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Abstract: In order to better understand the processes involved in the development of H2S and methanethiol (MeSH) along anoxic storage of wines, 24 wines were stored in strict anoxia at 50 degrees C for 3 weeks. Free and total forms of H2S and MeSH were measured at different times. Results showed that: (1) all wines contain relevant proportions of bonded forms of H2S and MeSH (93% and 47% on average); (2) such % decreases with age; (3) levels of total forms are related to wine metal composition; (4) anoxic storage brings about an increase of free forms, a strong decrease in the percentage of bonded forms, and except for H2S in red wines, an increase in total forms. Both de novo formation and release contribute to reductive off-odors. Release is predominant for reds and H2S, while at 50 degrees C, de novo formation dominates for whites and roses and MeSH.

Abstract: Enclosure devices have been studied and used for research purposes and practical applications in order to measure the emission rate of odorous pollutants from quiescent liquid surfaces to atmosphere. However, important questions remain about the interference of these measuring devices on the actual emission rate. The main concern regarding the use of a flux chamber is the fact that odorous compounds can accumulate into the chamber and yield gas-phase concentration increase inside the equipment, which causes a reduction of the emission rate during the measurement and thus gives an inaccurate local emission rate. Furthermore, the fluid flow inside the chamber does not reproduce the atmospheric boundary layer flow. This study applied the Computational Fluid Dynamics (CFD) technique in order to investigate the influence of the fluid flow features inside a flux chamber on the measured hydrogen sulfide emission rate at quiescent liquid surfaces. The flux chamber design and operational conditions are those supported by the United States Environmental Protection Agency (US EPA). The results show that the US EPA flux chamber presents a fairly well mixed air phase. However, a trend to stagnation and hydrogen sulfide accumulation near chamber walls was detected in the computational simulation, which also indicated that the positioning of the sampling tube in relation to the inlet orifices may lead to deviations in the measurement results. CFD results showed that the wall shear and concentration gradients spatially vary at the gas-liquid interface, and friction velocity inside the chamber does not match typical values of atmospheric flow.

Abstract: PURPOSE OF REVIEW: Hypertension is an important determinant of cardiovascular disease, and strict blood pressure regulation is beneficially associated with the risk for cardiovascular events or all-cause mortality. However, intensive antihypertensive treatment is not always sufficient to reach normotension. Hydrogen sulfide (H2S) is a gaseous signalling molecule with antihypertensive properties. It is endogenously produced, but can also be exogenously administrated. The current review...
provides an overview on H2S research performed in the context of hypertension and cardiovascular disease. RECENT FINDINGS: H2S has been increasingly found to contribute to different (patho-)physiological processes such as blood pressure regulation and scavenging of reactive oxygen species. A deficiency of H2S-producing enzymes results in hypertension, and administration of H2S donors lowers blood pressure and protects against organ damage in the experimental setting. Thiosulfate, a H2S metabolite, can act as a H2S donor, and is already clinically used for the treatment of calciphylaxis in patients with end-stage renal disease. Treatment of hypertensive rats with thiosulfate results in lower blood pressure and reduces organ damage. SUMMARY: Although human data on H2S and hypertension are scarce, experimental data indicate that elevation of H2S levels using dietary sulfate or exogenous H2S (donors) could be a promising therapeutic strategy in the setting of hypertension.

Abstract: Nitric oxide (NO) and hydrogen sulfide (H2S) pathways are involved in the development of hypertension, a condition that can originate from early life. We examined whether asymmetric dimethylarginine (ADMA, a nitric oxide synthase inhibitor)/NO and H2S generating pathway contributed to programmed hypertension in offspring exposed to prenatal dexamethasone (DEX) and postnatal high-fat (HF) and whether N-acetylcysteine (NAC) therapy prevented this process. We examined 16-week-old male rat offspring from five groups: control, DEX (0.1 mg/kg i.p. from gestational day 16-22), HF (58% high-fat diet from weaning to 4 months of age), DEX+HF, and NAC (1% in drinking water during lactation). Prenatal DEX and postnatal HF diet synergistically induced programmed hypertension in adult offspring, which was prevented by maternal NAC therapy. We attributed the protective effects of NAC on two-hit induced programmed hypertension to the reduction of plasma ADMA, restoration of plasma l-arginine-to-ADMA ratio, upregulation of gene expression of H2S-generating enzymes, restoration of renal 3-mercaptopropruvate sulphurtransferase (3MST) protein levels and activity, induction of plasma glutathione level, and reduction of oxidative stress. Manipulation of the ADMA-NO and H2S-generating pathways by maternal NAC therapy may be a potential approach to prevent programmed hypertension induced by two-hit insults.

Abstract: The measurement of sulfide, especially hydrogen sulfide, has held the attention of the analytical community due to its unique physiological and pathophysiological roles in biological systems. Electrochemical detection offers a rapid, highly sensitive, affordable, simple, and real-time technique to measure hydrogen sulfide concentration, which has been a well-documented and reliable method. This review details up-to-date research on the electrochemical detection of hydrogen sulfide (ion selective electrodes, polarographic hydrogen sulfide sensors, etc.) in biological samples for potential therapeutic use.

Abstract: Imaging hydrogen sulfide (H2S) at the subcellular resolution will greatly improve the understanding of functions of this signaling molecule. Taking advantage of the protein labeling technologies, we report a general strategy for the development of organelle specific H2S probes, which enables sub-cellular H2S imaging essentially in any organelles of interest.
Abstract: This work deals with the design, synthesis, and evaluation of the cardioprotective properties of a number of novel hybrid compounds combining the adenine nucleus with a suitable H2S slow-releasing moiety, coupled via a stable ether bond. The H2S release rate of the hybrids and their ability to increase cGMP were estimated in vitro. The most promising derivatives 4 and 11, both containing 4-hydroxythiobenzamide moiety as H2S donor, were selected for further in vivo evaluation. Their ability to release H2S in vivo was recorded using a new fully validated UPLC-DAD method. Both compounds reduced significantly the infarct size when administered at the end of sustained ischemia. Mechanistic studies showed that they conferred enhanced cardioprotection compared to adenine or 4-hydroxythiobenzamide. They activate the PKG/PLN pathway in the ischemic myocardium, suggesting that the combination of both pharmacophores results in synergistic cardioprotective activity through the combination of both molecular pathways that trigger cardioprotection.

Abstract: Manganese sulfide (MnS) thin films were synthesized via atomic layer deposition (ALD) using gaseous manganese bis(ethylcyclopentadienyl) and hydrogen sulfide as precursors. At deposition temperatures \(\leq 150\) degrees C phase-pure gamma-MnS thin films were deposited, while at temperatures \(>150\) degrees C, a mixed phase consisting of both gamma- and alpha-MnS resulted. In situ quartz crystal microbalance (QCM) studies validate the self-limiting behavior of both ALD half-reactions and, combined with quadrupole mass spectrometry (QMS), allow the derivation of a self-consistent reaction mechanism. Finally, MnS thin films were deposited on copper foil and tested as a Li-ion battery anode. The MnS coin cells showed exceptional cycle stability and near-theoretical capacity.

Abstract: Using low-temperature scanning tunneling microscopy (STM), the adsorption and reaction of hydrogen sulfide (H2S) and its fragments (SH and S) on Cu(110) are investigated at 5 K. H2S adsorbs molecularly on the surface on top of a Cu atom. With voltage pulses of STM, it is possible to induce sequential dehydrogenation of H2S to SH and S. We found two kinds of adsorption structures of SH. The short-bridge site is the most stable site for SH, while the long-bridge site is the second. Density functional theory calculations show that the S-H axis is inclined from the surface normal for both species. The reaction of H2S with OH and O was directly observed to yield SH and S, respectively, providing a molecular-level insight into catalyst poisoning.

Abstract: A new sensor for the detection of hydrogen sulfide (H2S) gas has been developed to replace commercial lead(II) acetate-based test papers. The new sensor is a wet, porous, paper-like substrate coated with Bi(OH)3 or its alkaline derivatives at pH 11. In contrast to the neurotoxic lead(II) acetate, bismuth is used due to its nontoxic properties, as Bi(III) has been a reagent in medications such as Pepto-Bismol. The reaction between H2S gas and the current sensor produces a visible color change from white to yellow/brown, and the sensor responds to \(>30\) ppb H2S in a total volume of 1.35 L of gas, a typical volume of human breath. The alkaline, wet coating helps the trapping of acidic H2S gas and its reaction with Bi(III) species, forming colored Bi2S3.
The sensor is suitable for testing human bad breath and is at least 2 orders of magnitude more sensitive than a commercial H2S test paper based on Pb(II)(acetate)2. The small volume of 1.35-L H2S is important, as the commercial Pb(II)(acetate)2-based paper requires large volumes of 5 ppm H2S gas. The new sensor reported here is inexpensive, disposable, safe, and user-friendly. A simple, laboratory setup for generating small volumes of ppb-ppm of H2S gas is also reported.

Abstract: A novel ratiometric mitochondrial cysteine (Cys)-selective two-photon fluorescence probe has been developed on the basis of a merocyanine as the fluorophore and an acrylate moiety as the biothiol reaction site. The biocompatible and photostable acrylate-functionalized merocyanine probe shows not only a mitochondria-targeting property but also highly selective detection and monitoring of Cys over other biothiols such as homocysteine (Hcy) and glutathione (GSH) and hydrogen sulfide (H2S) in live cells. In addition, this probe exhibits ratiometric fluorescence emission characteristics (F518/F452), which are linearly proportional to Cys concentrations in the range of 0.5-40 μM. More importantly, the probe and its released fluorophore, merocyanine, exhibit strong two-photon excited fluorescence (TPEF) with two-photon action cross-section (Phisigmamax) of 65.2 GM at 740 nm and 72.6 GM at 760 nm in aqueous medium, respectively, which is highly desirable for high contrast and brightness ratiometric two-photon fluorescence imaging of the living samples. The probe has been successfully applied to ratiometrically image and detect mitochondrial Cys in live cells and intact tissues down to a depth of 150 μm by two-photon fluorescence microscopy. Thus, this ratiometric two-photon fluorescent probe is practically useful for an investigation of Cys in living biological systems.

Abstract: In the past decades three gaseous signaling molecules-so-called gasotransmitters-have been identified: nitric oxide (NO), carbon monoxide (CO), and hydrogen sulfide (H2S). These gasotransmitters are endogenously produced by different enzymes in various cell types and play an important role in physiology and disease. Despite their specific functions, all gasotransmitters share the capacity to reduce oxidative stress, induce angiogenesis, and promote vasorelaxation. In patients with diabetes, a lower bioavailability of the different gasotransmitters is observed when compared with healthy individuals. As yet, it is unknown whether this reduction precedes or results from diabetes. The increased risk for vascular disease in patients with diabetes, in combination with the extensive clinical, financial, and societal burden, calls for action to either prevent or improve the treatment of vascular complications. In this Perspective, we present a concise overview of the current data on the bioavailability of gasotransmitters in diabetes and their potential role in the development and progression of diabetes-associated microvascular (retinopathy, neuropathy, and nephropathy) and macrovascular (cerebrovascular, coronary artery, and peripheral arterial diseases) complications. Gasotransmitters appear to have both inhibitory and stimulatory effects in the course of vascular disease development. This Perspective concludes with a discussion on gasotransmitter-based interventions as a therapeutic option.

Abstract: For centuries, garlic has been shown to exert substantial medicinal effects and is considered to be one of the best disease-preventative foods. Diet is important in the maintenance of health and prevention of many diseases including cardiovascular disease (CVD). Preclinical and clinical evidence has shown that garlic reduces risks associated with CVD by lowering cholesterol, inhibiting platelet aggregation, and lowering blood
pressure. In recent years, emerging evidence has shown that hydrogen sulfide (H2S) has cardioprotective and cytoprotective properties. The active metabolite in garlic, allicin, is readily degraded into organic diallyl polysulfides that are potent H2S donors in the presence of thiols. Preclinical studies have shown that enhancement of endogenous H2S has an impact on vascular reactivity. In CVD models, the administration of H2S prevents myocardial injury and dysfunction. It is hypothesized that these beneficial effects of garlic may be mediated by H2S-dependent mechanisms. This review evaluates the current knowledge concerning the cardioprotective effects of garlic-derived diallyl polysulfides.


