.4.3. Selected Modeling Approach 3-27
3.4.4. Monkey PK Data and Analysis 3-32
3.4.5. Summary and Conclusions 3-33

4...HAZARD IDENTIFICATION 4-1
4.1. STUDIES IN HUMANS – CASE REPORTS, OCCUPATIONAL AND CONTROLLED STUDIES 4-1
4.1.1. Case Reports 4-1
4.1.2. Occupational Studies 4-3
4.1.3. Controlled Human Studies 4-5
4.2. ACUTE, SUBCHRONIC AND CHRONIC STUDIES IN ANIMALS – ORAL AND INHALATION 4-7
4.2.1. Oral Studies 4-7
4.2.2. Inhalation Studies 4-11
4.3. REPRODUCTIVE AND DEVELOPMENTAL STUDIES – ORAL AND INHALATION 4-20
4.3.1. Oral Reproductive and Developmental Studies 4-20
4.3.2. Inhalation Reproductive and Developmental Studies 4-23
4.3.3. Other Reproductive and Developmental Studies 4-40
4.4. NEUROTOXICITY 4-47
4.4.1. Oral Neurotoxicity Studies 4-47
4.4.2. Inhalation Neurotoxicity Studies 4-50

4.4.3. Neurotoxicity Studies Employing i.p. and in vitro Methanol Exposures 4-58
4.5. IMMUNOTOXICITY 4-63
4.6. SYNTHESIS OF MAJOR NONCANCER EFFECTS 4-68
4.6.1. Summary of Key Studies in Methanol Toxicity 4-68
4.7. NONCANCER MOA INFORMATION 4-77
4.7.1. Role of Methanol and Metabolites in the Developmental Toxicity of Methanol 4-78
4.7.2. Role of Folate Deficiency in the Developmental Toxicity of Methanol 4-83
4.7.3. Methanol-Induced Formation of Free Radicals, Lipid Peroxidation, and Protein Modifications 4-84
4.7.4. Exogenous Formate Dehydrogenase as a Means of Detoxifying the Formic Acid that Results from Methanol Exposure 4-88
4.7.5. Summary and Conclusions Regarding MOA for Developmental Toxicity 4-89
4.8. EVALUATION OF CARCINOGENICITY 4-90
4.9. SUSCEPTIBLE POPULATIONS AND LIFE STAGES 4-90
4.9.1. Possible Childhood Susceptibility 4-90
4.9.2. Possible Gender Differences 4-91
4.9.3. Genetic Susceptibility 4-92

5...DOSE-RESPONSE ASSESSMENTS 5-1
5.1. INHALATION REFERENCE CONCENTRATION (RFC) 5-1
5.1.1. Choice of Principal Study and Critical Effect(s) 5-1
5.1.2. Methods of Analysis for Identifying the POD—Application of PBPK and BMD Models 5-7
5.1.3. RfC Derivation – Including Application of Uncertainty Factors 5-16
5.1.4. Previous RfC Assessment 5-24
5.2. ORAL REFERENCE DOSE (RFD) 5-25
5.2.1. Choice of Principal Study and Critical Effect–with Rationale and Justification 5-25
5.2.2. RfD Derivation–Including Application of Uncertainty Factors 5-28
5.2.3. Previous RfD Assessment 5-29
5.3. UNCERTAINTIES IN THE INHALATION RFC AND ORAL RFD 5-30
5.3.1. Choice of Study/Endpoint 5-31
5.3.2. Choice of Model for BMDL Estimation 5-35
5.3.3. Route-to-Route Extrapolation 5-35
5.3.4. Statistical Uncertainty at the POD 5-36
5.3.5. Choice of Species/Gender 5-36
5.3.6. Relationship of the RfC and RfD to Background Levels of Methanol in Blood 5-38
5.3.7. Relationship of the RfC and RfD to Methanol Blood Levels In Monkeys Associated with Unquantifiable Effects of Uncertain Adversity 5-40
5.4. CANCER ASSESSMENT 5-42

6...REFERENCES 6-1

LIST OF TABLES

Table 2-1 Relevant physical and chemical properties of methanol. 2-1

Table 3-1 Background blood methanol and formate levels in human studies. 3-2

Table 3-2 Human blood methanol and formate levels following methanol exposure. 3-3

Table 3-3 Monkey blood methanol and formate levels following methanol exposure. 3-4

Table 3-4 Mouse blood methanol and formate levels following methanol exposure. 3-5

Table 3-5 Rat blood methanol and formate levels following methanol exposure. 3-6

Table 3-6 Plasma methanol concentrations in monkeys. 3-16

Table 3-7 Plasma formate concentrations in monkeys. 3-17

Table 3-8 Serum folate concentrations in monkeys. 3-17

Table 3-9 Routes of exposure optimized in models – optimized against blood concentration data. 3-27

Table 3-10 Key methanol kinetic studies for model validation. 3-30

Table 4-1 Mortality rate for subjects exposed to methanol-tainted whisky in relation to their level of acidosis. 4-2

Table 4-2 Reproductive and developmental toxicity in pregnant Sprague-Dawley rats exposed to methanol via inhalation during gestation. 4-25

Table 4-3 Reproductive parameters in Sprague-Dawley dams exposed to methanol during pregnancy, and then allowed to deliver their pups. 4-27

Table 4-4 Embryonic and Developmental effects in CD-1 mice after methanol inhalation. 4-30

Table 4-5 Benchmark doses at two added risk levels. 4-31

Table 4-6 Developmental Phase-Specific Embryotoxicity and Teratogenicity in CD-1 mice after methanol inhalation. 4-32

Table 4-7 Developmental phase-specific embryotoxicity in CD-1 mice induced by methanol inhalation (15,000 ppm) during neurulation. 4-33

Table 4-8 Reproductive parameters in monkeys exposed via inhalation to methanol during prebreeding, breeding, and pregnancy. 4-36

Table 4-9 Mean serum levels of testosterone, luteinizing hormone, and corticosterone (± SD) in male Sprague-Dawley rats after inhalation of methanol, ethanol, n-propanol or n-butanol at threshold limit values. 4-38

Table 4-10 Maternal and litter parameters when pregnant female C57BL/6J mice were injected i.p. with methanol. 4-41