Abstract: BACKGROUND: In the vascular system, ATP-sensitive K(+) channels are a target for H2S. Recent evidence suggests that H2S may also modulate Na(+) and Ca(2+)-permeable channels and intracellular Ca(2+) stores, but the influence of H2S on endothelial Ca(2+) dynamics and Ca(2+)-dependent activation of endothelial nitric oxide synthase (eNOS) is unclear. In this study, we investigated the effects of H2S on Ca(2+) signaling in endothelial and smooth muscle cells with special emphasis given to the role of H2S in modulating endothelial NO formation. METHODS: Experiments were performed with endothelial cells from porcine aorta, the human endothelial cell line HMEC-1, and smooth muscle cells from rat aorta and trachea. Mobilization of intracellular Ca(2+) and Ca(2+) entry was monitored with Fura-2. Activity of eNOS was determined as conversion of incorporated l-[3H]arginine into l-[3H]citrulline. RESULTS: Incubation of endothelial cells with the H2S donors sodium hydrogen sulfide (NaHS) and GYY4137 blocked activation of eNOS by the receptor agonist ATP but not by the Ca(2+) ionophore A23187. Data revealed that H2S inhibited ATP-induced release of Ca(2+) from intracellular stores indicating that H2S attenuates eNOS activity by blocking capacitative Ca(2+) entry. A similar inhibitory effect of H2S on ATP-induced Ca(2+) release and Ca(2+) entry was also observed in human microvascular endothelial cells and smooth muscle cells.

CONCLUSIONS: H2S antagonized Ca(2+) mobilization by receptor agonists and store-operated Ca(2+) entry thereby limiting eNOS activation and NO formation. The effect of H2S on Ca(2+) stores was not restricted to endothelial cells but was also observed in vascular and tracheal smooth muscle cells.


Abstract: This study was designed to evaluate whether CSE/H2S system, which is regulated by miR-216a, regulated ABCA1-mediated cholesterol efflux and cholesterol contents in THP-1 macrophages-derived foam cells. Our qPCR and western blotting results showed that CSE/H2S significantly up-regulated the expression of ATP-binding cassette transporter A1 (ABCA1) mRNA and protein via PI3K/AKT pathway in foam cells derived from human THP-1 macrophages. The miR-216a directly targeted 3' untranslated region of CSE. It significantly reduced CSE and ABCA1 expression, and also decreased the phosphorylation of PI3K and AKT. Additionally, cholesterol efflux decreased, and cholesterol levels increased in THP-1 macrophage-derived foam cells in response to treatment with miR-216a. Our study demonstrates that CSE/H2S system is regulated by miR-216a, and regulates ABCA1-mediated cholesterol efflux and cholesterol levels through the PI3K/AKT pathway.


Abstract: Although the neuroprotective effects of hydrogen sulfide (H2S) have been demonstrated in several studies, whether H2S protects against early brain injury (EBI)
and secondary cognitive dysfunction in subarachnoid hemorrhage (SAH) model remain unknown. The present study was undertaken to evaluate the influence of H2S on both acute brain injury and neurobehavioral changes as well as the underlying mechanisms after SAH. The H2S donor, NaHS, was administered via an intraperitoneal injection at a dose of 5.6 mg/kg at 2h, 6h, 24h and 46h after SAH in rat model. The results showed that NaHS treatment significantly improved brain edema and neurobehavioral function, and attenuated neuronal cell death in the prefrontal cortex, associated with a decrease in Bax/Bcl-2 ratio and suppression of caspase-3 activation at 48h after SAH. NaHS also promoted phospho-Akt and phospho-ERK levels. Furthermore, NaHS treatment significantly enhanced the levels of BDNF and phospho-CREB. Importantly, NaHS administration improved learning and memory performance in the Morris water maze test at 7 days post SAH in rats. These results demonstrated that NaHS, as an exogenous H2S donor, could significantly alleviate the development of EBI and cognitive dysfunction induced by SAH via Akt/ERK-related anti-apoptosis pathway, and up-regulating BDNF-CREB expression. This article is protected by copyright. All rights reserved

Abstract: Prodrugs that release hydrogen sulfide upon esterase-mediated cleavage of an ester group followed by lactonization are described herein. By modifying the ester group and thus its susceptibility to esterase, and structural features critical to the lactonization rate, H2S release rates can be tuned. Such prodrugs directly release hydrogen sulfide without the involvement of perthiol species, which are commonly encountered with existing H2S donors. Additionally, such prodrugs can easily be conjugated to another non-steroidal anti-inflammatory agent, leading to easy synthesis of hybrid prodrugs. As a biological validation of the H2S prodrugs, the anti-inflammatory effects of one such prodrug were examined by studying its ability to inhibit LPS-induced TNF-alpha production in RAW 264.7 cells. This type of H2S prodrugs shows great potential as both research tools and therapeutic agents.

Abstract: Understanding the mechanistic aspects of heterogeneous reactions on supported metal catalysts is challenging due to several disparate factors, among which the dynamic nature of the surface is a major contributor. In this study, the dynamic aspect of a surface has been probed by choosing small metal clusters as illustrative models. Two anionic hetero-trimetallic clusters, namely, W2TcO6(-) and W2OsO6(-), were reacted with H2S gas to exhibit splitting of the gas molecule and complete oxygen-sulfur exchange in the metal core. During this atom-exchange process, the core exhibits remarkable fluxionality to augment a thiol proton migration from one metal center to another, as well as a rapid interchange of the terminal and bridging oxygens. The fluxional nature of the core is further evidenced by two oppositely oriented oxo groups working in concert to accomplish the proton transfer, upon introduction of sulfur inside the core. These fluxional processes in the small hetero-trimetallic cores closely resemble the dynamic nature of the surface in a heterogeneous reaction. Throughout the fluxional processes investigated in this study, two-state reactivity and multiple instances of spin crossover are observed in our computational studies. Interestingly, the neutral hetero-trimetallic cores can also undergo complete oxygen-sulfur exchange reaction with H2S. The investigated metal clusters are promising materials, since they not only can liberate dihydrogen from water (reported in J. Phys. Chem. A, 2014, 118, 11047) but also can completely strip the sulfur from environmentally hazardous H2S gas.

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Abstract: The ability to selectively detect or store small molecules, such as gases, is of enormous commercial potential. Calixarenes have been studied extensively as host molecules; however, recent synthetic advances have seen the formation of new polymetallic calixarene clusters, which have not yet been explored for such purposes. We therefore present a theoretical study, using Density Functional Theory, to thoroughly investigate the binding preferences of calix[4]arene, with a variety of transition metal cations coordinated to the calixarene tetraphenolic pocket, toward a series of important small molecules, H2S, SO2, H2O, O2, H2, N2, N2O, CO2, NH3, and HCN. It was found that the inclusion of a metal atom at the lower-rim of the calixarene caused significant strengthening of binding energy with all of the small molecules in our study as compared to metal-free calixarene. The guests, SO2 and NH3, were found to bind strongest with H2 binding weakest. Our calculations predict that simply introducing metal coordination of any type to calix[4]arene will make the largest difference to the binding energies. Subsequently changing the type, oxidation state, or the spin state of the metal coordinated to the calixarene tetraphenolic pocket was found to have a lesser effect on these

Abstract: Changjiang (Yangtze River) Estuary has experienced severe hypoxia since the 1950s. In order to investigate potential ecological functions of key microorganisms in relation to hypoxia, we performed 16S rRNA-based Illumina MiSeq sequencing to explore the bacterial diversity in the surface sediments of the hypoxic zone near the Changjiang Estuary and in the East China Sea (ECS). The results showed that numerous Proteobacteria-affiliated sequences in the sediments of the inner continental shelf were related to both sulfate-reducing and sulfur-oxidizing bacteria, suggesting an active sulfur cycle in this area. Many sequences retrieved from the hypoxic zone were also related to Planctomycetes from two marine upwelling systems, which may be involved in the initial breakdown of sulfated heteropolysaccharides. Bacteroidetes, which is expected to degrade high-molecular-weight organic matter, was abundant in all the studied stations except for station A8, which was the deepest and possessed the largest grain size. In addition, dissolved organic carbon, water depth, percentage ratio of clay to silt, salinity, and sedimentary grain size were environmental effectors that shaped the sedimentary microbial community structure. Our results showed that putative Gammaproteobacteria-affiliated sulfur-oxidizing bacteria may not only detoxify hydrogen sulfide produced by sulfate-reducing prokaryotes, but also serve as the primary producers in the marine sediments. Specific groups of aerobic Bacteroidetes and Planctomycetes participated in degrading organic matter, which might contribute to the oxygen depletion in the hypoxic zones.

Abstract: BACKGROUND: Hydrogen sulfide (H2S) is endogenously generated from L-cysteine (L-Cys) by the enzymes cystathionine-beta-synthase (CBS) and cystathionine-gamma-Lyase (CSE). Hydrogen sulfide is also produced from D-cysteine (D-Cys) by D-Amino acid oxidase (DAO). METHODS: The H2S production was measured by the methylene blue assay. The expression of DAO was investigated by Western blotting and immunohistochemistry. The short-circuit current (Isc) was recorded using the Ussing chamber technique. KEY RESULTS: The epithelium in rat jejunal possesses DAO, and generates H2S. D-cysteine, originally used as a negative control for L-Cys, significantly increases the H2S release, which is inhibited by I2CA, an inhibitor of DAO. In vitro study by Ussing chamber technique reveals that D-Cys decreases the Isc across the epithelium of the rat jejunum and enhances the Na+ -coupled L-alanine transport. CONCLUSIONS
& INFERENCES: A novel pathway for the production of H2S by DAO exists in rat jejunum

Abstract: Controlled field experiments were carried out for monitoring the emissions of three plastic commercial household waste bins, which were adapted for studying the effect of aeration process in the evolved volatiles, during house storing of green food waste for 2 weeks, prior to collection. Three experimental scenarios were examined based on no aeration ("NA," closed commercial waste bin), diffusion-based aeration ("DA," closed commercial waste bin with tiny holes), and enforced aeration ("EA," closed commercial waste bin with tiny holes and enforced aeration). The monitoring of volatile organic compounds (VOCs) emitted from organic household kitchen waste was performed using solid-phase microextraction-gas chromatography-mass spectrometry (SPME-GC-MS) analysis. Portable sensors were also used for monitoring selected gases and parameters of environmental, bioprocess, and health interest (e.g., CO2, O2, H2S, CH4, NH3, % RH, waste temperatures). VOC emissions are strongly dependent on the waste material. The most frequent VOCs identified over the storing waste, showing over 50 % appearance in all examined samples, were terpenes (e.g., di-limonene, beta-myrcene, delta-3-carene, alpha-pinene, alpha-terpinolene, linalool, etc.), sulfides (dimethyl disulfide), aromatics (benzene, 1-methyl-2-(2-propenyl)), alkanes (e.g., decane, dodecane), ketones (2-propanone), esters (e.g., acetic acid ethyl ester, acetic acid methyl ester), and alcohols (e.g., 3-cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)). The prominent role of terpenes in the "pre-compost" odor and especially that of di-limonene was highlighted. In all examined scenarios, the emitted volatiles were increased at raised temperatures and later decreased in time. Aeration of waste bins slightly affected the volatilization process resulting in higher profiles of VOCs; uniformity in the composition of VOCs was also noted. Slight modifications of commercial waste bins may favor the initiation of home composting

Abstract: We have developed a new ratiometric fluorescent probe composed of a coumarin-merocyanine dyad based on the FRET mechanism. The probe showed clear dual-emission signal changes in blue and red spectral windows upon addition of H2S in a dose dependent manner under a single wavelength excitation. The probe targeted mitochondria with high selectivity and sensitivity toward H2S

Abstract: Hyperglycemia, as well as diabetes mellitus, has been shown to impair ATP-sensitive K+ (KATP) channels in human vascular smooth muscle cells. Hydrogen sulfide (H2S) is also known to be an opener of KATP channels. We previously demonstrated the cardioprotective effects exerted by H2S against high-glucose (HG, 35 mM glucose)-induced injury in H9c2 cardiac cells. As such, we hypothesized that KATP channels play a role in the cardioprotective effects of H2S against HG-induced injury. In this study, to examine this hypothesis, H9c2 cardiac cells were treated with HG for 24 h to establish a model of HG-induced insults. Our findings revealed that treatment of the cells with HG markedly decreased the expression level of KATP channels. However, the decreased expression of KATP channels was reversed by the treatment of the cells with 400 microM sodium hydrogen sulfide (NaHS, a donor of H2S) for 30 min prior to exposure to HG. Additionally, the HG-induced cardiomyocyte injuries, including cytotoxicity, apoptosis, oxidative stress and mitochondrial damage, were ameliorated by treatment with NaHS or
100 microM diazoxide (a mitochondrial KATP channel opener) or 50 microM pinacidil (a non-selective KATP channel opener) for 30 min prior to exposure to HG, as indicated by an increase in cell viability, as well as a decrease in the number of apoptotic cells, the expression of cleaved caspase-3, the generation of reactive oxygen species (ROS) and the dissipation of mitochondrial membrane potential (MMP). Notably, treatment of the H9c2 cardiac cells with 100 microM 5-hydroxydecanoic acid (5-HD, a mitochondrial KATP channel blocker) or 1 mM glibenclamide (Gli, a non-selective KATP channel blocker) for 30 min prior to treatment with NaHS and exposure to HG significantly attenuated the above-mentioned cardioprotective effects exerted by NaHS. Notably, treatment of the cells with 500 microM N-acetyl-L-cysteine (NAC, a scavenger of ROS) for 60 min prior to exposure to HG markedly reduced the HG-induced inhibitory effect on the expression of KATP channels. Taken together, our results suggest that KATP channels play an important role in the cardioprotective effects of exogenous H2S against HG-induced injury. This study also provides novel data demonstrating that there is an antagonistic interaction between ROS and KATP channels in HG-exposed H9c2 cardiac cells.