Table 4-11 Developmental studies of rodent embryos exposed to methanol. 4-44

Table 4-12 Reported thresholds concentrations (and author-estimated ranges) for the onset of embryotoxic effects when rat and mouse conceptuses were incubated in vitro with methanol, formaldehyde, and formate. 4-46

Table 4-13 Brain weights of rats exposed to methanol vapors during gestation and lactation. 4-56

Table 4-14 Intraperitoneal injection neurotoxicity studies. 4-61

Table 4-15 Effect of methanol on Wistar rat acetylcholinesterase activities. 4-63

Table 4-16 Effect of methanol on neutrophil functions in in vitro and in vivo studies in male Wistar rats. 4-64

Table 4-17 Effect of intraperitoneally injected methanol on total and differential leukocyte counts and neutrophil function tests in male Wistar rats. 4-65

Table 4-18 Effect of methanol exposure on animal weight/organ weight ratios and on cell counts in primary and secondary lymphoid organs of male Wistar rats..... 4-67

Table 4-19 The effect of methanol on serum cytokine levels in male Wistar rats. 4-68

Table 4-20 Summary of noncancer effects reported in repeat exposure and developmental studies of methanol toxicity in experimental animals (oral). 4-69

Table 4-21 Summary of repeat exposure and developmental studies of methanol toxicity in experimental animals (inhalation exposure). 4-70

Table 4-22 Developmental outcome on GD10 following a 6-hour 10,000 ppm (13,104 mg/m^3) methanol inhalation by CD-mice or formate gavage (750 mg/kg) on GD8. 4-79

Table 4-23 Summary of ontogeny of relevant enzymes in CD-1 mice and humans. 4-80

Table 4-24 Dysmorphogenic effect of methanol and formate in neurulating CD-1 mouse embryos in culture (GD8)..... 4-81

Table 4-25 Time-dependent effects of methanol administration on serum liver and kidney function, serum ALT, AST, BUN, and creatinine in control and experimental groups of male Wistar rats. 4-87

Table 4-26 Effect of methanol administration on male Wistar rats on malondialdehyde concentration in the lymphoid organs of experimental and control groups and the effect of methanol on antioxidants in spleen. 4-87

Table 5-1 Summary of studies considered most appropriate for use in derivation of an RfC..... 5-7

Table 5-2 The EPA PBPK model estimates of methanol blood levels (AUC) adjusted for background (control) levels in rat dams following methanol inhalation exposures and reported mean brain weights of 6-week-old male pups. 5-12

Table 5-3 Maximum methanol blood levels (Cmax) adjusted for background, in mice following inhalation exposures to methanol along with the corresponding incidence of extra cervical ribs observed..... 5-14

Table 5-4 Summary of PODs for critical endpoints, application of UFs and conversion to candidate RfCs using PBPK modeling. 5-16

Table 5-5 Comparison of the lowest rodent and monkey methanol blood LOAELs (excluding background) observed in developmental neurotoxicity studies. 5-23

Table 5-6 Summary of PODs for critical endpoints, application of UFs and conversion to candidate RfDs using PBPK modeling. 5-29

Table 5-7 Summary of uncertainties in methanol noncancer assessment. 5-31

LIST OF FIGURES

Figure 3-1 Methanol metabolism and key metabolic enzymes in primates and rodents. 3-9

Figure 3-2 Folate-dependent formate metabolism. Tetrahydrofolate (THF)-mediated one carbon metabolism is required for the synthesis of purines, thymidylate, and methionine. 3-10

Figure 3-3 Plot of fetal (amniotic) versus maternal methanol concentrations in GD20 rats. 3-13

Figure 3-4 Conceptus versus maternal blood AUC values for rats and mice. 3-24

Figure 3-5 Schematic of the PBPK model used to describe the inhalation, oral, and i.v. route pharmacokinetics of methanol. 3-31

Figure 4-1 Exposure response array for noncancer effects reported in animals from repeat exposure and developmental studies of methanol (Oral). 4-72

Figure 4-2 Exposure response array for noncancer effects reported in animals from repeat exposure and developmental studies of methanol (Inhalation). 4-73

Figure 5-1 Fit of the Hill model to decreased mean brain weight in male rats at 6 weeks age using estimated AUC of methanol in blood (adjusted for background) as the dose metric. The BMD is estimated based on a BMR of one SD change from the control mean. 5-13

Figure 5-2 Fit of the nested logistic (NLogistic) model– to the incidence of extra cervical rib in fetal mice versus C_{max} adjusted for background of methanol in blood from a GD6-GD15 inhalation study in mice. The BMD is estimated based on a BMR of 0.05 extra risk 5-15

Figure 5-3 Projected impact of daily peak RfD and RfC exposures on sample background methanol blood levels (mg MeOH/Liter [mg/L] blood) in humans. 5-40

Figure 5-4 Relationship of monkey blood levels associated with effects of uncertain adversity with projected impact of daily peak RfC and RfD exposures on sample background methanol blood levels (mg MeOH/Liter [mg/L] blood) in humans. 5-42

LIST OF ABBREVIATIONS AND ACRONYMS

ACGIH	American Conference of Governmental and Industrial Hygienists
ADH	alcohol dehydrogenase
ADH1	alcohol dehydrogenase-1
ADH3	formaldehyde dehydrogenase-3
AIC	Akaike Information Criterion
ALD	aldehyde dehydrogenase
ALDH2	mitochondrial aldehyde dehydrogenase-2
ALT	alanine aminotransferase
ANOVA	analysis of variance
AP	alkaline phosphatase
AST	aspartate aminotransferase
ATP	adenosine triphosphate
ATSDR	Agency for Toxic Substances and Disease Registry
AUC	area under the curve, representing the cumulative product of time and concentration for a substance in the blood
β-NAG	N-acetyl-beta-D-glucosaminidase
Bav	oral bioavailability
BMD	benchmark dose(s)
BMD_{1SD}	BMD for response one standard deviation from control mean
BMDL	lower limit of a one-sided 95% confidence interval on BMD (benchmark dose)
$BMDL_{1SD}$	BMDL for response one standard deviation from control mean
BMDS	benchmark dose software
BMR	benchmark response
BSO	butathione sulfoximine
BUN	blood urea nitrogen
BW, bw	body weight
C_1 pool	one carbon pool
C_{max}	peak concentration of a substance in the blood during the exposure period
C-section	Cesarean section
CA	chromosomal aberrations
CAR	conditioned avoidance response
CASRN	Chemical Abstracts Service Registry Number
CAT	catalase
CERHR	Center for the Evaluation of Risks to Human Reproduction at the NTP
CH_3OH	methanol
CHL	Chinese hamster lung (cells)
CI	confidence interval
Cl_S	clearance rate
C_{max}	peak concentration
CNS	central nervous system
CO_2	carbon dioxide
con-A	concanavalin-A
CR	crown-rump length
CSF	Cancer slope factor
C_{ss}	steady-state concentration
CT	computed tomography
C_{VB}	concentration in venous blood
C_{VBbg}	background concentration in venous blood
C_{VBmb}	concentration in venous blood minus constant background
CYP450	cytochrome P450
d, δ, Δ	delta, difference, change
D_2	dopamine receptor
DA	dopamine
DIPE	diisopropyl ether
DMDC	dimethyl dicarbonate
DNA	deoxyribonucleic acid
DNT	developmental neurotoxicity test(ing)
DOPAC	dihydroxyphenyl acetic acid
DPC	days past conception
DTH	delayed-type hypersensitivity
EFSA	European Food Safety Authority
EKG	electrocardiogram
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERF	European Ramazzini Foundation
EtOH	ethanol
F	fractional bioavailability
F_0	parental generation
F_1	first generation
F_2	second generation
F344	Fisher 344 rat strain
FAD	folic acid deficient
FAS	folic acid sufficient
FD	formate dehydrogenase

FP	folate paired
FR	folate reduced
FRACIN	fraction inhaled
FS	folate sufficient
FSH	follicular stimulating hormone
γ-GT	gamma glutamyl transferase
g	gravity
g, kg, mg, μg	gram, kilogram, milligram, microgram
G6PD	glucose-6-phosphate dehydrogenase
GAP43	growth-associated protein (neuronal growth cone)
GD	gestation day
GFR	glomerular filtration rate
GI	gastrointestinal track
GLM	generalized linear model
GLP	good laboratory practice
GSH	glutathione
HAP	hazardous air pollutant
HCHO	formaldehyde
HCOO	formate
Hct	hematocrit
HEC	human equivalent concentration
HED	human equivalent dose
HEI	Health Effects Institute
HERO	Health and Environmental Research Online (database system)
HH	hereditary hemochromatosis
5-HIAA	5-hydroxyindolacetic acid
HMGSH	S-hydroxymethylglutathione
Hp	haptoglobin
HPA	hypothalamus-pituitary-adrenal (axis)
HPLC	high-performance liquid chromatography
HSDB	Hazardous Substances Databank
HSP70	biomarker of cellular stress
5-HT	serotonin
IL	interleukins
i.p.	intraperitoneal (injection)
IPCS	International Programme on Chemical Safety
IQ	intelligence quotient
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
i.v.	intravenous (injection)
k_l	first-order urinary clearance
k_lC	first-order urinary clearance scaling constant; first order clearance of methanol from the blood to the bladder for urinary elimination
k_{ai}	first order uptake from the intestine
k_{as}	first order methanol oral absorption rate from stomach
k_{bl}	rate constant for urinary excretion from bladder
k_{iv}	respiratory/cardiac depression constant
KLH	keyhole limpet hemocyanin
KLL	alternate first order rate constant
K_m	apparent Michaelis-Menten constant; substrate concentration at half the maximum velocity (V_{max})
k_{st}	first order transfer between stomach and intestine
L, dL, mL	liter, deciliter, milliliter
LD_{50}	median lethal dose
LDH	lactate dehydrogenase
LH	luteinizing hormone
LLF	(maximum) log likelihood function
LMI	leukocyte migration inhibition (assay)
LOAEL	lowest-observed-adverse-effect level
M, mM, μM	molar, millimolar, micromolar
MeOH	methanol
MLE	maximum likelihood estimate
M-M	Michaelis-Menten
MN	micronuclei
MOA	mode of action
4-MP	4-methylpyrazole (fomepizole)
MRI	magnetic resonance imaging
mRNA	messenger RNA
MTBE	methyl tertiary butyl ether
MTX	methotrexate
N_2O/O_2	nitrous oxide
NAD^+	nicotinamide adenine dinucleotide
NADH	reduced form of nicotinamide adenine dinucleotide
NBT	nitroblue tetrazolium (test)
NCEA	National Center for Environmental Assessment
ND	not determined
NEDO	New Energy Development Organization (of Japan)
NIEHS	National Institute for Environmental Health Sciences