Abstract: Ion channels represent a large and growing family of target proteins regulated by gasotransmitters such as nitric oxide, carbon monoxide and, as described more recently, hydrogen sulfide. Indeed, many of the biological actions of these gases can be accounted for by their ability to modulate ion channel activity. Here, we report recent evidence that H2S is a modulator of low voltage-activated T-type Ca2+ channels, and discriminates between the different subtypes of T-type Ca2+ channel in that it selectively modulates Cav3.2, whilst Cav3.1 and Cav3.3 are unaffected. At high concentrations, H2S augments Cav3.2 currents, an observation which has led to the suggestion that H2S exerts its pro-nociceptive effects via this channel, since Cav3.2 plays a central role in sensory nerve excitability. However, at more physiological concentrations, H2S is seen to inhibit Cav3.2. This inhibitory action requires the presence of the redox-sensitive, extracellular region of the channel which is responsible for tonic metal ion binding, and which particularly distinguishes this channel isoform from Cav3.1 and 3.3. Further studies indicate that H2S may act in a novel manner to alter channel activity by potentiating the zinc sensitivity/affinity of this binding site. This review discusses the different reports of H2S modulation of T-type Ca2+ channels, and how such varying effects may impact on nociception, given the role of this channel in sensory activity. This subject remains controversial, and future studies are required before the impact of T-type Ca2+ channel modulation by H2S might be exploited as a novel approach to pain management. This article is protected by copyright. All rights reserved.

Abstract: Previously, hepatic ischemia followed by reperfusion (hepatic I/R) has been found to cause cognitive impairment. Hydrogen sulfide (H2S) attenuates hepatectomy induced cognitive deficits and also protects against cognitive dysfunction induced by neurodegenerative diseases. In this study, we aim to determine whether sodium hydrosulfide (NaHS), a H2S donor, could alleviate hepatic I/R-induced cognitive impairment and the underlying mechanisms. Rats were injected intraperitoneally with NaHS (5 mg/kg/d) for 11 days. A segmental hepatic I/R model was established on the fourth day. Cognitive function, proinflammatory cytokines levels, and hippocampal ionized calcium-binding adaptor molecule 1 (Iba1) expression was analyzed. We found hepatic I/R increased proinflammatory cytokines levels in serum and hippocampus, up-regulated Iba1 expression, leading to cognitive impairment in rats. However, treatment with NaHS alleviated hepatic I/R induced these neuroinflammatory changes and effectively improved...
cognitive function. Thus, NaHS appears to protect against cognitive impairment in rats undergoing hepatic I/R by attenuating neuroinflammation in the hippocampus.

Abstract: Despite an obnoxious smell and toxicity at a high dose, hydrogen sulfide (H2S) is emerging as a cardioprotective gasotransmitter. H2S mitigates pathological cardiac remodeling by regulating several cellular processes including fibrosis, hypertrophy, apoptosis, and inflammation. These encouraging findings in rodents led to initiation of a clinical trial using a H2S donor in heart failure patients. However, the underlying molecular mechanisms by which H2S mitigates cardiac remodeling are not completely understood. Empirical evidences suggest that H2S may regulate signaling pathways either by directly influencing a gene in the cascade, interacting with nitric oxide (another cardioprotective gasotransmitter), or both. Recent studies revealed that H2S may ameliorate cardiac dysfunction by up-, or down-regulating specific microRNAs. MicroRNAs are non-coding, conserved, regulatory RNAs that modulate gene expression mostly by translational inhibition and are emerging as a therapeutic target for cardiovascular disease (CVD). Few miRNAs also regulate H2S biosynthesis. The inter-regulation of microRNAs and H2S opens a new avenue for exploring the H2S-microRNA cross-talk in cardiovascular disease. This review embodies regulatory mechanisms that maintain the physiological level of H2S, exogenous H2S donors used for increasing the tissue levels of H2S, H2S-mediated regulation of cardiovascular disease, H2S-microRNAs cross-talk in relation to the pathophysiology of heart disease, clinical trials on H2S, and future perspectives for H2S as a therapeutic agent for heart failure.

Abstract: Periodontal disease is associated with changes in the composition of the oral microflora where health associated oral streptococci decrease while Gram negative anaerobes predominate in disease. A key feature of periodontal disease associated anaerobes is their ability to produce hydrogen sulfide (H2S) abundantly as a byproduct of anaerobic metabolism. So far, H2S has been reported to be either cytoprotective or cytotoxic by modulating bacterial antioxidant defense systems. Although oral anaerobes produce large amounts of H2S, the potential effects of H2S on oral streptococci are currently unknown. The aims of this study were to determine the effects of H2S on the survival and biofilm formation of oral streptococci. The growth and biofilm formation of Streptococcus mitis and S. oralis were inhibited by H2S. However, H2S did not significantly affect the growth of S. gordonii and S. sanguinis. The differential susceptibility of oral streptococci to H2S was attributed to differences in the intracellular concentrations of reduced glutathione (GSH). In the absence of GSH, H2S elicited its toxicity through an iron dependent mechanism. Collectively, our results showed that H2S exerts antimicrobial effects on certain oral streptococci, potentially contributing to the decrease in health associated plaque microflora.

Abstract: To detect Salmonella more efficiently and isolate strains more easily, a novel and simple detection method that uses an enrichment assay and two chromogenic reactions on a chromatography membrane was developed. Grade 3 chromatography paper is used as functionalized solid phase support (SPS), which contains specially optimized medium. One reaction for screening is based on the sulfate-reducing capacity of Salmonella. Hydrogen sulfide (H2S) generated by Salmonella reacts with ammonium ferric citrate to produce black colored ferrous sulfide. Another reaction is based on Salmonella C8 esterase that is unique for Enterobacteriaceae except Serratia and interacts with 4-methylumbelliferyl caprylate (MUCAP) to produce fluorescent...
umbelliferone, which is visible under ultraviolet light. A very low detection limit (101 CFU ml-1) for Salmonella was achieved on the background of 105 CFU ml-1 Escherichia coli. More importantly, testing with more than 1,000 anal samples indicated that our method has a high positive detection rate and is relatively low cost, compared with the traditional culture-based method. It took only 1 day for the preliminary screening and 2 days to efficiently isolate the Salmonella cells, indicating that the new assay is specific, rapid, and simple for Salmonella detection. In contrast to the traditional culture-based method, this method can be easily used to screen and isolate targeted strains with the naked eye. The results of quantitative and comparative experiments showed that the visual detection technique is an efficient alternative method for the screening of Salmonella spp. in many applications of large-sized samples related to public health surveillance.


Abstract: An obligately anaerobic, hyperthermophilic, organoheterotrophic archaeon, strain 1633T, was isolated from a terrestrial hot spring of the Uzon Caldera (Kamchatka Peninsula, Russia). Cells were regular cocci, 0.5-0.9 mum in diameter, with one flagellum. The temperature range for growth was 80-95 degrees C, with an optimum at 84 degrees C. Strain 1633T grew on yeast extract, beef extract, peptone, cellulose and cellobiose. No growth was detected on other sugars or carbohydrates, organic acids, or under autotrophic conditions. The only detected growth products were CO2, acetate, and H2. Growth rate was stimulated by elemental sulfur, which was reduced to hydrogen sulfide. In silico calculated G+C content of strain 1633T genomic DNA was 55.64 mol%. 16S rRNA gene sequence analysis placed the strain 1633T together with the non-validly published "Thermogladius shockii" strain WB1 in a separate genus-level cluster within the Desulfurococcaceae family. ANI results revealed 75.72% identity between 1633T and WB1. Based on these results we propose a novel genus and species, for which the name Thermogladius calderae gen. nov., sp. nov. (type strain 1633T=DSM 22663T=VKM B-2946T) is proposed.


Abstract: The alphabetaalpha metallo beta-lactamase (MBL) fold (MBLf) was first observed in bacterial enzymes that catalyze the hydrolysis of almost all beta-lactam antibiotics, but is now known to be widely distributed. The MBL core protein fold is present in human enzymes with diverse biological roles, including cell detoxification pathways and enabling resistance to clinically important anticancer medicines. Human (h)MBLf enzymes can bind metals, including zinc and iron ions, and catalyze a range of chemically interesting reactions, including both redox (e.g., ETHE1) and hydrolytic processes (e.g., Glyoxalase II, SNM1 nucleases, and CPSF73). With a view to promoting basic research on MBLf enzymes and their medicinal targeting, here we summarize current knowledge of the mechanisms and roles of these important molecules.


Abstract: We demonstrate that sol-gel-derived manganese oxide (MnOx) nanoarchitectures exhibit broad-spectrum filtration activity for three chemically diverse toxic gases: NH3, SO2, and H2S. Manganese oxides are synthesized via the reaction of NaMnO4 and fumaric acid to form monolithic gels of disordered, mixed-valent Na-MnOx; incorporated Na(+), is readily exchanged for H(+) by subsequent acid rinsing to form a more crystalline H-MnOx phase. For both Na-MnOx and H-MnOx forms, controlled pore-fluid removal yields either densified, yet still mesoporous, xerogels or low-density aerogels (prepared by drying from supercritical CO2). The performance of these MnOx
nanoarchitectures as filtration media is assessed using dynamic-challenge microbreakthrough protocols. We observe technologically relevant sorption capacities under both dry conditions and wet (80% relative humidity) for each of the three toxic industrial chemicals investigated. The Na-MnOx aerogels and aerogels provide optimal performance with the aerogel exhibiting maximum sorption capacities of 39, 200, and 680 mg g\(^{-1}\) for NH\(_3\), SO\(_2\), and H\(_2\)S, respectively. Postbreakthrough characterization using X-ray photoelectron spectroscopy (XPS) and diffuse-reflectance infrared Fourier transform spectroscopy (DRIFTS) confirms that NH\(_3\) is captured and partially protonated within the MnOx structure, while SO\(_2\) undergoes oxidation by the redox-active oxide to form adsorbed sulfate at the MnOx surface. Hydrogen sulfide is also oxidized to form a combination of sulfate and sulfur/polymer products, concomitant with a decrease in the average Mn oxidation state from 3.43 to 2.94 and generation of a MnOOH phase.


Abstract: Bamboo salt (BS) is a Korean traditional type of salt and has been reported to have therapeutic effects on allergic inflammation. Thymic stromal lymphopoietin (TSLP) aggravates inflammation in the pathogenesis of allergic reactions, such as allergic rhinitis (AR). To confirm an active compound of BS, we investigated the effect of sulfur, a compound of BS, on the levels of TSLP in a human mast cell line, HMC-1 cells and a mouse model of AR using hydrogen sulfide (H\(_2\)S) donor, sodium hydrosulfide (NaSH).

We treated NaSH or BS in HMC-1 cells and activated the HMC-1 cells with phorbol myristate acetate and calcium ionophore A23187 (PMACI). ELISA for the production measurement of TSLP, PCR for the mRNA expression measurement of TSLP, and western blot analysis for the expression measurement of upstream mediators were performed. Mice were treated with NaSH and sensitized with ovalbumin (OVA). The levels of TSLP were measured in serum and nasal mucosa tissue in an OVA-induced AR mouse model. NaSH or BS diminished the production and mRNA expression of TSLP as well as interleukin (IL)-6 and tumor necrosis factor (TNF)-alpha in the PMACI-activated HMC-1 cells. NaSH or BS diminished the level of intracellular calcium in the PMACI-activated HMC-1 cells. NaSH or BS reduced the expression and activity of caspase-1 in the PMACI-activated HMC-1 cells. And NaSH or BS inhibited the expression of receptor interacting protein-2 and the phosphorylation of extracellular signal-regulated kinase in the PMACI-activated HMC-1 cells. The translocation of NF-kappaB into the nucleus as well as the phosphorylation and degradation of IkappaBalpha in the cytoplasm were diminished by NaSH or BS in the PMACI-activated HMC-1 cells. Furthermore, NaSH inhibited the production of TSLP, IL-6, and IL-8 in TNF-alpha-activated HMC-1 cells.