NIOSH	National Institute for Occupational Safety and Health
nmol	nanomole
NOAEL	no-observed-adverse-effect level
NOEL	no-observed-effect level
NP	nonpregnant
NR	not reported
NRC	National Research Council
NS	not specified
NTP	National Toxicology Program at NIEHS
NZW	New Zealand White (rabbit strain)
OR	osmotic resistance
ORD	Office of Research and Development
OSF	oral slope factor
OU	oculus uterque (each eye)
OXA	oxazolone
P, p	probability
PB	blood:air partition coefficient
PBPK	physiologically based pharmacokinetic model
PC	partition coefficient
PEG	polyethylene glycol
PFC	plaque-forming cell
PK	pharmacokinetic
PMN	polymorphonuclear leukocytes
PND	postnatal day
POD	point of departure
ppb, ppm	parts per billion, parts per million
PR	body:blood partition coefficent
PWG	Pathology Working Group of the NTP of NIEHS
Q wave	the initial deflection of the QRS complex
Q_CC	cardiac output scaling constant
Q_P	pulmonary (alveolar) ventilation
QRS	portion of electrocardiogram corresponding to the depolarization of ventricular cardiac cells.
R^2	square of the correlation coefficient, a measure of the reliability of a linear relationship.
RBC	red blood cell
RfC	reference concentration
RfD	reference dose
RNA	ribonucleic acid
$R_{Øbg}$	zero-order endogenous production rate
ROS	reactive oxygen species
S9	microsomal fraction from liver
SAP	serum alkaline phosphatase
s.c.	subcutaneous
SCE	sister chromatid exchange
S-D	Sprague-Dawley rat strain
SD	standard deviation
S.E.	standard error
SEM	standard error of mean
SGPT	serum glutamate pyruvate transaminase
SHE	Syrian hamster embryo
SOD	superoxide dismutase
SOP	standard operating procedure(s)
T; $T_{½}$, $t_{½}$	time; half-life
T wave	the next deflection in the electrocardiogram after the QRS complex; represents ventricular repolarization
TAME	tertiary amyl methyl ether
TAS	total antioxidant status
Tau	taurine
THF	tetrahydrofolate
TLV	threshold limit value
TNFα	tumor necrosis factor-alpha
TNP-LPS	trinitrophenyl-lipopolysaccharide
TRI	Toxic Release Inventory
U83836E	vitamin E derivative
UF(s)	uncertainty factor(s)
UF_A	UF associated with interspecies (animal to human) extrapolation
UF_D	UF associated with deficiencies in the toxicity database
UF_H	UF associated with variation in sensitivity within the human population
UF_S	UF associated with subchronic to chronic exposure
V_d	volume of distribution
V_{max}	pseudo-maximal velocity of metabolism
$V_{max}C$	multiplier for allometric scaling of V_{max}
VDR	visually directed reaching test
VitC	vitamin C
VPR	ventilation perfusion ratio
v/v	volume of solute/volume of solution
VYS	visceral yolk sac
WBC	white blood cell
WOE	weight of evidence
w/v	weight (mass of solute)/volume of solution
χ^2	chi square

AUTHORS, CONTRIBUTORS, AND REVIEWERS

Assessment Team	
Jeffrey Gift, Ph.D. (Chemical Manager) J. Allen Davis, MSPH	U.S. EPA/ORD/NCEA Research Triangle Park, NC
Paul Schlosser, Ph.D.	U.S. EPA/ORD/NCEA Washington, DC

Scientific Support Team	
Jane Caldwell, Ph.D. *J. Michael Davis, Ph.D. Robert Dewoskin, Ph.D., DABT *Angela Howard, Ph.D. Jennifer Jinot, Ph.D. Eva McLanahan, Ph.D. Connie Meacham, M.S. Reeder Sams, II, Ph.D.	U.S. EPA/ORD/NCEA Research Triangle Park, NC
*Stanley S. Barone, Jr., Ph.D. Ted Berner, M.S. *Chad Thompson, Ph.D., MBA Paul D. White, Ph.D.	U.S. EPA/ORD/NCEA Washington, DC
Marina Evans, Ph.D. John Rogers, Ph.D.	U.S. EPA/ORD/NHEERL Research Triangle Park, NC
*Hugh Barton, Ph.D.	U.S. EPA/ORD/NCCT Research Triangle Park, NC

*Formerly at EPA-NCEA.

Production Team	
*Ellen Lorang, M.S. *Deborah Wales Richard N. Wilson	U.S. EPA/ORD/NCEA Research Triangle Park, NC
*J. Sawyer Lucy	U.S. EPA/ORD/NCEA Student Services Contractor Research Triangle Park, NC
Kenneth J. Breito *Mark Greenberg, Ph.D. Barbara Wright	U.S. EPA/ORD/NCEA Senior Environmental Employment Program

*Formerly at EPA-NCEA.

Contractor Support	
Susan Goldhaber, M.S. Frank Stack Errol Zeiger, Ph.D.	Alpha-Gamma Technologies, Inc.
Torka Poet, Ph.D. Justin TeeGuarden, Ph.D.	Battelle, Pacific Northwest National Laboratories
Bruce C. Allen, M.S.	Bruce Allen Consulting
Robinan Gentry, M.S.	ENVIRON International
George Holdsworth, Ph.D. Lisa Lowe, Ph.D. Kan Shao, Ph.D. Lutz Weber, Ph.D., DABT	Oak Ridge Institute for Science and Education
Annette Iannucci, M.S.	Sciences International, Inc.

Executive Direction

Kenneth Olden, Ph.D., Sc.D., L.H.D. Debra Walsh, M.S. Lynn Flowers, Ph.D., DABT Vincent Cogliano, Ph.D. Samantha Jones, Ph.D.	U.S. EPA/ORD/NCEA Washington, DC
John Vandenberg, Ph.D. Ila Cote, Ph.D., DABT Reeder Sams, Ph.D. Lyle Burgoon, Ph.D.	U.S. EPA/ORD/NCEA Research Triangle Park, NC

Reviewers

The methanol (noncancer) assessment was provided for review to scientists in EPA's Program and Region Offices. Comments were submitted by:

Office of Air Quality and Planning Standards, Research Triangle Park, NC
Office of Children's Health Protection, Washington, DC
Office of Policy, Economics, and Innovation, Washington, DC
Office of Solid Waste and Emergency Response, Washington, DC
Office of Water, Washington, DC

The methanol (noncancer) assessment was provided for review to other federal agencies and the Executive Office of the President. Comments were submitted by:

Agency for Toxic Substances Disease Registry, Centers for Disease Control and Prevention, Department of Health & Human Services
Council on Environmental Quality, Executive Office of the President
National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Department of Health & Human Services
Office of Management and Budget, Executive Office of the President
United States Department of Defense

The methanol (noncancer) assessment was released for public comment in April 2011 and a revised assessment was released for public comment in May 2013. A summary and EPA's disposition of the comments from the public is included in Appendix A. Comments were received from the following entities:

Kimberly Wise, Ph.D.	American Chemistry Council
Paul Noe	American Forest & Paper Association
Robert Glowinski	American Wood Council
Patrick Beatty, Ph.D., DABT	American Petroleum Institute
Greg Dolan	Methanol Institute
Steve Howell	National Biodiesel Board
Andrew G. Salmon M.A., D.Phil.*	Private Citizen
Lisa M. Sweeney, Ph.D., DABT*	Private Citizen
George Cruzan, Ph.D., DABT	ToxWorks

*Members of the 2011 peer review panel, who also provided public comments on the 2013 revised draft of the methanol (noncancer) toxicological review.

The methanol (noncancer) assessment was peer reviewed by independent expert scientists external to EPA and a peer-review meeting was held on July 22, 2011. A follow-up peer review was completed in July 2013 to obtain feedback from members of the original 2011 peer review panel (identified with an asterisk below) on the 2013 revised draft methanol (noncancer) toxicological review and EPA's response to the 2011 peer review comments. The original and follow-up external peer-review comments are available on the IRIS Web site. A summary and EPA's disposition of the comments received from the independent external peer reviewers is included in Appendix A.

Stephen Roberts, Ph.D. (Chair)**	University of Florida Gainesville, FL
Janusz Z. Byczkowski, Ph.D.**	Independent Consultant Fairborn, OH
Thomas M. Burbacher, Ph.D.	University of Washington Seattle, WA
David C. Dorman, Ph.D.	North Carolina State University-College of Veterinary Medicine Raleigh, NC
Kenneth McMartin, Ph.D.**	Louisiana State University Health Sciences Center Shreveport, LA
Andrew Salmon, Ph.D.	California EPA- Office of Environmental Health Hazard Assessment Lafayette, CA
Lisa M. Sweeney, Ph.D.	Henry M. Jackson Foundation for the Advancement of Military Medicine, Naval Medical Research Unit-Dayton Kettering, OH

**Members of the original 2011 peer review panel, who also reviewed the 2013 revised draft of the methanol (noncancer) toxicological review.

EXECUTIVE SUMMARY

Introduction

Methanol is a high production volume chemical with many commercial uses. It is a basic building block for numerous chemicals. Many of its derivatives are used in the construction, housing or automotive industries. Consumer products that contain methanol include varnishes, shellacs, paints, windshield washer fluid, antifreeze, adhesives, and deicers.

Methanol can be formed in the mammalian organism as a metabolic byproduct. Endogenous background levels [naturally generated from within the body] are not the same as exogenous exposure (exposure from a source outside the body), but the combination of endogenous background levels of methanol plus exogenous methanol exposure can lead to toxicity. Diet can contribute to background levels of methanol, principally from the ordinary ingestion of fruits and vegetables. This Toxicological Review provides scientific support and rationale for a hazard identification and dose-response assessment of the noncancer effects associated with chronic exposures to exogenous sources of methanol that add to background levels of methanol. For the purpose of this methanol (noncancer) assessment, EPA estimates that a diet that includes fruits and vegetables would not increase methanol blood levels above 2.5 mg/L (see discussion in Section 5.3.6). Thus, for a population with background blood levels of methanol at or below 2.5 mg/L, the inhalation reference concentration (RfC) and oral reference dose (RfD) that are derived in this assessment represent estimates (with uncertainty spanning perhaps an order of magnitude) of daily exposures to the human population (including sensitive subgroups) that are likely to be without an appreciable risk of deleterious effects during a lifetime. In Section 5 (Dose Response Assessments), the basis for a RfC of 2×10^{1} mg/m^3 and a RfD of 2 mg/kg-day are described.

This health assessment does not assess the potential carcinogenicity of methanol, or the health effects associated with background levels of methanol that arise from metabolic and dietary sources such as vegetables, fruits and juices that naturally contain methanol or have components (e.g., plant pectin) that convert to methanol. Hence, as discussed in Section 3.4.3.2 (Model Structure), responses observed in oral and inhalation studies of laboratory animals exposed to methanol are evaluated against blood concentrations of methanol after subtracting an estimate of the background blood levels in control animals.

Chemical and Physical Information

Methanol is the smallest member of the family of aliphatic alcohols. Also known as methyl alcohol or wood alcohol, among other synonyms, it is a clear, colorless, very volatile, and flammable liquid. Methanol is widely used as a solvent in many commercial and consumer products. It is freely miscible with water and other short-chain aliphatic alcohols but has little tendency to distribute into lipophilic media.

Toxicokinetics

Due to its very low oil:water partition coefficient, methanol is taken up efficiently by the lung or the intestinal tract and distributes freely in body water (blood volume, extracellular and intracellular fluid, etc.) without any tendency to accumulate in fatty tissues. Methanol can be metabolized completely to CO_2, but may also, as a regular byproduct of metabolism, enter the formic acid C_1-pool (1-carbon unit pool), and become incorporated into biomolecules. Animal studies indicate that blood methanol levels increase with the breathing rate and that metabolism becomes saturated at high exposure levels. Because of its volatility methanol can be exhaled with air, and also excreted unchanged via urine. As discussed in Section 3.1 (Toxicokinetics Overview), the enzymes responsible for metabolizing methanol are different in rodents and primates (Figure 3-1). Several published rat, mouse, and human PBPK models which attempt to account for these species differences are described in Section 3.4.2 (Methanol PBPK Models).

The development of methanol PBPK models was organized around a set of criteria, described in Section 3.4.1.2 (Criteria for the Development of Methanol PBPK Models), that take into account the dose routes used in key toxicity studies, the availability of pharmacokinetic information necessary for PBPK model development and the most likely toxicological mode of action (MOA). Specifically, EPA developed new PBPK models or modified the existing ones, which allowed for the estimation of monkey and rat internal dose metrics. A human model was also developed to extrapolate those internal metrics to inhalation and oral exposure concentrations that would result in the same internal dose in humans (human equivalent concentrations [HECs] and human equivalent doses [HEDs]). The procedures used for the development, calibration and use of these EPA models are summarized in Section 3.4 (Physiologically Based Pharmacokinetic Models), with further details provided in Appendix B, "Development, Calibration and Application of a Methanol PBPK Model."