Finally, the administration of NaSH showed a decrease in number of rubs on mice with OVA-induced AR. And the levels of immunoglobulin E and TSLP in the serum and the level of TSLP in the nasal mucosa tissue of the OVA-induced AR mice were reduced by NaSH. In conclusion, these findings show that H\(_2\)S, as an active compound of BS is a potential agent to cure allergic inflammation.

Francisco JS, Kumar M. H\(_2\)S-Induced CO\(_2\) Activation via Metal Free Dual Catalysis. Chemistry 2016 Jan 19.

Abstract: The role of metal free dual catalysis in the hydrogen sulfide (H\(_2\)S)-induced activation of carbon dioxide (CO\(_2\)) and subsequent decomposition of resulting monothiol carbonic acid has been explored. The results suggest that monofunctional amines and bifunctional acids via dual activation mechanisms promote both activation and decomposition reactions implying that the judicious selection of a dual catalyst is crucial to the efficient C-S bond formation via CO\(_2\) activation. Considering that our results also suggest a new mechanism for the formation of carbonyl sulfide from CO\(_2\) and H\(_2\)S, these new insights may help in better understanding the coupling between the carbon and sulfur cycles in industry as well as in the atmosphere of Earth and Venus.

Abstract: Taurine, the most abundant, semiessential, sulfur-containing amino acid, is well known to lower blood pressure (BP) in hypertensive animal models. However, no rigorous clinical trial has validated whether this beneficial effect of taurine occurs in human hypertension or prehypertension, a key stage in the development of hypertension. In this randomized, double-blind, placebo-controlled study, we assessed the effects of taurine intervention on BP and vascular function in prehypertension. We randomly assigned 120 eligible prehypertensive individuals to receive either taurine supplementation (1.6 g per day) or a placebo for 12 weeks. Taurine supplementation significantly decreased the clinic and 24-hour ambulatory BPs, especially in those with high-normal BP. Mean clinic systolic BP reduction for taurine/placebo was 7.2/2.6 mm Hg, and diastolic BP was 4.7/1.3 mm Hg. Mean ambulatory systolic BP reduction for taurine/placebo was 3.8/0.3 mm Hg, and diastolic BP was 3.5/0.6 mm Hg. In addition, taurine supplementation significantly improved endothelium-dependent and endothelium-independent vasodilation and increased plasma H2S and taurine concentrations. Furthermore, changes in BP were negatively correlated with both the plasma H2S and taurine levels in taurine-treated prehypertensive individuals. To further elucidate the hypertensive mechanism, experimental studies were performed both in vivo and in vitro. The results showed that taurine treatment upregulated the expression of hydrogen sulfide-synthesizing enzymes and reduced agonist-induced vascular reactivity through the inhibition of transient receptor potential channel subtype 3-mediated calcium influx in human and mouse mesenteric arteries. In conclusion, the antihypertensive effect of chronic taurine supplementation shows promise in the treatment of prehypertension through improvement of vascular function.


Abstract: In the past years, biomedical research has recognized hydrogen sulfide (H(2)S) not only as an environmental pollutant but also, along with nitric oxide and carbon monoxide, as an important biological gastransmitter with paramount roles in health and disease. Current research focuses on several aspects of H(2)S biology such as the biochemical pathways that generate the compound and its functions in human pathology or drug synthesis that block or stimulate its biosynthesis. The present work addresses the knowledge we have to date on H(2)S production and its biological roles in the general human environment with a special focus on the oral cavity and its involvement in the initiation and development of periodontal diseases.


Abstract: To learn more about the emission characteristics of odorants released from sewer manholes and stormwater catch basins in an urban environment, we measured the emission concentrations of major odorants including 22 target compounds designated as offensive odorants by the Korean Ministry of Environment (KMOE). All of our measurements were made from urban sewer manholes and SCBs in a highly commercialized location in Seoul, Korea. The results of our study were analyzed to identify the major odorants from such sources and to assess their contribution to odor intensity. The malodor strengths at both types of underground sources were considerably higher in the afternoon than in the morning. The assessment of odor intensity (OI) and odor activity value (OAV) confirmed the dominance of key odorants like H2S, CH3SH, and ammonia along with various volatile fatty acids (VFAs) and phenol. The concentration of these major odorants (H2S, CH3SH, and NH3) exceeded the maximum permissible limit given as the odor prevention law in Korea. As such, significantly high
levels of odorants released from these underground sources were greatly distinguished from those seen at above ground locations.

Abstract: Livestock workers are involved in a variety of tasks, such as caring for animals, maintaining the breeding facilities, cleaning, and manure handling, and are exposed to health and safety risks. Hydrogen sulfide is considered the most toxic by-product of the manure handling process at livestock facilities. Except for several reports in developed countries, the statistics and cause of asphyxiation incidents in farms have not been collected and reported systematically, although the number of these incidents is expected to increase in developing and underdeveloped countries. In this study we compiled the cases of work-related asphyxiation incidents at livestock manure storage facilities and analyzed the main causes. In this survey a total of 17 incidents were identified through newspapers or online searches and public reports. Thirty workers died and eight were injured due to work-related tasks and rescue attempts from 1998 to 2013 in Korea. Of the 30 fatalities, 18 occurred during manure handling/maintenance tasks and 12 during rescue attempts. All incidents except for one case occurred during the warm season from the late spring (April) to early autumn (September) when manure is likely to decompose rapidly. It is important to train employees involved in the operation of the facilities (i.e., owners, managers, employees) regarding the appropriate prevention strategies for confined space management, such as hazard identification before entry, periodical facility inspection, restriction of unnecessary access, proper ventilation, and health and safety. Sharing information or case reports on previous incidents could also help prevent similar cases from occurring and reduce the number of fatalities and injuries.

Abstract: Hydrogen sulfide (H2S) is a gaseous signalling molecule involved in many physiological and pathological processes. There is increasing evidence that H2S is implicated in aging and lifespan control in the diet-induced longevity models. However, blood sulfide concentration of naturally long-lived species is not known. Here we measured blood sulfide in the long-lived naked mole-rat and five other mammalian species considerably differing in lifespan and found a negative correlation between blood sulfide and maximum longevity residual. In addition, we show that the naked mole-rat cystathionine beta-synthase (CBS), an enzyme whose activity in the liver significantly contributes to systemic sulfide levels, has lower activity in the liver and is activated to a higher degree by S-adenosylmethionine compared to other species. These results add complexity to the understanding of the role of H2S in aging and call for detailed research on naked mole-rat transsulfuration.

Abstract: Stepwise one-electron reduction of oxygen to water produces reactive oxygen species (ROS) that are chemically and biochemically similar to reactive sulfide species (RSS) derived from one-electron oxidation of hydrogen sulfide to elemental sulfur. Both ROS and RSS are endogenously generated and signal via protein thiols. Given the similarities between ROS and RSS we wondered if extant methods for measuring the former would also detect the latter. Here we compared ROS to RSS sensitivity of five common ROS methods, redox-sensitive green fluorescent protein (roGFP), 2', 7'-dihydrodichlorofluorescein, MitoSox Red, Amplex Red and amperometric electrodes. All methods detected RSS and were as or more sensitive to RSS than to ROS. roGFP,
arguably the "gold standard" for ROS measurement, was over two-hundred fold more sensitive to the mixed polysulfide H2Sn (n=1-8) than to H2O2. These findings suggest that RSS may be far more prevalent in intracellular signaling than previously appreciated and that the contribution of ROS may be over estimated. This conclusion is further supported by the observation that estimated daily sulfur metabolism and ROS production are approximately equal and the fact that both RSS and antioxidant mechanisms have been present since the origin of life nearly 4 billion years ago, long before the rise in environmental oxygen 600 million years ago. Although ROS are assumed to be the most biologically relevant oxidants, our results question this paradigm. We also anticipate our findings will direct attention toward development of novel and clinically relevant anti-(RSS)-oxidants

(41) Chi L, Lv A, Wang M, Wang Y, Bo Z. Investigation on Sensing Process of High-Performance H2S Sensors Based on Polymer Transistors. Chemistry 2016 Jan 12. Abstract: Herein a H2S sensor based on polymer field-effect transistor is reported and the sensor shows high sensitivity, excellent selectivity, fast response, and good operational stability. Concentration as low as 1 ppb is detectable, which is so far the most sensitive H2S sensor based on the organic semiconducting film. Thinning the thickness of active layer does not necessarily improve the sensitivity, but rather leads to the reduction of performance if the thickness is too low. Further analysis proposes a mechanism that the changing rate of absorption and desorption of H2S molecules is different when the thickness of active layer varies, indicating the necessity for the thickness optimization

(42) Luna-Vazquez FJ, Ibarra-Alvarado C, Rojas-Molina A, Romo-Mancillas A, Lopez-Vallejo FH, Solis-Gutierrez M, et al. Role of Nitric Oxide and Hydrogen Sulfide in the Vasodilator Effect of Ursolic Acid and Uvaol from Black Cherry Prunus serotina Fruits. Molecules 2016;21(1). Abstract: The present research aimed to isolate the non-polar secondary metabolites that produce the vasodilator effects induced by the dichloromethane extract of Prunus serotina (P. serotina) fruits and to determine whether the NO/cGMP and the H(2)S/KATP channel pathways are involved in their mechanism of action. A bioactivity-directed fractionation of the dichloromethane extract of P. serotina fruits led to the isolation of ursolic acid and uvaol as the main non-polar vasodilator compounds. These compounds showed significant relaxant effect on rat aortic rings in an endothelium- and concentration-dependent manner, which was inhibited by NG-nitro-l-arginine methyl ester (l-NAME), dl-propargylglycine (PAG) and glibenclamide (Gli). Additionally, both triterpenes increased NO and H(2)S production in aortic tissue. Molecular docking studies showed that ursolic acid and uvaol are able to bind to endothelial NOS and CSE with high affinity for residues that form the oligomeric interface of both enzymes. These results suggest that the vasodilator effect produced by ursolic acid and uvaol contained in P. serotina fruits, involves activation of the NO/cGMP and H(2)S/KATP channel pathways, possibly through direct activation of NOS and CSE

(43) Li C, Liu Y, Tang P, Liu P, Hou C, Zhang X, et al. Hydrogen sulfide prevents OGD/R-induced apoptosis by suppressing the phosphorylation of p38 and secretion of IL-6 in PC12 cells. Neurorport 2016 Mar 2;27(4):230-4. Abstract: Hydrogen sulfide (H2S), a well-known endogenous mediator, has been shown to exert protective effects against neuronal damage caused by brain ischemia, but the mechanism of its action remains unclear. We have reported the neuroprotective properties of H2S against oxygen-glucose deprivation/reoxygenation (OGD/R)-induced injury by inhibiting the phosphorylation of p38. The present study evaluates the effect of H2S on OGD/R-induced cell injury or apoptosis and the mechanisms for its action in PC12 cells. Pretreatment of PC12 cells with exogenous sodium hydrosulfide (NaHS) (a H2S donor, 100 or 300 microM) for 12 h before exposure to OGD/R markedly attenuated p38 phosphorylation. Activation of p38 MAPK by transfection of activated p38alpha, but
not p38beta, reversed the protective effect of NaHS, as measured by enzyme-linked immunosorbent assay analysis. Importantly, SB203580 (a p38 MAPK inhibitor) also reversed the protective effects of p38alpha-activated p38 MAPK. Interleukin-6 secretion after OGD/R decreased significantly with NaHS compared with without NaHS. Taken together, we show that the p38 pathway contributes toward OGD/R-induced cell death and p38alpha plays a key role in OGD/R-induced interleukin-6 secretion.

(44) Kozich V, Krijt J, Sokolova J, Melenovska P, Jesina P, Vozdek R, et al. Thioethers as markers of hydrogen sulfide production in homocystinurias. Biochimie 2016 Jan 11. Abstract: Two enzymes in the transsulfuration pathway of homocysteine -cystathionine beta-synthase (CBS) and gamma-cystathionase (CTH)-use cysteine and/or homocysteine to produce the important signaling molecule hydrogen sulfide (H2S) and simultaneously the thioethers lanthionine, cystathionine or homolanthionine. In this study we explored whether impaired flux of substrates for H2S synthesis and/or deficient enzyme activities alter production of hydrogen sulfide in patients with homocystinurias. As an indirect measure of H2S synthesis we determined by LC-MS/MS concentrations of thioethers in plasma samples from 33 patients with different types of homocystinurias, in 8 patient derived fibroblast cell lines, and as reaction products of seven purified mutant CBS enzymes. Since chaperoned recombinant mutant CBS enzymes retained capacity of H2S synthesis in vitro it can be stipulated that deficient CBS activity in vivo may impair H2S production. Indeed, in patients with classical homocystinuria we observed significantly decreased cystathionine and lanthionine concentrations in plasma (46% and 74% of median control levels, respectively) and significantly lower cystathionine in fibroblasts (8% of median control concentrations) indicating that H2S production from cysteine and homocysteine may be also impaired. In contrast, the grossly elevated plasma levels of homolanthionine in CBS deficient patients (32-times elevation compared to median of controls) clearly demonstrates a simultaneous overproduction of H2S from homocysteine by CTH. In the remethylation defects the accumulation of homocysteine and the increased flux of metabolites through the transsulfuration pathway resulted in elevation of cystathionine and homolanthionine (857% and 400% of median control values, respectively) indicating a possibility of an increased biosynthesis of H2S by both CBS and CTH. This study shows clearly disturbed thioether concentrations in homocystinurias, and modeling using these data indicates that H2S synthesis may be increased in these conditions. Further studies are needed to confirm our findings and to explore the possible implications for pathophysiology of these disorders.

(45) Akter F. The role of hydrogen sulfide in burns. Burns 2016 Jan 11. Abstract: Hydrogen sulfide is a novel gasotransmitter that has been shown to play a major role in regulating vascular tone. However, the role of hydrogen sulfide in inflammation, sepsis and burns has only recently been studied. In animal studies, hydrogen sulfide has been shown to play a role in both promoting and inhibiting inflammation. Understanding the role of H2S in sepsis and shock is particularly important due to the high mortality associated with both conditions. In animal sepsis models, hydrogen sulfide appears to increase survival. Severe burns are associated with an inflammatory response that causes increased permeability and edema. Currently, there are few studies that have examined the exact role of hydrogen sulfide in burns. However, the role of hydrogen sulfide in inflammation enables us to hypothesize its role in burns. This review highlights the role of hydrogen sulfide in the mechanisms of action underlying inflammation, wound healing and sepsis as well as examining the potential role of hydrogen sulfide in burns. The authors of this article hope that this review will stimulate research to discover the exact role of this fascinating molecule in burns.

and a new study identifies cable bacteria in the sediment as the saviors. The bacterial electrical activity creates an iron “carpet”, trapping toxic hydrogen sulfide.


Abstract: DNA-based sensors can detect disease biomarkers, including acetone and ethanol for diabetes and H2S for cardiovascular diseases. Before experimenting on thousands of potential DNA segments, we conduct full atomistic steered molecular dynamics (SMD) simulations to screen the interactions between different DNA sequences with targeted molecules to rank the nucleobase sensing performance. We study and rank the strength of interaction between four single DNA nucleotides (Adenine (A), Guanine (G), Cytosine (C), and Thymine (T)) on single-stranded DNA (ssDNA) and double-stranded DNA (dsDNA) with acetone, ethanol, H2S and HCl. By sampling forward and reverse interaction paths, we compute the free-energy profiles of eight systems for the four targeted molecules. We find that dsDNA react differently than ssDNA to the targeted molecules, requiring more energy to move the molecule close to DNA as indicated by the potential of mean force (PMF). Comparing the PMF values of different systems, we obtain a relative ranking of DNA base for the detection of each molecule. Via the same procedure, we could generate a library of DNA sequences for the detection of a wide range of chemicals. A DNA sensor array built with selected sequences differentiating many disease biomarkers can be used in disease diagnosis and monitoring.


Abstract: The effects and the underlying mechanisms of hydrogen sulfide (H2S) on keratinocyte proliferation and differentiation are still less known. In the current study, we investigated the effects and the underlying mechanisms of exogenous H2S on keratinocyte proliferation and differentiation. Human keratinocytes (HaCaT cells) were treated with various concentrations (0.05, 0.25, 0.5 and 1 mM) of sodium hydrosulfide (NaHS, a donor of H2S) for 24 h. A CCK-8 assay was used to assess cell viability. Western blot analysis was performed to determine the expression levels of proteins associated with differentiation and autophagy. Transmission electron microscopy was performed to observe autophagic vacuoles, and flow cytometry was applied to evaluate apoptosis. NaHS promoted the viability, induced the differentiation, and enhanced autophagic activity in a dose-dependent manner in HaCaT cells but had no effect on cell apoptosis. Blockage of autophagy by ATG5 siRNA inhibited NaHS-induced cell proliferation and differentiation. The current study demonstrated that autophagy in response to exogenous H2S treatment promoted keratinocyte proliferation and differentiation. Our results provide additional insights into the potential role of autophagy in keratinocyte proliferation and differentiation.


Abstract: OBJECTIVE: Infrarenal aortic cross-clamping (IAC) is a common procedure during infrarenal vascular operations. It often causes ischemia-reperfusion injury to lower limbs, resulting in systemic inflammation response and damage to remote organs (particularly lungs). Hydrogen sulfide (H2S) is a gaseous mediator that has been shown to have a protective effect against lung injury. METHODS: Wistar rats underwent IAC for 2 hours, followed by 4 hours of reperfusion. GYY4137 (a slow-releasing H2S donor) and dl-propargylglycine (PAG, an inhibitor of cystathionine gamma-lyase) were preadministered to rats 1 hour before IAC, and their effects on severity of lung injury and related mechanisms were investigated. RESULTS: IAC induced a significant increase in plasma levels of H2S, H2S-synthesizing activity, and cystathionine gamma-lyase.
expression in lung tissues compared with sham operation. Administration of GYY4137 significantly increased the levels of H2S but had little effect on H2S-synthesizing activity, whereas PAG reduced H2S levels and H2S-synthesizing activity. Preadministration of GYY4137 significantly attenuated acute lung injury induced by IAC, evidenced by reduced histologic scores and wet lung contents; improved blood gas parameters; reduced cell counts and protein amounts in bronchoalveolar lavage fluids; and reduced myeloperoxidase activity in lung tissues and plasma levels of tumor necrosis factor alpha, interleukin 6, and interleukin 1beta. However, PAG further aggravated the severity of lung injury and displayed opposite effects to GYY4137. In exploration of the mechanisms, we found that IAC increased the release of angiopoietin 2 (Ang2) and its expression in lung tissues. GYY4137 attenuated the increase of Ang2 release and expression and increased the phosphorylation of Akt and the activation of its downstream factors, glycogen synthase kinase 3beta and ribosomal protein S6 kinase; PAG showed opposite effects. CONCLUSIONS: The study indicates that H2S may play a protective role in IAC-induced acute lung injury in rats by inhibiting inflammation and Ang2 release.

Abstract: BACKGROUND: The transient receptor potential ankyrin 1 (TRPA1) is a calcium-permeable cation channel that is expressed on capsaicin-sensitive sensory neurons, endothelial and inflammatory cells. It is activated by a variety of inflammatory mediators, such as methylglyoxal, formaldehyde and hydrogen sulphide. Since only few data are available about the role of TRPA1 in arthritis and related pain, we investigated its involvement in inflammation models of different mechanisms. METHODS: Chronic arthritis was induced by complete Freund's adjuvant (CFA), knee osteoarthritis by monosodium iodoacetate (MIA) in TRPA1 knockout (KO) mice and C57Bl/6 wildtype mice. For comparison, carrageenan- and CFA-evoked acute paw and knee inflammatory changes were investigated. Thermonociception was determined on a hot plate, cold tolerance in icy water, mechanonociception by aesthesiometry, paw volume by plethysmometry, knee diameter by micrometry, weight distribution with incapacitance tester, neutrophil myeloperoxidase activity and vascular leakage by in vivo optical imaging, and histopathological alterations by semiquantitative scoring. RESULTS: CFA-induced chronic mechanical hypersensitivity, tibiotalar joint swelling and histopathological alterations, as well as myeloperoxidase activity in the early phase (day 2), and vascular leakage in the later stage (day 7), were significantly reduced in TRPA1 KO mice. Heat and cold sensitivities did not change in this model. Although in TRPA1 KO animals MIA-evoked knee swelling and histopathological destruction were not altered, hypersensitivity and impaired weight bearing on the osteoarthritic limb were significantly decreased. In contrast, carrageenan- and CFA-induced acute inflammation and pain behaviours were not modified by TRPA1 deletion. CONCLUSIONS: TRPA1 has an important role in chronic arthritis/osteoarthritis and related pain behaviours in the mouse. Therefore, it might be a promising target for novel analgesic/anti-inflammatory drugs.

Abstract: We investigated the response of microbial community to changes in H2S loading rate in a microaerated desulphurisation system treating biogas from vinasse methanisation. H2S removal efficiency was high, and both COD and DO seemed to be important parameters to biomass activity. DGGE analysis retrieved sequences of sulphide-oxidising bacteria (SOB), such as Thioalkalimicrobium sp. Deep sequencing analysis revealed that the microbial community was complex and remained constant throughout the experiment. Most sequences belonged to Firmicutes and Proteobacteria, and, to a lesser extent, Bacteroidetes, Chloroflexi, and Synergistetes. Despite the high
sulphide removal efficiency, the abundance of the taxa of SOB was low, and was negatively affected by the high sulphide loading rate


Abstract: Hydrogen sulphide (H2S), the third endogenous gaseous signalling molecule, has attracted attention in biochemical research. The selective detection of H2S in living systems is essential for studying its functions. Fluorescence detection methods have become useful tools to explore the physiological roles of H2S because of their real-time and non-destructive characteristics. Herein we report a near-infrared fluorescent probe, NIR-HS, capable of tracking H2S in living organisms. With high sensitivity, good selectivity and low cytotoxicity, NIR-HS was able to recognize both the exogenous and endogenous H2S in living cells. More importantly, it realized the visualization of endogenous H2S generated in cells overexpressing cystathionine beta-synthase (CBS), one of the enzymes responsible for producing endogenous H2S. The probe was also successfully applied to detect both the exogenous and endogenous H2S in living mice. The superior sensing properties of the probe render it a valuable research tool in the H2S-related medical research


Abstract: Molar tooth structures are ptygmatically folded and microspar-filled structures common in early- and mid-Proterozoic (approximately 2,500-750 million years ago, Ma) subtidal successions, but extremely rare in rocks <750 Ma. Here, on the basis of Mg and S isotopes, we show that molar tooth structures may have formed within sediments where microbial sulphate reduction and methanogenesis converged. The convergence was driven by the abundant production of methyl sulphides (dimethyl sulphide and methanethiol) in euxinic or H2S-rich seawaters that were widespread in Proterozoic continental margins. In this convergence zone, methyl sulphides served as a non-competitive substrate supporting methane generation and methanethiol inhibited anaerobic oxidation of methane, resulting in the buildup of CH4, formation of degassing cracks in sediments and an increase in the benthic methane flux from sediments. Precipitation of crack-filling microspar was driven by methanogenesis-related alkalinity accumulation. Deep ocean ventilation and oxygenation around 750 Ma brought molar tooth structures to an end


Abstract: It is of great importance to protect the brain against cerebral ischemia and reperfusion (I/R) injury, which leads to excitotoxicity, redox imbalance, inflammation and apoptosis; however, there is currently no effective treatment. The present study aimed to investigate the effect of H2S preconditioning on cerebral I/R injury and its underlying mechanism. The results demonstrated that H2S preconditioning significantly prevented the development of neurological function abnormality, inflammation and oxidative injury in mice as well as cognitive impairment caused by cerebral I/R. H2S preconditioning also suppressed the apoptosis caused by cerebral I/R. Moreover, the protective effect of H2S preconditioning was found to involve heat shock protein 70 (HSP70), in which the PI3K/Akt/Nrf2 pathway was involved. The data showed that H2S preconditioning could protect mice against cerebral I/R injury by the induction of HSP70 and the PI3K/Akt/Nrf2 pathway

Abstract: Hydrogen sulfide (H2S), a novel signaling gasotransmitter in the respiratory system, may have anti-inflammatory properties in the lung. We examined the preventive and therapeutic effects of H2S on ozone-induced feature of lung inflammation and emphysema. C57/BL6 mice were exposed to ozone or filtered air over 6 weeks. Sodium hydrogen sulfide (NaHS), a H2S donor, was administered to the mice either before ozone exposure (preventive effect) or after completion of ozone exposure for 6 weeks (therapeutic effect). The ozone-exposed mice developed emphysema measured by micro-computed tomography and histology, airflow limitation measured by the forced maneuver system, and increased lung inflammation with augmented IL-1beta, IL-18 and MMP-9 gene expression. Ozone-induced changes were associated with increased NLRP3-caspase-1 activation and p38 MAPK phosphorylation and decreased Akt phosphorylation. NaHS both prevented and reversed lung inflammation and emphysematous changes in alveolar space. In contrast, NaHS prevented but did not reverse ozone-induced airflow limitation and bronchial structural remodeling. In conclusion, NaHS administration prevented and partially reversed ozone-induced feature of lung inflammation and emphysema via regulation of the NLRP3-caspase-1, p38 MAPK and Akt pathways.