Developmental malformations and anomalies in gestationally exposed fetal mice (and developmental neurotoxicity, as indicated by reduced absolute brain weight, in gestationally and lactationally exposed fetal and neonate rats) observed in inhalation studies are sensitive endpoints considered in the derivation of an RfC. However, questions remain regarding the

relative involvement of parent methanol, formaldehyde, and reactive oxygen species (ROS) in the MOA for these developmental effects. Given the reactivity of formaldehyde and the lack of relevant pharmacokinetic information, PBPK models that predict levels of formaldehyde (or subsequent metabolites of formaldehyde) in the blood would be difficult to validate.[1] However, the high reactivity of formaldehyde (see Section 3.1 [Toxicokinetics Overview]) would limit its unbound and unaltered transport as free formaldehyde from maternal to fetal blood (see discussion in Section 3.4.1.1 [MOA and Selection of a Dose Metric] and 4.7.1 [Role of Methanol and Metabolites in the Developmental Toxicity of Methanol]), and the ROS MOA requires the presence of methanol to alter embryonic catalase activity. Hence, it is likely that all of these MOAs require methanol to be present at the target site. For this reason, and because adequate pharmacokinetic information was available, PBPK models that estimate levels of parent methanol in blood were developed and validated for rats and humans. Because actual measured internal blood methanol levels suitable for use as estimates of peak concentrations (C_{max}) in mice were provided in the Rogers et al. (1993b) study, and these data were considered better than a predictive model, the mouse PBPK model was not used or discussed in detail in this toxicological review. A simple PK model for monkey methanol kinetics was also developed and used to evaluate the results of monkey developmental studies (Burbacher et al., 2004a; 2004b; 1999a; 1999b).

A pregnancy-specific PBPK model does not exist for methanol and limited data exist for the development and validation of a fetal/gestational/conceptus compartment. For this reason, and because levels of methanol in non-pregnant and pregnant adult females, and fetal blood (all measures of maternal exposure) are expected to be similar following the same oral or inhalation methanol exposure (see discussion in Section 3.4.1.2 [Criteria for the development of Methanol PBPK Models]), EPA developed and used non-pregnancy models for the appropriate species and routes of exposure for the derivation of candidate RfCs and RfDs. It is recognized that these models may not accurately represent neonate blood levels following the gestation, lactation and inhalation exposure regimen used in one of the key rat studies (NEDO, 1987), but they are considered appropriate for use in deriving HEC values from this study assuming the ratio of maternal to offspring blood methanol would be similar in rats and humans (see discussion in Sections 5.1.3.2.2 [Animal-to-Human Extrapolation UF_A]).

The rat and human methanol PBPK models fit multiple data sets for inhalation, oral, and i.v. exposures, from multiple research groups using consistent parameters that are representative of each species but are not varied within species or by dose or source of data. Also, a simple PK

[1] The PBPK models developed by EPA estimate total amount of methanol cleared by metabolic processes, but this has limited value as a metric of formaldehyde or formate dose since it ignores metabolic processes that may differ between species and between the mother and the fetus/neonate.

model calibrated to non-pregnant (NP) monkey data, which were shown to be essentially indistinguishable from pregnant monkey PK data, was used to estimate blood methanol area under the curve (AUC) values (internal doses) in that species. In the case of the mouse, a PK model developed from in vivo blood methanol levels in (Rogers et al., (1993b) resulted in more reliable estimates compared to the PBPK model and was used for derivation of effect levels in this species. Section 5 (Dose Response Assessments and Characterization) describes how the human PBPK model was used in the derivation of candidate RfCs and RfDs.

Hazard Identification

In humans, acute central nervous system (CNS) toxicity can result from relatively low ingested doses (as low as 3-20 mL of methanol), which can metabolize to formic acid and lead to metabolic acidosis. The resulting acidosis can potentially cause lasting nervous system effects such as blindness, Parkinson-like symptoms, and cognitive impairment. These effects have been observed in humans with blood methanol levels as low as 200 mg/L (Adanir et al., 2005).

CNS effects have not been observed in rodents following acute exposures to methanol, and NEDO (1987) reported that methanol blood levels around 5,000 mg/L were necessary to cause clinical signs and CNS changes in cynomolgus monkeys. The species differences in toxicity from acute exposures appear to be the result of a limited ability of humans to metabolize formic acid.

Occupational studies and case reports offer valuable information on the effects of methanol following acute human exposures, but the relatively small amount of data for subchronic, chronic, or in utero human exposures are inconclusive. However, a number of reproductive, developmental, subchronic, and chronic toxicity studies have been conducted in mice, rats, and monkeys.

Data regarding effects from oral exposure in experimental animals exist, but they are more limited than data from the inhalation route of exposure (see Sections 4.2 [Acute, Subchronic, and Chronic Studies in Animals – Oral and Inhalation], 4.3 [Reproductive and Developmental Studies – Oral and Inhalation], and 4.4 [Neurotoxicity]). Two oral studies in rats (Soffritti et al., 2002; TRL, 1986), one oral study in mice (Apaja, 1980) and several inhalation studies in monkeys, rats and mice (NEDO, 1987, 1985a, b) of 90-days duration or longer have been reported. Some noncancer effects of methanol exposure were noted in these studies, principally in the liver and brain tissues, but they occurred at relatively high doses.

A number of studies have used the inhalation route of exposure to assess the potential of reproductive or developmental toxicity of methanol in mice, rats, and monkeys (see Section 4.3.2 [Inhalation Reproductive and Developmental Studies]). These studies indicate that fetal and

neonate toxicity occurs at lower doses than maternal toxicity. At exposure concentrations of 5,000 ppm or above, methanol has been shown to cause an increase in litters with resorptions (Bolon et al., 1993), and severe malformations (exencephaly and cleft palate) in mice, the most sensitive gestational days being GD6 and GD7 (i.e., early organogenesis) (Rogers and Mole, 1997; Rogers et al., 1993a; Rogers et al., 1993b). Increased occurrences of ossification disturbances and skeletal anomalies were observed at exposure concentrations of 2,000 ppm in mice (Rogers et al., 1993b) and at 10,000 ppm in rats (Nelson et al., 1985). NEDO (1987) conducted a series of developmental and reproductive studies, including a two generation and a follow up one generation reproductive toxicity study in rats, which used exposure times of 20 hours/day or more at concentrations between 100 and 5,000 ppm. Details were not reported (e.g., means, variances, sample sizes, pup-to-litter correlations) that would allow for an analysis of the findings from this study. However, a follow-up one-generation study conducted by NEDO (1987) contained enough information to confirm and quantify the primary endpoint identified, pup brain weight changes. This developmental neurotoxicity study is discussed in Section 4.4.2 (Inhalation Neurotoxicity Studies). Section 4.4.2 also describes another key developmental neurotoxicity study conducted in pregnant cynomolgus monkeys exposed to 200-1,800 ppm methanol for 2.5 hours/day throughout pre-mating, mating, and gestation (Burbacher et al., 2004a; 2004b; 1999a; 1999b). Potential compound-related effects noted were a shortening of the gestation period by less than 5%, and developmental neurotoxicity (particularly delayed sensorimotor development) in the monkeys.