Abstract: BACKGROUND: Lyme disease control strategies may include tick control interventions in high risk areas. Public authorities may be interested to assess how these types of interventions are perceived by the public which may then impact their acceptability. The aims of this paper are to compare socio-cognitive factors associated with high acceptability of tick control interventions and to describe perceived issues that may explain their low acceptability in populations living in two different regions, one being an endemic region for LD since the last 30 years, the Neuchatel canton, in Switzerland, and another where the disease is emerging, the Monteregie region, in Canada.

METHODS: A mixed methods' design was chosen. Quantitative data were collected using web-surveys conducted in both regions (n = 814). Multivariable logistic regressions were used to compare socio-cognitive factors associated with high acceptability of selected interventions. Qualitative data were collected using focus group’s discussions to describe perceived issues relative to these interventions. RESULTS: Levels of acceptability in the studied populations were the lowest for the use of acaricides and landscaping and were under 50 % in both regions for six out of eight interventions, but were higher overall in Monteregie. High perceived efficacy of the intervention was strongly associated with high acceptability of tick control interventions. A high perceived risk about LD was also associated with a high acceptability of intervention under some models. High level of knowledge about LD was negatively associated with high acceptability of the use of acaricides in Neuchatel. Perceived issues explaining low acceptability included environmental impacts, high costs to the public system, danger of individual disempowerment and perceptions that tick control interventions were disproportionate options for the level of LD risk. CONCLUSION: This study suggests that the perceived efficacy and LD risk perception may be key factors to target to increase the acceptability of tick control interventions. Community-level issues seem to be important considerations driving low acceptability of public health interventions. Results of this study highlight the importance for decision-makers to account for socio-cognitive factors and perceived issues that may affect the acceptability of public health interventions in order to maximize the efficacy of actions to prevent and control LD.


Abstract: A novel catalyst functionalization method, based on protein-encapsulated metallic nanoparticles (NPs) and their self-assembly on polystyrene (PS) colloid
templates, is used to form catalyst-loaded porous WO3 nanofibers (NFs). The metallic NPs, composed of Au, Pd, or Pt, are encapsulated within a protein cage, i.e., apoferritin, to form unagglomerated monodispersed particles with diameters of less than 5 nm. The catalytic NPs maintain their nanoscale size, even following high-temperature heat-treatment during synthesis, which is attributed to the discrete self-assembly of NPs on PS colloid templates. In addition, the PS templates generate open pores on the electrospun WO3 NFs, facilitating gas molecule transport into the sensing layers and promoting active surface reactions. As a result, the Au and Pd NP-loaded porous WO3 NFs show superior sensitivity toward hydrogen sulfide, as evidenced by responses (Rair /Rgas ) of 11.1 and 43.5 at 350 degrees C, respectively. These responses represent 1.8- and 7.1-fold improvements compared to that of dense WO3 NFs (Rair /Rgas = 6.1). Moreover, Pt NP-loaded porous WO3 NFs exhibit high acetone sensitivity with response of 28.9. These results demonstrate a novel catalyst loading method, in which small NPs are well-dispersed within the pores of WO3 NFs, that is applicable to high sensitivity breath sensors.


Abstract: The transsulfuration pathway (TS) acts in sulfur amino acid metabolism by contributing to the regulation of cellular homocysteine, cysteine production, and the generation of H2S for signaling functions. Regulation of TS pathway kinetics involves stimulation of cystathionine beta-synthase (CBS) by S-adenosylmethionine (SAM) and oxidants such as H2O2, and by Michaelis-Menten principles whereby substrate concentrations affect reaction rates. Although pyridoxal phosphate (PLP) serves as coenzyme for both CBS and cystathionine gamma-lyase (CSE), CSE exhibits much greater loss of activity than CBS during PLP insufficiency. Thus, cellular and plasma cystathionine concentrations increase in vitamin B6 deficiency mainly due to the bottleneck caused by reduced CSE activity. Because of the increase in cystathionine, the canonical production of cysteine (homocysteine --> cystathionine --> cysteine) is largely maintained even during vitamin B6 deficiency. Typical whole body transsulfuration flux in humans is 3-7 mumol/h per kg body weight. The in vivo kinetics of H2S production via side reactions of CBS and CSE in humans are unknown but they have been reported for cultured HepG2 cells. In these studies, cells exhibit a pronounced reduction in H2S production capacity and rates of lanthionine and homolanthionine synthesis in deficiency. In humans, plasma concentrations of lanthionine and homolanthionine exhibit little or no mean change due to 4-wk vitamin B6 restriction, nor do they respond to pyridoxine supplementation of subjects in chronically low-vitamin B6 status. Wide individual variation in responses of the H2S biomarkers to such perturbations of human vitamin B6 status suggests that the resulting modulation of H2S production may have physiological consequences in a subset of people. Supported by NIH grant DK072398. This paper refers to data from studies registered at clinicaltrials.gov as NCT01128244 and NCT00877812.


Abstract: This work presents a methodology that combines spectroscopic speciation, performed through portable Raman spectroscopy, diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS), and energy dispersive X-ray fluorescence spectrometry (ED-XRF) working in situ, and thermodynamic speciation to diagnose the environmental impacts, induced by past and current events, on two wall painting panels (Nos. 9103 and 9255) extracted more than 150 years ago from the walls of a Pompeian house (Marcus Lucretius House, Regio IX, Insula 3, House 5/24) and deposited in the
Naples National Archaeological Museum (MANN). The results show a severe chemical attack of the acid gases that can be explained only by the action of H2S during and just after the eruption of the Vesuvius volcano, that expelled a high concentration of sulfur gases. This fact can be considered as the most important process impacting the wall painting panels deposited in the museum, while the rain-wash processes and the colonization of microorganisms have not been observed in contrast to the impacts shown by the wall paintings left outside in the archaeological site of Pompeii. Moreover, the systematic presence of lead traces and strontium in both wall paintings suggests their presence as impurities of the calcite mortars (intonacco) or calcite binder of these particular fresco Pompeian murals.


Abstract: Hydrogen sulfide (H2S) functions in many physiological processes, including relaxation of vascular smooth muscles, mediation of neurotransmission, inhibition of insulin signaling, and regulation of inflammation. On the other hand, sulfane sulfur, which is a sulfur atom with six valence electrons but no charge, has the unique ability to bind reversibly to other sulfur atoms to form hydropersulfides (R-S-SH) and polysulfides (-S-Sn-S-). H2S and sulfane sulfur always coexist, and recent work suggests that sulfane sulfur species may be the actual signaling molecules in at least some biological phenomena. For example, one of the mechanisms of activity regulation of proteins by H2S is the S-sulfhydration of cysteine residues (protein Cys-SSH). In this review, we summarize recent progress on chemical tools for the study of H2S and sulfane sulfur, covering fluorescence probes utilizing various design strategies, H2S caged compounds, inhibitors of physiological H2S-producing enzymes (cystathionine gamma-lyase, cystathionine beta-synthase and 3-mercaptopyruvate sulfurtransferase), and labeling reagents. Fluorescence probes offer particular advantages as chemical tools to study physiological functions of biomolecules, including ease of use and real-time, nondestructive visualization of biological processes in live cells and tissues.


Abstract: Background. The study was designed to investigate if H2S could inhibit high-salt diet-induced renal excessive oxidative stress and kidney injury in Dahl rats. Methods. Male salt-sensitive Dahl and SD rats were used. Blood pressure (BP), serum creatinine, urea, creatinine clearance rate, and 24-hour urine protein were measured. Renal ultra- and microstructures were observed. Collagen-I and -III contents the oxidants and antioxidants levels in renal tissue were detected. Keap1/Nrf2 association and Keap1 s-sulfhydration were detected. Results. After 8 weeks of high-salt diet, BP was significantly increased, renal function and structure were impaired, and collagen deposition was abundant in renal tissues with increased renal MPO activity, H2O2, MDA, GSSG, and (*)OH contents, reduced renal T-AOC and GSH contents, CAT, GSH-PX and SOD activity, and SOD expressions in Dahl rats. Furthermore, endogenous H2S in renal tissues was decreased in Dahl rats. H2S donor, however, decreased BP, improved renal function and structure, and inhibited collagen excessive deposition in kidney, in association with increased antioxidant activity and reduced oxidative stress in renal tissues. H2S activated Nrf2 by inducing Keap1 s-sulfhydration and subsequent Keap1/Nrf2 disassociation. Conclusions. H2S protected against high-salt diet-induced renal injury associated with enhanced antioxidant capacity and inhibited renal oxidative stress.

Abstract: The clam Lucina pectinata lives in sulfide-rich muds and houses intracellular symbiotic bacteria that need to be supplied with hydrogen sulfide and oxygen. This clam possesses three hemoglobins: hemoglobin I (HbI), a sulfide-reactive protein, and hemoglobin II (HbII) and III (HbIII), which are oxygen-reactive. We characterized the complete gene sequence and promoter regions for the oxygen reactive hemoglobins and the partial structure and promoters of the HbI gene from Lucina pectinata. We show that HbI has two mRNA variants, where the 5'end had either a sequence of 96 bp (long variant) or 37 bp (short variant). The gene structure of the oxygen reactive Hbs is defined by having 4-exons/3-introns with conservation of intron location at B12.2 and G7.0 and the presence of pre-coding introns, while the partial gene structure of HbI has the same intron conservation but appears to have a 5-exon/4-intron structure. A search for putative transcription factor binding sites (TFBSs) was done with the promoters for HbII, HbIII, HbI short and HbI long. The HbII, HbIII and HbI long promoters showed similar predicted TFBSs. We also characterized MITE-like elements in the HbI and HbII gene promoters and intronic regions that are similar to sequences found in other mollusk genomes. The gene expression levels of the clam Hbs, from sulfide-rich and sulfide-poor environments showed a significant decrease of expression in the symbiont-containing tissue for those clams in a sulfide-poor environment, suggesting that the sulfide concentration may be involved in the regulation of these proteins. Gene expression evaluation of the two HbI mRNA variants indicated that the longer variant is expressed at higher levels than the shorter variant in both environments.


Abstract: The role of cocaine in modulating the metabolism of sulfur-containing compounds in the peripheral tissues is poorly understood. In the present study we addressed the question about the effects of acute and repeated (5 days) cocaine (10 mg/kg i.p.) administration on the total cysteine (Cys) metabolism and on the oxidative processes in the rat liver and kidney. The whole pool of sulfane sulfur, its bound fraction and hydrogen sulfide (H2S) were considered as markers of anaerobic Cys metabolism while the sulfate as a measure of its aerobic metabolism. The total-, non-protein- and protein- SH group levels were assayed as indicators of the redox status of thiols. Additionally, the activities of enzymes involved in H2S formation (cystathionine gamma-lyase, CSE; 3-mercaptopyruvate sulfrurttransferase, 3-MST) and GSH metabolism (gamma-glutamyl transeptidase, gamma-GT; glutathione S-transferase, GST) were determined. Finally, we assayed the concentrations of reactive oxygen species (ROS) and malondialdehyde (MDA) as markers of oxidative stress and lipid peroxidation, respectively. In the liver, acute cocaine treatment, did not change concentrations of the whole pool of sulfane sulfur, its bound fraction, H2S or sulfate but markedly decreased levels of non-protein SH groups (NPSH), ROS and GST activity while gamma-GT was unaffected. In the kidney, acute cocaine significantly increased concentration of the whole pool of sulfane sulfur, reduced the content of its bound fraction but H2S, sulfate and NPSH levels were unchanged while ROS and activities of GST and gamma-GT were reduced. Acute cocaine enhanced activity of the CSE and 3-MST in the liver and kidney, respectively. Repeatedly administered cocaine enhanced the whole pool of sulfane sulfur and reduced H2S level simultaneously increasing sulfate content both in the liver and kidney. After repeated cocaine, a significant decrease in ROS was still observed in the liver while in the kidney, despite unchanged ROS content, a marked increase in MDA level was visible. The repeated cocaine decreased 3-MST and increased gamma-GT activities in both organs but reduced GST in the kidney. Our results show that cocaine administered at a relatively low dose shifts Cys metabolism towards the formation of
sulfane sulfur compounds which possess antioxidant and redox regulatory properties and are a source of H2S which can support mitochondrial bioenergetics.