As discussed in Section 4.6.1.2 (Key Studies, Inhalation), due largely to the lack of clear dose-response information, the data from the monkey developmental study are not conclusive, and there was insufficient evidence to determine if the primate fetus is more sensitive, or less sensitive, than rodents to the developmental or reproductive effects of methanol. Taken together, however, the NEDO (1987) rat study and the Burbacher et al. (2004a; 2004b; 1999a; 1999b) monkey study suggest that prenatal exposure to methanol can result in adverse effects on developmental neurology pathology and function, which can be exacerbated by continued postnatal exposure. Among an array of findings indicating developmental neurotoxicity and developmental malformations and anomalies that have been observed in rodents, a decrease in the brain weights of gestationally and lactationally exposed neonatal rats (NEDO, 1987) and an increase in the incidence of cervical ribs of gestationally exposed fetal mice (Rogers et al., 1993b) are considered the most robust endpoints for the purposes of RfD and RfC derivation. See Section 4.6 (Synthesis of Major Noncancer Effects) for a more extensive summary of the dose-related effects that have been observed following subchronic or chronic exposure.

Sections 4.7 (Noncancer MOA Information) and 5.3.5 (Choice of Species/Sex), provide a discussion of the uncertainty regarding human relevance of the mouse and rat developmental

studies due to differences in the way humans and rodents metabolize methanol. Adult humans metabolize methanol principally via alcohol dehydrogenase (ADH1) and rodents via catalase and ADH1. Recent studies in mice have demonstrated that high catalase activity can reduce, and low catalase activity can enhance, methanol's embryotoxic effects. However, the MOA for these effects, and the role of catalase, have not been determined. Further, while catalase does not appear to be involved in adult human methanol metabolism, less is known about the metabolism of methanol in human infants (see Section 3.3 [Human Variability in Methanol Metabolism]). Thus, the effects observed in rodents are considered relevant for the assessment of human health.

Dose-Response Assessment and Characterization

As discussed above and in Section 5.1.1 (Choice of Principal Study and Critical Effect[s]), reproductive and developmental effects are considered the most sensitive and quantifiable effects reported in studies of methanol. Because the oral reproductive and developmental studies employed single and comparatively high doses (i.e., oral versus inhalation), the developmental effects observed in the inhalation studies were used to derive the RfC and, using a route-to-route extrapolation, the RfD.

Clearly defined toxic endpoints at moderate exposure levels have been observed in inhalation studies of reproductive and developmental toxicity (see Section 5.1.1.2 [Selection of Critical Effect[s]). Three endpoints from inhalation developmental toxicity studies were critically evaluated for derivation of the RfC: (1) increased occurrences of ossification disturbances and skeletal abnormalities (i.e., formation of cervical ribs) in CD-1 mice exposed to methanol during organogenesis (Rogers et al., 1993b); (2) reduced brain weights in rats exposed to methanol from early gestation through 8 weeks of postnatal life (NEDO, 1987); and (3) deficits in sensorimotor development in the offspring of monkeys exposed to methanol throughout gestation (Burbacher et al., 2004a; 2004b; 1999a; 1999b).

Rogers et al. (1993b) exposed CD-1 mice to air concentrations of 0, 1,000, 2,000, and 5,000 ppm methanol for 7 hours/day on GD7 to GD17. A lower limit of a one-sided 95% confidence interval on the BMD (BMDL) of 43 mg/L was estimated for the internal peak blood methanol (C_{max}) associated with 5% extra risk for the formation of cervical ribs (see Section 5.1.2.3 [BMD Approach Applied to Cervical Rib Data in Mice] and Appendix D [RfC Derivation Options]). This $BMDL_{05}$ was then divided by 100 to account for uncertainties associated with human variability (UF_H), the animal-to-human extrapolation (UF_A) and the database (UF_D), and to reduce it to a level that is within the range of blood levels for which the human PBPK model was calibrated (see discussion in Section 5.1.3.2 [Application of UFs]). The PBPK model was then used to convert this adjusted internal $BMDL_{05}$ of 0.43 mg/L to a human equivalent

candidate RfC of 20.0 mg/m^3 (see Section 5.1.3 [RfC Derivation – Including Application of Uncertainty Factors]) and a candidate RfD of 1.9 mg/kg-day (see Section 5.2.2 [RfD Derivation – Including Application of Uncertainty Factors]).

NEDO (1987) exposed fetal Sprague-Dawley rats and their dams to air concentrations of 0, 500, 1,000 and 2,000 ppm methanol from the first day of gestation (GD1) until 8 weeks of age, and brain weights were determined at 3, 6, and 8 weeks of age. A BMDL of 858 mg-hr/L was estimated for the area under the curve (AUC) internal blood methanol dose, associated with a brain weight reduction at 6 weeks equal to one standard deviation (SD) from the control mean (see Section 5.1.2.2 [BMD Approach Applied to Brain Weight Data in Rats], and Appendix D [RfC Derivation Options]). This $BMDL_{1SD}$ was then divided by 100 to account for uncertainties associated with human variability (UF_H), the animal-to-human extrapolation (UF_A) and the database (UF_D), and to reduce it to a level that is within the range of blood levels for which the human PBPK model was calibrated (see discussion in Section 5.1.3.2 [Application of UFs]). The PBPK model was then used to convert this adjusted internal $BMDL_{1SD}$ of 8.58 mg-hr/L to a human equivalent candidate RfC of 17.8 mg/m^3 (see Section 5.1.3 [RfC Derivation – Including Application of Uncertainty Factors]) and a candidate RfD of 5.2 mg/kg-day (see Section 5.2.2 [RfD Derivation – Including Application of Uncertainty Factors]).

Burbacher et al. (2004a; 2004b; 1999a; 1999b) exposed *M. fascicularis* monkeys to 0, 200, 600, or 1,800 ppm methanol 2.5 hours/day, 7 days/week during pre-mating/mating and throughout gestation (approximately 168 days). A $BMDL_{SD}$ of 19.6 mg/L was estimated for the blood methanol C_{max} associated with a one SD delay in sensorimotor development in the offspring as measured by a visually directed reaching (VDR) test (see Appendix D [RfC Derivation Options]). However, only the unadjusted VDR response for females exhibited a response that could be modeled and the dose-response was marginally significant, with only the high dose exhibiting a response significantly different from controls. Although, the metabolism of methanol in monkeys is comparable to humans (Section 3.1 [Toxicokinetics Overview]) and a delay in VDR is a potentially relevant CNS effect (Section 4.4.2 [Inhalation Neurotoxicity Studies]), EPA concluded that the use of this data for RfC/D derivation was not preferable, given the availability of more reliable dose-response data from the Rogers et al. (1993b) and NEDO (1987) rodent studies.

In summary, after the evaluation of different species, different endpoints, different protocols and different data sources, the Rogers et al. (1993b) mouse, NEDO (1987) rat, and Burbacher et al. (2004a; 2004b; 1999a; 1999b) monkey studies exhibited developmental effects at similar doses, providing consistent results. As described in Sections 5.1.1.2 (Selection of Critical Effects) and 5.2.1.1 (Expansion of the Oral Database by Route-to-Route Extrapolation), because the Rogers et al. (1993b) and NEDO (1987) studies identified relevant effects in relevant

species that could be adequately quantified in a dose-response analysis, they are considered the most appropriate studies for use in the RfC and RfD derivation. The candidate RfC of 2×10^{1} mg/m^3 based on decreased brain weight observed in the NEDO (1987) rat developmental study (see Table 5-4 [Summary of POD values for critical endpoints, application of UFs and conversion to candidate RfCs using PBPK modeling]) was selected as the RfC for methanol. The candidate RfD of 2 mg/kg-day based on the formation of extra cervical ribs observed in the Rogers et al. (1993b) mouse developmental study (see Table 5-6 [Summary of POD values for critical endpoints, application of UFs and conversion to candidate RfDs using PBPK modeling]) was selected as the RfD for methanol. As described in Sections 5.1.3 (RfC Derivation – Including Application of Uncertainty Factors) and 5.2.2 (RfD Derivation – Including Application of Uncertainty Factors), the UFs employed for both the RfC and RfD derivations include a UF_H of 10 for intraspecies variability, a UF_A of 3 to address pharmacodynamic uncertainty and a UF_D of 3 for database uncertainty.

Relationship of the RfC and RfD to Background Methanol Blood Levels and Monkey Blood Levels Associated with Effects of Uncertain Adversity

In Section 5.3.6, PBPK model predictions for the increase in methanol levels in blood resulting from exposure to methanol at the level of the RfC or RfD are compared to background blood levels of methanol estimated from (1) daily endogenous production and dietary exposure estimates from the U.K. report (COT, 2011) and (2) a sample background distribution derived from relevant study groups in Table 3-1 of this toxicological review. Both the EPA and the U.K. data are consistent with approximately 2.5 mg/L representing a high end of the range of background (as defined in Section 5.3.6) methanol blood levels. EPA estimates that the shift in EPA's sample background methanol blood level distribution that would be associated with daily exposures of the entire population to methanol at the RfC or the RfD would increase the number of individuals with peak methanol blood levels at or above 2.5 mg/L from ~7% to ~14%. EPA's PBPK model predicts that a continuous daily methanol exposure at the RfD or RfC would raise the peak methanol blood level of an individual with a high end background methanol blood level of 2.5 mg/L to just under 3 mg/L. As discussed in Section 5.3.7, this 3 mg/L methanol blood level is at the low end of the range of methanol blood levels that have been reported in monkey chronic and gestational exposure studies to be associated with CNS and reproductive/developmental effects of uncertain, but potential adversity.

1. INTRODUCTION

This document presents background information and justification for the Integrated Risk Information System (IRIS) Summary of the hazard and dose-response assessment of methanol. IRIS Summaries may include oral reference dose (RfD) and inhalation reference concentration (RfC) values for chronic and other exposure durations, and a carcinogenicity assessment.

The RfD and RfC, if derived, provide quantitative information for use in risk assessments for noncancer health effects known or assumed to be produced through a nonlinear (presumed threshold) mode of action (MOA). The RfD (expressed in units of milligrams per kilogram per day [mg/kg-day]) is defined as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The inhalation RfC (expressed in units of milligrams per cubic meter [mg/m^3]) is analogous to the oral RfD but provides a continuous inhalation exposure estimate. The inhalation RfC considers toxic effects for both the respiratory system (portal-of-entry) and for effects peripheral to the respiratory system (extrarespiratory or systemic effects). Reference values are generally derived for chronic exposures (up to a lifetime), but may also be derived for acute ($\leq$ 24 hours), short-term (>24 hours up to 30 days), and subchronic (>30 days up to 10% of lifetime) exposure durations, all of which are derived based on an assumption of continuous exposure throughout the duration specified. Unless specified otherwise, the RfD and RfC are derived for chronic exposure duration.

Development of these hazard identification and dose-response assessments for the noncancer effects of methanol has followed the general guidelines for risk assessment as set forth by the National Research Council (NRC) (1983). EPA Guidelines and Risk Assessment Forum Technical Panel Reports that may have been used in the development of this assessment include the following: *Guidelines for the Health Risk Assessment of Chemical Mixtures* (U.S. EPA, 1986b), *Guidelines for Mutagenicity Risk Assessment* (U.S. EPA, 1986a), *Recommendations for and Documentation of Biological Values for Use in Risk Assessment* (U.S. EPA, 1988), *Guidelines for Developmental Toxicity Risk Assessment* (U.S. EPA, 1991), *Interim Policy for Particle Size and Limit Concentration Issues in Inhalation Toxicity Studies* (U.S. EPA, 1994a), *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (U.S. EPA, 1994b), *Use of the Benchmark Dose Approach in Health Risk Assessment* (U.S. EPA, 1995), *Guidelines for Reproductive Toxicity Risk Assessment* (U.S. EPA, 1996), *Guidelines for Neurotoxicity Risk Assessment* (U.S. EPA, 1998a), *Science Policy Council Handbook: Risk Characterization* (U.S. EPA, 2000a), *Supplementary Guidance for Conducting*