Abstract: Hydrogen sulfide (H2S) has anti-fibrotic potential in lung, kidney and other organs. The exogenous H2S is released from sodium hydrosulfide (NaHS) and can influence the renal fibrosis by blocking the differentiation of quiescent renal fibroblasts to myofibroblasts. But whether H2S affects renal epithelial-to-mesenchymal transition (EMT) and the underlying mechanisms remain unknown. Our study is aimed at investigating the in vitro effects of H2S on transforming growth factor-beta1 (TGF-beta1)-induced EMT in renal tubular epithelial cells (HK-2 cells) and the associated mechanisms. The induced EMT is assessed by Western blotting analysis on the expressions of alpha-SMA, E-cadherin and fibronectin. HK-2 cells were treated with NaHS before incubating with TGF-beta1 to investigate its effect on EMT and the related molecular mechanism. Results demonstrated that NaHS decreased the expression of alpha-SMA and fibronectin, and increased the expression of E-cadherin. NaHS reduced the expression of TGF-beta receptor type I (TbetaR I) and TGF-beta receptor type II (TbetaR II). In addition, NaHS attenuated TGF-beta1-induced increase of beta-catenin expression and ERK phosphorylation. Moreover, it inhibited the TGF-beta1-induced nuclear translocation of betabeta-catenin. These effects of NaHS on fibronectin, E-cadherin and TbetaR I were abolished by the ERK inhibitor U0126 or beta-catenin inhibitor XAV939, or beta-catenin siRNA interference. We get the conclusion that NaHS attenuated TGF-beta1-induced EMT in HK-2 cells through both ERK-dependent and beta-catenin-dependent pathways.

Abstract: There is growing evidence to suggest that radiotherapy can paradoxically promote tumor invasion and metastatic processes, however, the underlying molecular mechanisms remain obscure. In this study, we found that exposure to X rays promoted cell invasion by triggering the epithelial mesenchymal transition (EMT) in two hepatocellular carcinoma (HCC) cell lines, HepG2 and PLC/PRF/5. This was made evident by a reduced expression of E-cadherin and enhanced expressions of N-cadherin, Vimentin and Snail. Moreover, exposure to radiation stimulated the signaling of hydrogen sulfide (H2S), a newly found gas transmitter, by upregulating the expressions of H2S-producing proteins of cysthionine-gamma-lyase (CSE), cystathionine-beta-synthase (CBS). Inhibition of CSE by siRNA or inhibitor not only increased the radiosensitivity but also strongly suppressed radiation-enhanced invasive properties of HCC cells. Interestingly, we found that H2S/CSE inhibition attenuated radiation-enhanced EMT, and the above effect was an end result of blockage of the radiation-activated pathway of p38 mitogen-activated protein kinase (p38MAPK). Collectively, our findings indicate that radiation could promote HCC cell invasion through EMT mediated by endogenous H2S/CSE signaling via the p38MAPK pathway.

Abstract: Improving natural photosynthesis can enable the sustainable production of chemicals. However, neither purely artificial nor purely biological approaches seem poised to realize the potential of solar-to-chemical synthesis. We developed a hybrid approach, whereby we combined the highly efficient light harvesting of inorganic semiconductors with the high specificity, low cost, and self-replication and -repair of biocatalysts. We induced the self-photosensitization of a nonphotosynthetic bacterium, Moorella thermoacetica, with cadmium sulfide nanoparticles, enabling the photosynthesis of acetic acid from carbon dioxide. Biologically precipitated cadmium sulfide
nanoparticles served as the light harvester to sustain cellular metabolism. This self-augmented biological system selectively produced acetic acid continuously over several days of light-dark cycles at relatively high quantum yields, demonstrating a self-replicating route toward solar-to-chemical carbon dioxide reduction.


Abstract: This report presents the permanent draft genome sequence of Desulfurococcus mobilis type strain DSM 2161, an obligate anaerobic hyperthermophilic crenarchaeon that was isolated from acidic hot springs in Hveravellir, Iceland. D. mobilis utilizes peptides as carbon and energy sources and reduces elemental sulfur to H2S. A metabolic construction derived from the draft genome identified putative pathways for peptide degradation and sulfur respiration in this archaeon. Existence of several hydrogenase genes in the genome supported previous findings that H2 is produced during the growth of D. mobilis in the absence of sulfur. Interestingly, genes encoding glucose transport and utilization systems also exist in the D. mobilis genome though this archaeon does not utilize carbohydrate for growth. The draft genome of D. mobilis provides an additional mean for comparative genomic analysis of desulfurococci. In addition, our analysis on the Average Nucleotide Identity between D. mobilis and Desulfurococcus mucosus suggested that these two desulfurococci are two different strains of the same species.


Abstract: Fluorescence probes are now widely used as indispensable tools in many cell functional analyses. At present, the design of fluorescent probes largely depends on the limited numbers of established sensing mechanisms such as photo-induced electron transfer (PET), photo-induced charge transfer (PCT), and fluorescence resonance energy transfer (FRET). Although these mechanisms are versatile in metal ion sensing, introduction of a new sensing mechanism is highly desirable not only to design a more sophisticated probe with high selectivity and sensitivity but also to expand the diversity of the sensing targets to unveil biological phenomena. In this article, we report the design of dual emission fluorescent probes for metal ions based on a unique fluorescence-sensing mechanism. The fluorescent probes incorporating this sensing mechanism displayed a large emission red-shift on complexation with metal ions such as Cd(II) and Ag(I). X-ray crystallography and theoretical computational calculations of the Cd(II) and Ag(I) complexes revealed that the emission shift was induced by non-coordination contact between the aromatic ring of fluorophore and the metal ion (arene-metal ion contact; AM-contact), which modulates the energy levels of molecular orbitals. The fluorescent probe was successfully applied to in cell ratiometric bioimaging of bioactive hydrogen sulfide (H2S). These successful applications highlight the usefulness of this sensing mechanism in biological fluorescence analysis.


Abstract: Hydrogen sulfide (H2S) is a gasotransmitter that has been described to affect the membrane potential of neurons in a number of brain areas. Using whole cell patch-clamp electrophysiological techniques, we investigated the effects of H2S on the membrane potential of neurons in the nucleus of the solitary tract (NTS). Whole cell patch clamp recordings were obtained from 300microm coronal NTS brain slices and bath application of the H2S donor, sodium hydrosulfide (NaHS)(1mM, 5mM and 10mM) was shown to have clear concentration-dependent, reversible, depolarizing effects on the membrane potential of 95% of neurons tested (72/76), an effect which in 64% (46/72) of these responding neurons was followed by a hyperpolarization. In the presence of the
voltage-gated sodium channel blocker tetrodotoxin (TTX) and the glutamate receptor antagonist kynurenic acid (KA), these depolarizing effects of 5 mM NaHS (5.0+/−2.2 mV (n=7)) were still observed, although they were significantly reduced compared to regular aCSF (7.7+/−2.0 mV (n=7), p*<0.05, paired t-test). We also demonstrated that hyperpolarizations in response to 5mM NaHS resulted from modulation of the KATP channel with recordings showing that following KATP channel block with glibenclamide these hyperpolarizing effects were abolished (Control -7.9+/−1.2 mV, Glibenclamide -1.9+/−0.9 mV (n=8) p<0.05, paired t-test). This study has for the first time described post-synaptic effects of this gasotransmitter on the membrane potential of NTS neurons and thus implicates this transmitter in regulating the diverse autonomic systems controlled by the NTS.


Abstract: Hydrogen sulfide (H2S) is an important gaseous transmitter in organisms. It widespreads in the organs and tissues of animals and participates in the biological process of cardiovascular relaxation, cell apoptosis and protection, inflammation and neuromodulation. H2S also can be synthesized in plants system and is involved in stress responses and the biological process of growth and development. This review describes the synthesis and biological function of H2S in plants. Based on our research for the adaptation of Lamiophlomis rotata to different altitude gradients, we firstly proposed H2S plays an important role in the adaptation of Lamiophlomis rotata to alpine environment.


Abstract: Lake County, California, is in a high geothermal-activity area. Over the past 30 years, the city of Clearlake has reported health effects and building evacuations related to geothermal venting. Previous investigations in Clearlake revealed hydrogen sulfide at levels known to cause health effects and methane at levels that can cause explosion risks. The authors conducted an investigation in multiple cities and towns in Lake County to understand better the risk of geothermal venting to the community. They conducted household surveys and outdoor air sampling of hydrogen sulfide and methane and found community members were aware of geothermal venting and some expressed concerns. The authors did not, however, find hydrogen sulfide above the California Environmental Protection Agency air quality standard of 30 parts per billion over one hour or methane above explosive thresholds. The authors recommend improving risk communication, continuing to monitor geothermal gas effects on the community, and using community reports and complaints to monitor and document geothermal venting incidents.


Abstract: Old Mystery Solved For 170 years the true identities of the red-violet and blue transient intermediates of the Gmelin reaction between nitroprusside and hydrogen sulfide have remained unknown and often disputed in the literature. In their Communication on page 17172 ff., Wu et al. report the structural elucidation of these colorful but rather unstable compounds in this historically important chemical reaction.


Abstract: INTRODUCTION/OBJECTIVE: Ureteral obstruction is a common pathology and causes kidney fibrosis and dysfunction at late period. In this present study, we investigated the antifibrotic and antiinflammatory effects of hydrogen sulfide on kidney damage after unilateral ureteral obstruction (UOU) in rats. MATERIALS AND METHODS:
24 rats were divided into four groups. Group 1 was control, group 2 was sham, group 3 included rats with UUO and group 4 rats with UUO which were given sodium hydrogen sulfide (NaHS)-exogenous donor of hydrogen sulfide (intraperitoneally 56micromol/kg/day). After 14 days, rats were killed and their kidneys were taken and blood analysis was performed. Tubular necrosis, mononuclear cell infiltration and interstitial fibrosis were determined histopathologically in a part of the kidneys; nitric oxide (NO), malondialdehyde (MDA) and reduced glutathione (GSH) levels were determined in the other part of the kidneys. Urea-creatinine levels were investigated by blood analysis. Statistical analyses were made by the Chi-square test and one-way analysis of variance (ANOVA). RESULTS: There was no significantly difference for urea-creatinine levels among groups. Pathologically, there was serious tubular necrosis and fibrosis in group 3 and there was significantly decreasing of tubular necrosis and fibrosis in group 4 (p<0.005). Also, there was significantly increase of NO and MDA levels and decrease of GSH levels in group 3 compared to other groups (p<0.005). CONCLUSIONS: hydrogen sulfide prevents kidney damage with antioxidant and antiinflammatory effect

(75) Yamaguchi T, Hanabusa M, Hosoya N, Chiba T, Yoshida T, Morito A. Enamel surface changes caused by hydrogen sulfide. J Conserv Dent 2015 Nov;18(6):427-30. Abstract: BACKGROUND: Volatile sulfur compounds (VSCs) produced inside the mouth are a well-known cause of halitosis. Recent studies have suggested that VSCs modify the pathology of periodontitis by encouraging the migration of bacterial toxins associated with increased permeability of gingival epithelia, and enhancing the production of matrix metalloproteinases in gingival connective tissue. Nonetheless, the effects on the enamel of direct exposure to VSCs within the oral cavity remain unclear. In the present study, we observed the effects of VSCs in the form of hydrogen sulfide (H2S) on enamel surfaces and determined their effects on restorations. MATERIALS AND METHODS: Extracted human tooth and bovine tooth samples were divided into the H2S experimental side and the control side. We observed the effects of H2S on enamel surfaces using electron microscopy and conducted a shear test. RESULTS: We found that exposure to H2S obscured the enamel surface's crystal structure. The surface also exhibited coarseness and reticular changes. Shear testing did not reveal any differences in bond strength. CONCLUSIONS: Our findings suggested that H2S occurring inside the mouth causes changes to the crystal structure of the enamel surface that can lead to tooth wear, but that it does not diminish the effects of dental bonding in adhesive restorations

(76) Katoch A, Kim JH, Kim SS. CuO/SnO2 Mixed Nanofibers for H2S Detection. J Nanosci Nanotechnol 2015 Nov;15(11):8637-41. Abstract: In this work we report the synthesis of copper oxide/tin oxide (CuO/SnO2) mixed nanofibers and their gas sensing properties in terms of H2S gas. The CuO/SnO2 mixed nanofibers were synthesized by electrospinning technique using two needles. Based on the thermogravimetric-differential thermal analysis, the calcination temperature was optimized at 700 degrees C to acquire both phases of CuO and SnO2. With this method, intermixed nanofibers of SnO2 and CuO were obtained. The sensing properties of the CuO/SnO2 mixed nanofibers to H2S are investigated as functions of operating temperature and gas concentration. The CuO/SnO2 mixed nanofibers were highly sensitive towards H2S with a response 522 for 10 ppm H2S and a response time 1 s at 300 degrees C. The semiconductor-metal transition of CuO due to H2S is likely to the reason of the high H2S response. The results evidently demonstrate that the CuO/SnO2 mixed nanofibers synthesized with double needles are a promising sensor material for detection of H2S

pattern transfer process in addition to defect density, line edge/width roughness, etc. In this study, sulfur containing plasma treatment was used to modify the BCP and the effects of the plasma on the properties of plasma treated BCP were investigated. The polystyrene hole pattern obtained from polystyrene polystyrene-block-poly(methyl methacrylate) (PS-b-PMMA) was initially degraded when the polystyrene hole was annealed at 190 degrees C for 15 min. However, when the hole pattern was treated using sulfur containing plasmas using H2S or SF6 up to 2 min, possibly due to the sulfurization of the polystyrene hole surface, no change in the hole pattern was observed after the annealing even though there is a slight change in hole shapes during the plasma treatment. The optimized plasma treated polystyrene pattern showed the superior characteristics as the mask layer by showing better thermal stability, higher chemical inertness, and higher etch selectivity during plasma etching.

(78) Zhang W, Zhang Z, Yang W. Stability and Electronic Properties of Hydrogenated MoS2 Monolayer: A First-Principles Study. J Nanosci Nanotechnol 2015 Oct;15(10):8075-80. Abstract: First-principles total energy studies are used to investigate the stability of hydrogenated MoS2 monolayer (MoS2-Hx) (x = 1-8), which is a compound with different numbers of H atoms adsorbed on the MoS2 surface. Energetically, the S-top side of the MoS2 is found to be the most favorable for H-adsorption. H2S and graphene are well-known to be stable, and MoS2-Hx is predicted to be even more stable because its binding energy is lower than that of H2S and its formation energy and adsorption energy are lower than those of graphene. The analysis of the electronic density distribution and the orbital hybrid also shows that MoS2-Hx forms stable structures. In addition, the influence of the number of the adsorbed H-atoms in the MoS2-Hx on the electronic structure of the compound is also investigated. The MoS2-Hx band structure exhibits a dispersion and the MoS2-Hx band gap gradually decreases from 1.72 eV to 0 eV as the number of adsorbed H atoms increases. The corresponding work function increases as a result of the strengthening of the dipole moment formed between the H atoms that are adsorbed and the hydrogenated MoS2.

(79) Wang X, Wang B, Huang Q, Zhang B, Hua Z. [Regulation of hydrogen sulfide on transporter protein Bsep and Mdr2 in acute liver failure]. Zhonghua Yi Xue Za Zhi 2015 Oct;95(39):3176-9. Abstract: OBJECTIVE: To observe the effect of hydrogen sulfide on Bsep and Mdr2 in acute liver failure induced by thioacetamide. METHODS: Twenty-four male SD rats were randomly divided into thioacetamide (TAA) induced model group (n=6), control group (n=6), TAA+sodium hydrosulfide group (n=6), and TAA+ propargylglycine group (n=6). TAA was given to enterocoelia at the dose of 600 mg/kg for the model group, sodium hydrosulfide group and propargylglycine group rats. Sodium hydrosulfide with the dose of 0.15 mmol/kg and propargylglycine of 30 mg/kg was injected into enterocoelia one hour before the TAA used. All rats were sacrificed and serum specimen was collected to test hydrogen sulfide and hepatic function. The method of Western blot and Immunohistochemistry were used to measure the expression of Bsep and Mdr2 in the liver. RESULTS: The Liver function of TAA group rats was severely injured [ALT(524.0+/-32.0) vs (28.3+/-8.4) U/L]. It was worsened by application of sodium hydrosulfide [ALT(861.9+/-55.1) U/L] while recovered [ALT(59.5+/-10.2) U/L] by propargylglycine. The level of bilirubin and bile acid was significantly higher in the TAA group rats than in the normal control group, and the application of sodium hydrosulfide caused bile acids increased further besides of bilirubin. On the contrary, the levels of bile acids and bilirubin were significantly decreased with PPG application. The level of hydrogen sulfide in the serum of the TAA group rats was higher than normal group rats. That was elevated by sodium hydrosulfide and decreased by propargylglycine. Severely edema, necrosis and inflammatory cell infiltration were observed in TAA group rats, which worse by sodium hydrosulfide and released by propargylglycine. The expression of Bsep and Mdr2 down regulated in TAA and deteriorated by sodium hydrosulfide application and relieved by
propargylglycine application. CONCLUSION: Hydrogen sulfide exacerbated the Bsep and Mdr2 loss in the liver failure and contributed to high serum concentration of bile acids.

(80) Wang Y, Xu LY, Wang SF, Xiao F, Jia YF. [XAS Analysis upon Dissolved Species of Orpiment in Anoxic Environment]. Huan Jing Ke Xue 2015 Sep;36(9):3298-303. Abstract: The orpiment[As2S3(s)] is an important secondary mineral in the geochemical process of arsenic in the environment. The study upon orpiment dissolution is important to investigate the migration and transformation of arsenic in the environment. The environmental pH and sulfur content have vital influence on species changing and stability of arsenic species in orpiment. Here we analyzed the stable arsenic species of anoxic orpiment dissolution in sulfidic and the absence of sulfide solutions at neutral condition with simulation test via X-ray absorption near edge spectroscopy(XANES) and extended X-ray absorption fine structure(EXAFS). The results showed that orpiment dissolution contained a mixture of arsenite and thioarsenite species at neutral condition, and arsenic species in sulfidic solutions is mainly thioarsenic, while arsenic species in the absence of sulfide solutions is oxythioarsenic. The results of Linear Combination of Fits showed that arsenic species were arsenite (88.2%) and thioarsenite(11.8%) in sulfidic solutions, and there were arsenite (56.3%) and thioarsenite(43.7%) in the absence of sulfide solutions. Our results confirmed that the formation of arsenite was related to the total sulfur to total arsenic ratios, and the form of thioarsenite species could be enriched by increasing of the total sulfur to total arsenic ratio.

(81) Ding ZJ, Wang PH, Li ZJ, Du B, Guo L, Yu JH. [Analysis of H2S/PH3/NH3/AsH3/Cl2 by Full-Spectral Flame Photometric Detector]. Guang Pu Xue Yu Guang Pu Fen Xi 2015 Jul;35(7):2025-8. Abstract: Flame photometric analysis technology has been proven to be a rapid and sensitive method for sulfur and phosphorus detection. It has been widely used in environmental inspections, pesticide detection, industrial and agricultural production. By improving the design of the traditional flame photometric detector, using grating and CCD sensor array as a photoelectric conversion device, the types of compounds that can be detected were expanded. Instead of a single point of characteristic spectral lines, full spectral information has been used for qualitative and quantitative analysis of H2S, PH3, NH3, AsH3 and Cl2. Combined with chemometric method, flame photometric analysis technology is expected to become an alternative fast, real-time on-site detection technology to simultaneously detect multiple toxic and harmful gases.

(82) Steen IH, Dahlle H, Stokke R, Roalkvam I, Daae FL, Rapp HT, et al. Novel Barite Chimneys at the Loki’s Castle Vent Field Shed Light on Key Factors Shaping Microbial Communities and Functions in Hydrothermal Systems. Front Microbiol 2015;6:1510. Abstract: In order to fully understand the cycling of elements in hydrothermal systems it is critical to understand intra-field variations in geochemical and microbiological processes in both focused, high-temperature and diffuse, low-temperature areas. To reveal important causes and effects of this variation, we performed an extensive chemical and microbiological characterization of a low-temperature venting area in the Loki’s Castle Vent Field (LCVF). This area, located at the flank of the large sulfide mound, is characterized by numerous chimney-like barite (BaSO4) structures (<1 m high) covered with white cotton-like microbial mats. Results from geochemical analyses, microscopy (FISH, SEM), 16S rRNA gene amplicon-sequencing and metatranscriptomics were compared to results from previous analyses of biofilms growing on black smoker chimneys at LCFV. Based on our results, we constructed a conceptual model involving the geochemistry and microbiology in the LCFV. The model suggests that CH4 and H2S are important electron donors for microorganisms in both high-temperature and low-temperature areas, whereas the utilization of H2 seems restricted to high-temperature areas. This further implies that sub-seafloor processes can affect energy-landscapes, elemental cycling, and the metabolic activity of primary producers on the seafloor. In the cotton-like microbial mats on top of the active barite chimneys, a unique network of single
cells of Epsilonproteobacteria interconnected by threads of extracellular polymeric substances (EPS) was seen, differing significantly from the long filamentous Sulfurovum filaments observed in biofilms on the black smokers. This network also induced nucleation of barite crystals and is suggested to play an essential role in the formation of the microbial mats and the chimneys. Furthermore, it illustrates variations in how different genera of Epsilonproteobacteria colonize and position cells in different vent fluid mixing zones within a vent field. This may be related to niche-specific physical characteristics. Altogether, the model provides a reference for future studies and illustrates the importance of systematic comparative studies of spatially closely connected niches in order to fully understand the geomicrobiology of hydrothermal systems.


Abstract: Hydrothermal vents are thermally and geochemically dynamic habitats, and the organisms therein are subject to steep gradients in temperature and chemistry. To date, the influence of these environmental dynamics on microbial sulfate reduction has not been well constrained. Here, via multivariate experiments, we evaluate the effects of key environmental variables (temperature, pH, H2S, [formula: see text], DOC) on sulfate reduction rates and metabolic energy yields in material recovered from a hydrothermal flange from the Grotto edifice in the Main Endeavor Field, Juan de Fuca Ridge. Sulfate reduction was measured in batch reactions across a range of physico-chemical conditions. Temperature and pH were the strongest stimuli, and maximum sulfate reduction rates were observed at 50 degrees C and pH 6, suggesting that the in situ community of sulfate-reducing organisms in Grotto flanges may be most active in a slightly acidic and moderate thermal/chemical regime. At pH 4, sulfate reduction rates increased with sulfide concentrations most likely due to the mitigation of metal toxicity. While substrate concentrations also influenced sulfate reduction rates, energy-rich conditions muted the effect of metabolic energetics on sulfate reduction rates. We posit that variability in sulfate reduction rates reflect the response of the active microbial consortia to environmental constraints on in situ microbial physiology, toxicity, and the type and extent of energy limitation. These experiments help to constrain models of the spatial contribution of heterotrophic sulfate reduction within the complex gradients inherent to seafloor hydrothermal deposits.


Abstract: Being a salt sensitive crop, rice growth and development are frequently affected by soil salinity. Hydrogen sulfide (H2S) has been recently explored as an important priming agent regulating diverse physiological processes of plant growth and development. Despite its enormous prospects in plant systems, the role of H2S in plant stress tolerance is still elusive. Here, a combined pharmacological, physiological and biochemical approach was executed aiming to examine the possible mechanism of H2S in enhancement of rice salt stress tolerance. We showed that pretreating rice plants with H2S donor sodium bisulfide (NaHS) clearly improved, but application of H2S scavenger hypotaurine with NaHS decreased growth and biomass-related parameters under salt stress. NaHS-pretreated salt-stressed plants exhibited increased chlorophyll, carotenoid and soluble protein contents, as well as suppressed accumulation of reactive oxygen species (ROS), contributing to oxidative damage protection. The protective mechanism of H2S against oxidative stress was correlated with the elevated levels of ascorbic acid, glutathione, redox states, and the enhanced activities of ROS- and methylglyoxal-detoxifying enzymes. Notably, the ability to decrease the uptake of Na(+) and the Na(+)/K(+) ratio, as well as to balance mineral contents indicated a role of H2S in ion homeostasis under salt stress. Altogether, our results highlight that modulation of the level of endogenous H2S genetically or exogenously could be employed to attain better...
growth and development of rice, and perhaps other crops, under salt stress. Furthermore, our study reveals the importance of the implication of gasotransmitters like H2S for the management of salt stress, thus assisting rice plants to adapt to adverse environmental changes.